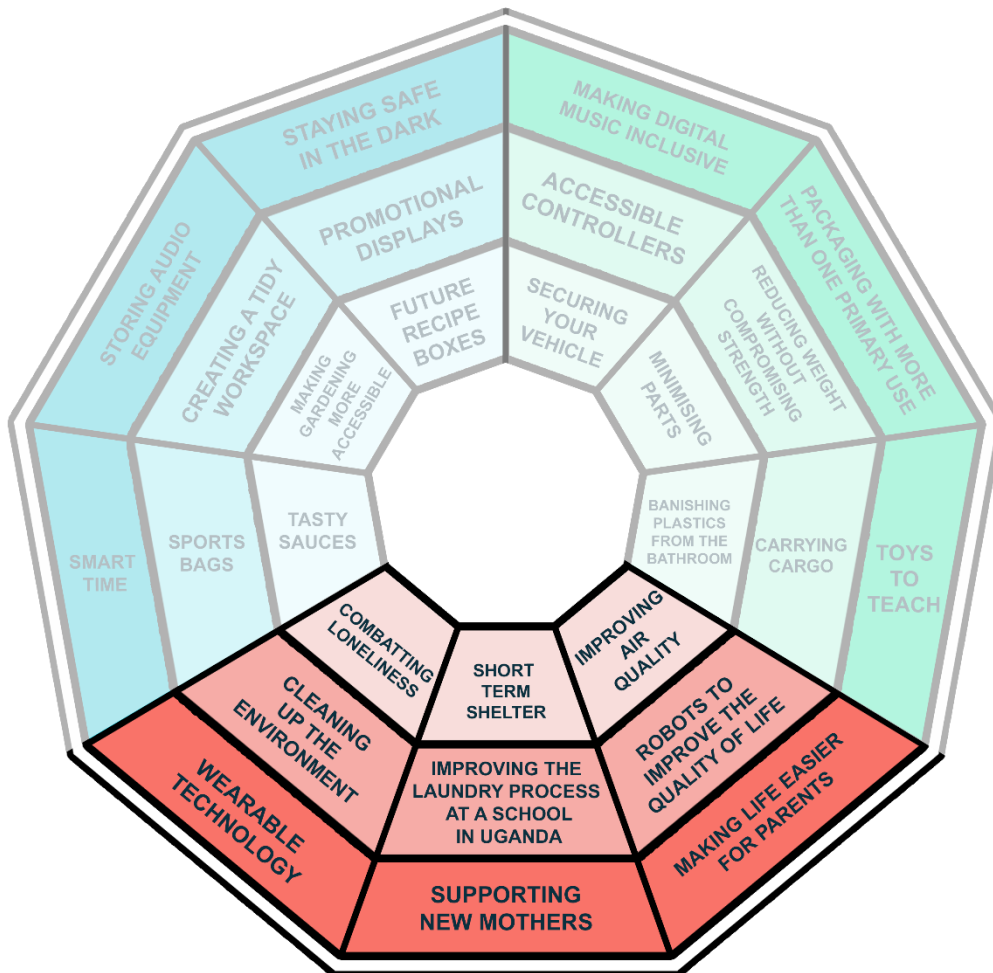


INSPIRED BY INDUSTRY

Short-term shelter

#InspiredbyTheRAF



 **ROYAL
AIR FORCE**

Introduction

This context has been put together to allow for a range of opportunities for students to explore how shelters can be designed to meet the needs of a range of situations. Whilst The RAF approach this from a humanitarian need, such as responding to emergencies, students can identify any situation where temporary shelters might be required.

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 and their properties may be key to meeting the brief. You may want to consider looking at small tests of them to check their insulating properties, water-proof etc. 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 potentially one situation or application– such as a pop-up market stall. Similarly, group work may be possible for this context especially of exploring larger structures for human accommodation with utilities. There is a good opportunity to explore mechanical systems for collapsible structures, and also the opportunity to engage in some destructive testing and links to testing and experiments in science for structural integrity.

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. The teacher may decide to take a more conceptual route and look at a non-working prototype, exploring CAD functions such as mechanical assemblies and FEA to virtually test structures. This can also be condensed into a 'classic' team-building exercise similar to those done in the Scouts and outdoor pursuits creating an outdoor shelter in the woods, tested with a bucket of water thrown over! Similarly using (for example) only corrugated card, as a team, how long can someone remain dry/undercover. These competition elements may be a different approach to regular D&T lessons/units.

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

Examples may include (but not be limited to):

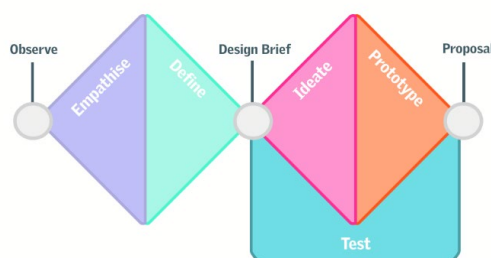
Pop up stalls, emergency shelters, homelessness shelter, pet-carriers etc.

Consider any type of shelter where the whole structure or components can be collapsed, folded etc.to enable easier transporting and/or storage of the shelter.

Consider sharing work on social media using the hashtag #InspiredbyTheRAF

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.
- Access to users with a need for shelter would be useful for the initial research. Consider using examples of recent events such as natural disasters and/or conflicts. However, there is also the opportunity to consider one-off events such as fetes, shows, even 'activities' such as taking an animal to a vet or protecting plants from the frost?
- If looking at shelter for a different environment, Google Maps and 'street view' can allow students to explore the terrain in greater detail. This could be a flipped learning opportunity. You may want to discuss with the geography department to see if there is a cross-curricular opportunity here, possibly working on a recent or future topic and can align.
- 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 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.
- When looking at a range of different 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.
- Consider getting inspiration from a range of sources and products, not just those related to the context.

Define stage

- This is where students try to get the real root of the problem and decide what they are going to do.
- You/students may wish to base it on improving an existing product. For example, you could get a [cardboard pet carrier](#) and analyse it before looking to improve it. The improvements may be minimal/superficial but still an opportunity for model-making, iteration, testing etc.
- There may be a whole range of problems identified. Identifying the user and their needs as well as constraints or barriers to making lighter equipment may help.
- Remember that The RAF are part of the armed forces and not a company, nor do they design the products they use. For this reason, it's even more important that they can clearly communicate their specific needs to the designers.
- 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.
- Whilst it may not be applicable at this stage initially, defining costs for an existing solution and then comparing it with their proposal could be useful.

- A technical specification would be useful to ensure the shelter meets the needs of the user and the environment it will be used in.
- As a teacher you will need to consider constraints such as material usage/size and may need to add limitations at this stage yourself to ensure outcomes are realistic.
- Consider running a 'competition' or team-building exercise of creating a shelter from found materials (PVC tarpaulin, corrugated card etc) and test with foam balls and a watering can (to recreate a storm)?

Ideate stage

- For the ideation stage, you may be drawing on existing ideas (e.g., improving an existing product) rather than starting from scratch.
- Consider giving students the initial freedom of how to approach their ideas. For example, it may be CAD, a card model or a sketch. Giving students autonomy of how to approach their designs will prevent them feeling restricted. Working in groups can help generate creative ideas.
- You may wish to show students examples of where temporary shelters have been used and possibly collapsible structures used in portable shelters.
- Consider pre-making and demonstrating/testing a few designs. For example, create some folding linkages or 'pop up' structures.
- Consider that expanding the function of a product through modular, expandable and multi-functional approaches is another way of looking at the context.
- Encourage students to annotate elements of their drawings – things like WHY it's that big, WHY it's that shape, WHY it has holes where it does (for example), How they are proposing to flat pack or reduce the shelter for storage etc.
- A range of techniques such as 2D, 3D, Exploded and cross sections are good. It is likely that for this unit, 3D drawings may not be the most useful viewpoint for the product being designed, and instead, 2D / cross sections are more beneficial.
- It is likely that physical modelling will be one of the most useful elements for this context, and so having reusable materials or low-cost and/or recyclable materials for experimentation would be handy.

Prototype stage

- Getting students to realise when and why to make a prototype is key. What are they looking to prove / disprove? Linking the prototype method with the problem is a good task. In the video they suggest any realisation of a design is a prototype, even small-scale trials.
- Prototypes may be mechanical or structural models, test rigs, mock ups, painted models, or CAD models and/or assemblies.
- It may be that components/connections are created (for example, there may be an abundance of a particular sheet material on site that can be used e.g. OSB from crates, that could be connected in some way easily)
- 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](#) reduced fee for schools/students
- There are some good Autodesk Fusion tutorials [HERE](#) and TinkerCad [HERE](#)
- Consider asking stakeholders to give some feedback on the prototypes, as they are being developed and at the testing stage.
- Whilst the CAD models produced may be fairly simplistic in their nature, it is an opportunity to explore different techniques with students such as using mechanical assemblies, frame structures, creating shells etc to replicate stretched fabric and using these elements to add additional strength. Again, you may produce some in advance to showcase the difference they can make to a product when subjected to external forces.
- 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.
- The assignment of actual materials to models is necessary if both FEA and generative design are to work correctly. You could use this opportunity to introduce theory of materials properties to this context.
- Portability is the key to this product working, so explore collapsible, flatpack and folding solutions as scale models.

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.
- Test in as many different scenarios and environments 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).
- With destructive testing it is important to ensure safety at all times as products may react in unexpected ways. For example, if students are to test the strength of their structures by hanging weights from it, get the students to attempt to write a risk assessment for the test. This will be similar to what is done in science, and ensure they adhere to all relevant PPE and safety procedures when carrying out supervised tests.
- 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.
- Remember that any structure can collapse and cause potential harm, so take extra care if the structure is being made full size and people will be inside it.

Focused Tasks

'Structural models'	'Amenities'	'Collapsibles'
Make a scale model of your shelter design using basic modelling materials such as card and paper. Avoid using block materials such as foam as this would not represent thin lightweight structures. Consider using lollipop sticks for levers/linkages and stretching thin fabrics such as Spandex to represent materials for your shelter. Try and use materials that will represent the real-world materials used, but in a scale form.	A structure is just one aspect of this project. Shelters will need amenities such as electricity, water, air conditioning, heating to name a few... Make a list of the amenities, resources, supplies etc. that your shelter would need. Prioritise these in terms of importance and draw a plan of the shelter to show where key features might be placed.	You are designing a temporary shelter so this will likely involve collapsing/portable structures incorporating mechanisms. Explore a range of mechanisms that could be used to collapse a structure. Could they be designed so that they simply 'pop up' or will your design require elements that need to be assembled on site?

Investigative and Evaluative Activities

'Types of shelter'	'Natural disasters'	'Environmental challenges'
What is a shelter, and what defines its purpose? Investigate different types of shelters for a range of applications. Produce a chart to show any key features that certain types of shelter might share. Are there any common aspects in terms of construction or application that you can use to inspire your own designs?	People are often displaced from their homes due to natural disasters such as earthquakes, landslides, floods etc. Investigate the immediate needs of people who have suddenly found themselves without homes or shelter. Look through the news from the last decade and see what natural disaster have occurred, the causes (if any) and the effects these had on communities affected.	We often make projects in our school workshops, but what about taking these products into the world outside. What obstacles might we have to overcome when delivering these shelters to their intended locations? Investigate a range of different and challenging environments and list the difficulties you might overcome. For example, compare a jungle location to one with ice and snow.

