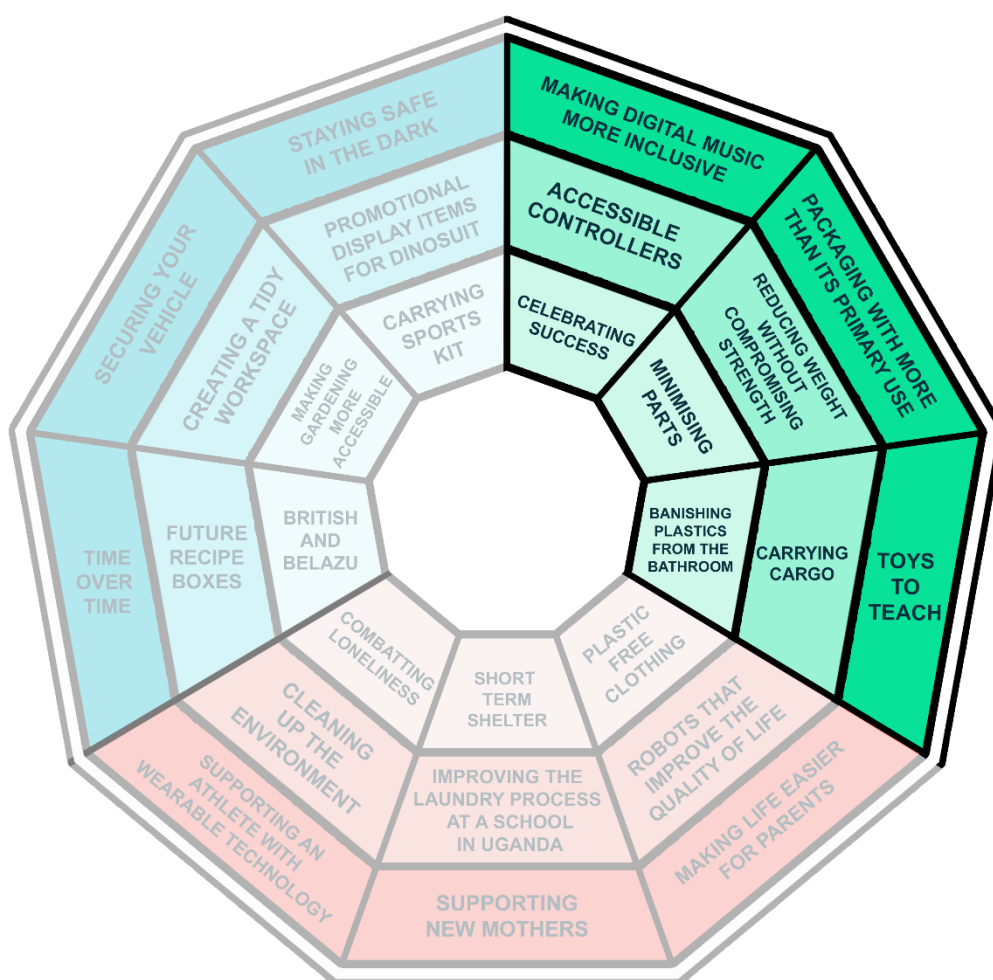


INSPIRED BY INDUSTRY

Carrying cargo

#InspiredbyPure



PURE
ELECTRIC

Introduction

This context has been put together to allow for a range of opportunities for students to explore how they can design a system for carrying cargo on a bike, scooter, e-scooter or similar. Whilst the company (Pure Electric) focuses on the creation of electric scooters, the same intent could be applied to any aspect of personal transport.

Materials

Because of this very open context, there is the scope to use a wide range of materials. In some ways, the exploration of a range of materials may be key to meeting the brief. There is the opportunity to look at small-scale trials of components or whole products in the pursuit of component or material reducing outcomes. Depending on how confident the group are, it may be advisable to constrain it to identifying the cargo – small items such as tyre pump, lock etc, or possibly give them a small range to choose from. Similarly, you may wish to explore a free choice. As with many of the contexts you may also wish to consider the possibility of group work for this context. There is a good opportunity to explore physical and virtual modelling in this context, and also the opportunity to engage in destructive testing and links to testing and experiments in science.

Potential outcomes

The outcomes are prototypes but will require testing in terms of their function and performance as well as being measurable in terms of size and weight. One of the main elements of interest with this context is the accessibility and relevance to students who are all likely to have ridden a bicycle, scooter or similar, and may do so daily. The opportunity to test the attachment to the cycle/scooter as well as testing its capability to hold it is fundamental. You may want to bring in a cycle / scooter into the class to allow students to measure and test using this. Whilst the final outcome may not be of shop-bought quality it also opens up for a more conceptual route with CAD renders of the appearance the manufactured product may take (consider using AI to render a photo of the students' prototype).

It is important that students are given some freedom and choice within this context and so outcomes should vary between students / groups. You may decide to limit your class to 2-3 possible outcomes as mentioned above.

Examples may include (but not be limited to):

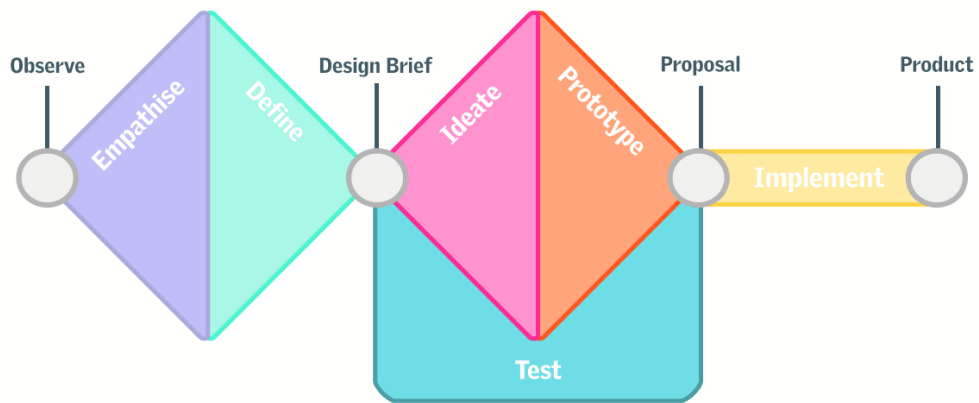
Holder for a cycle pump, new water-bottle carrier, utilising the water-bottle attachment hols, fabric carry case, emergency kit carrier, fashionable basket, water-proof cover and cargo.

Connection to the frame / body of the vehicle is likely to be a key area. This may mean precise fabrication following some accurate measuring (consider introducing micrometers, callipers etc) and exploration of different fastening in alternative locations (handle bars, cross bar, frame etc). The versatility of fabrics and fabric fastenings can be explored here to allow for an adjustable connection to a variety of sized cycles / scooters. It may also allow for a multi-material product e.g. fabrics and polymers.

Consider sharing work on social media using the hashtag #InspiredbyPure

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.



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.
- Buy in / collect existing methods of carrying cargo This may be cycle baskets, holders for pumps, panniers and more. How do they connect? Do they damage the cycle/scooter? How much do they hold? Do they protect the contents from weather, damage, theft?
- 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 and identifying problems.
- Trying not to have preconceived ideas is hard. You may want to consider students tackling an unusual cargo e.g. blood for donation, a pizza(s), eggs, the scooter charger, a helmet...
- Trying various aspects as a group can also be useful – using and analysing existing equipment for example, then sharing thoughts and feedback.
- Collaboration software such as Miro, or Google/Microsoft collaboration can be good to use to collate ideas from all.
- Students should get as much information to help them later in the challenge. They may present this in any way they wish. This may be products that are similar in terms of connecting to a circular frame, or how certain things are carried. Where possible, exploring actual physical products is often best.
- When looking at a range of different furniture applications it is an opportunity for students to look at Gantt charts and similar, to identify comment features or attributes as well as planning their time and highlight any possible issues that may arise.
- Pure have a website [here](#) that you may wish to explore to match styles / branding.
- You will also find some YouTube videos on how people have tackled this problem (that may or may not help!).

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 problems (and/or cargo) identified. Identifying the user and their needs rather than being really generic is likely to help. It may be a certain profession or task that currently uses a car or motorcycle as using a cycle or e-scooter isn't practical.
- For this stage, you may possibly constrain it to ensure students are working with materials and processes you wish to cover in the unit of work. There will still be plenty of opportunity for designs, testing, iteration etc.
- 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 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'.

- Material properties (without stating the actual material) is useful. Consider what cargo requirements there are, requirements of the cycle / scooter, will it need to be weather-proof, prevent damage to the 'vehicle', available in different colours / patterns, resist bumps and bashes?

Ideate stage

- Encourage students to think wide initially. No ideas are too silly, too big (although you may wish to limit the actual size of the final outcome due to budget constraints amongst others).
- Ideas can be generated through making. Get students working with the 'vehicle' early on. Consider having several cycles / scooters in the class to work with. These may be the frames only. Students can model directly on the product to get a true idea of size, scale and possibilities.
- Whilst *function* is arguably more important than *form* in this instance, the outcome can also be a re-design / update of an existing product. How can a cycle basket be made desirable? This may open opportunities for sketching organic shapes and representing different materials such as fabrics and plastics.
- There are a range of videos on YouTube to help students with sketching techniques. [HERE](#)
- 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.
- Get students to keep sketching. It may not be the whole item, it may be parts of it – a fastening or ways to open the cargo holder.
- 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.
- Research may be needed at this stage. Consider a handling collection of products that do a similar job such as phone holders for runners. Can they think of things that do a similar job and bring them in?
- Ideas don't have to be revolutionary and completely new. It may be to carry an unusual item of cargo, maybe a new user? Consider 'development' with your class. Maybe they can start with an existing product and improve it. This [VIDEO](#) is a good introduction to this for older students / teachers.
- You may wish to provide a sample of fastenings to use as a head-start to the design process, rather than students designing the whole thing.

Prototype stage

- Getting students to realise when and why to make a prototype is key. What are they looking to prove / disprove in the model? Linking the prototype method with the problem is a good task.
- Prototypes may be part (e.g. a fastening) or the entire product.
- If using fabric, consider modelling from Dipryl or scrap fabrics to get an idea of shape, size and construction.

- You may wish to ‘cut and shut’ models by taking apart existing products. Consider asking the school community to donate old related products to allow this.
- 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](#) is available for schools/students
- There are some good Autodesk Fusion tutorials [HERE](#) and TinkerCad [HERE](#)
- Consider asking stakeholders / users to give some feedback on the prototypes, as they are being developed and at the testing stage. You may want to get in touch with a cycle shop for this.
- CAD models may be explored for fastenings (think 3D printed clips / joints), but similarly lay plans for fabric patterns which could be laser-cut.
- Investigating properties of materials lends itself well to this context. Students will naturally test items in the next stage, and so learning about a range of properties is useful.
- You may wish to explore a range of manufacturing methods to showcase what is possible within a school workshop. This may include (amongst others) vacuum forming for a shell casing, brazing / soldering a wire frame, 3D printing around a water bottle shape, cutting screw threads to allow connection to the water bottle mount.
- You may want to share this brief [video](#) from Reekon tools that show the variety and quantity of models that a company may produce.

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. Testing on the ‘vehicle’ itself is really important. Does it act differently when in motion?
- Test in as many different scenarios as possible to ensure you get realistic feedback. Observe how users are interacting with the product and use these observations to add more detail to your questions for feedback.
- Consider whether you need to test with static or dynamic tests, and show students the difference between these. This [short video](#) helps to explain, using a can to illustrate it.
- Be sure to record the testing results, either in data form, written test or use digital audio and video to record. You may wish to get students to do lab-testing (testing in the classroom) and also field testing (testing with a user).
- Draw on approaches from science here. It may be worth speaking with a science colleague to replicate how students predict and record experiments. Doing this using similar methods will help to reinforce the learning.
- Consider AR (Augmented Reality). If you use windows, PAINT 3D allows you to open .obj files and students can then view their design on an e-scooter to see how it may appear.
- To help students that are **reluctant to improve their idea**, consider prompts such as “What if money was no object?” “What if you could only use locally sourced

materials?" "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?"

- This could be a good opportunity to explore mathematical content by getting students to calculate amount of material used, costs etc. Some programs such as Autodesk Fusion allow you to calculate the amount of material you have used [HERE](#).
- 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?
- 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, safety etc.

Implement stage

- The implement stage is when a prototype is put into production.
- This is an opportunity to reinforce that a prototype outcome is only one stage in the creation of a product.
- What processes are required to convert that prototype into a commercially available product?
- What manufacturing processes used to create the prototype would need to be re-evaluated for a larger scale of production?
- Would this involve reconsidering the materials and components used?
- This is a good opportunity to introduce industrial manufacturing processes that are not used in the classroom. It will undoubtedly need some support from you as a teacher.
- There is an opportunity to explore a business plan here looking at the sales cost including a variety of elements such as packaging, shipping, marketing and more, to give students an insight into bringing a product to market.
- Reducing material is important to minimise environmental impact and to make things easier to transport. Consider working in pairs / small groups to critique designs / prototypes and what could be done to make it lighter, smaller etc to potentially minimise environmental impact. You may want to look at a simple [Life Cycle Analysis](#) to assess the impact from material extraction to disposal.
- As a conclusion to the unit, you could get students to create an advertising campaign / promotional feature to sell their new product. Consider giving students free reign with regards to platform and media. They may surprise you with their ability to produce content!

Focused Tasks

'Visuals vs function'	'AI visuals'	'Attached canvas'	'Micro carrier'
Use CAD to create early idea concepts and use rendering or AI to visualise the finished product. Make a functional model or prototype and present both to show your vision without spending a long time making a finished prototype.	Using online tools such as Vizcom.ai or iPad apps such as Hypersketch, experiment with generative design and text prompts to visualise your final commercial product using your own sketches and photos of simple models.	Whilst not on e-scooters, bicycles often have the option for a water bottle carrier. Make a new carrier prototype that uses this water bottle mount. Using an attached canvas of a water bottle / other product, design around this for a perfect fit.	Often it's small items that need carrying – pumps, mobile phones, house keys. Consider using scrap water-proof fabrics to make a simple carrier that connects to the handlebars or similar. Fabric may include old tent fabric / advertising banners or waterproof clothing.
'Radar charts'	'Screw threads'	'Pricing'	'Metal bottle holder'
Provide (or collect) data for students to create their own radar chart as a way of making a visual judgement. This can be using Excel or similar.	Demonstrate how to add an external screw thread to a bar, allowing it to be screwed into the bottle mount of a bicycle frame, utilising this area for attaching something.	As a class, explore the potential costs of a simple product. This may be a previously made student product. What did the materials cost? What about paying the manufacturer, adding on sales %. What would it cost to sell?	Using wire, create a simple design for a bottle holder for a bicycle. Can a single piece be bent to hold it and then brazed onto a flat to mount to a bicycle. Consider powder coating the final piece.

Investigative and Evaluative Activities

'Bag analysis'	'CAD testing'	'Material tests'
Looking at bags / holdalls / suitcases can allow for students to know how to carry out research as well as gain valuable inspiration. Consider getting a few varieties of bags / suitcases and carry out a product analysis. Students could deem what is frustrating and beneficial about them. This may be scuffing, storage when empty, ease of use, weight, allowing you to fit	FEA (Finite Element Analysis) is a form of virtual stress testing built into many CAD packages. Using the 3D CAD model from the focused tasks, use the FEA in your CAD package to test the model by applying forces to it.	The cargo system could be a combination of hard and soft materials, but this means there is a wide range of possibilities. What materials are available to you? The context allows an opportunity to explore properties of materials by carrying out a range of tests. Is it water-proof or splash-proof? How can you test durability? What tests / properties are necessary / useful? For example, even when thinking of suitcases, are hard-shells preferable to soft? Lots of discussion point opportunities here.

in large amounts / awkward shapes etc.		
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