AIMING FOR AWESOME

1918 2018

Radar

Teacher's Guide

Royal Academy of Engineering

THIS IS ENGINEERING

ROYAL AIR FORCE Youth STEM

The aim of this resource is to give students the opportunity to investigate the impact of science, technology, engineering and mathematics (STEM) on radar technology.

Ground penetrating radar

Curriculum links

England

Activity	Key Stage	Subject	National Curriculum
Design challenge	KS2	*Design and technology*	**Design** **Make** **Evaluate** **Technical knowledge** – apply their understanding of how to strengthen, stiffen and reinforce more complex structures
Design challenge	KS3	*Design and technology*	**Design** **Make** **Evaluate**
Design challenge	KS3	*Mathematics*	**Working mathematically:** solve problems

Scotland

Activity	Subject	Topic	Experiences and outcomes
Design challenge	*Technologies*	Craft, design engineering and graphics contexts	TCH 2-14a, THC 3-14a TCH 4-14b
Design challenge	*Numeracy and mathematics*	Number and number process Money	MNU 1-03a, MNU 2-03a, MNU 2-09a, MNU 2-09c, MNU 3-09b

Wales

Activity	Key Stage	Subject	National Curriculum
Design challenge	KS2	*Design and technology*	**Designing** **Making** **Rigid and flexible materials**
Time to investigate	KS3	*Design and technology*	**Resistant materials and textiles**
Design challenge	KS3	*Design and technology*	**Designing** **Making**
Design challenge	KS3	*Mathematics*	**Using number skills: manage money**

Northern Ireland

Activity	Key Stage	Subject	National Curriculum
Design challenge	KS2	*Mathematics and numeracy*	Processes in mathematics: making and monitoring decisions, communicating mathematically
Design challenge	KS3	*The arts*	Art and design: evaluate their own and others' work and how it was made, explain and share their ideas, discuss difficulties and review and modify work to find solutions

Preparation

- Ensure all materials and equipment needed is available well in advance of the session. See the resource list below for essential materials and components.
- A full risk assessment should be conducted prior to the session.
- This session is expected to last 120 minutes.
- Ensure technology is available to project the relevant video materials.

This resource has been linked to the Engineering Habits of Mind (EHoM). For more information about the EHoM please see the information sheet provided or www.raeng.org.uk/ltbae

Resource list

For this activity, you will need the following per team:

- One copy of radar support sheet one
- One copy of radar support sheet two
- One copy of radar support sheet three if additional support is required
- £100 RAF money
- 6 art straws
- Split pins

You will also need the following in the shop:

- Art straws
- Sticky tape
- Masking tape
- Ruler

The following specific components may not be readily available in schools and other educational establishments, so it may be necessary to order these items.

Description	Product code	Pack size	Supplier
Artstraws	70-0518	1000	www.rapidonline.com

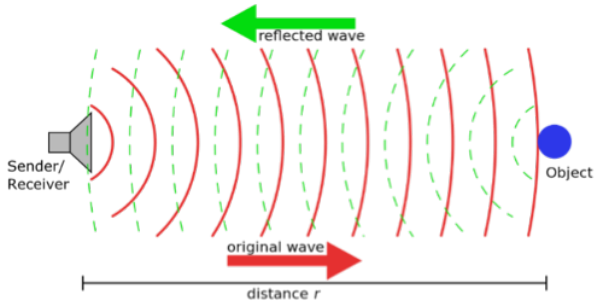
Radar

British physicist Robert Watson-Watt is often referred to as the father of radar.

Initially appointed by the Air Ministry to develop a weapon in response to rumours of a German death ray machine in 1934, Watson-Watt instead began experimenting on the potential use of radar. Building on previous research by German scientists such as Christian Huelsmeyer and Heinrich Hertz, Watson-Watt developed a radar system which played a pivotal role during the Battle of Britain.

Radar is used to detect objects including aircraft, ships and even weather formations and can be used to determine the range, angle, or velocity of objects.

A radar system has a transmitter that emits radio waves. Radio waves from the transmitter reflect off the object and return to the receiver, giving information about the object's location and speed.



TIME TO DEMONSTRATE

To introduce the idea of reflection, throw a tennis ball at a wall and catch it on its return.

This is how radar works. A radio wave is emitted from a transmitter, when the radio wave hits an object it is reflected and detected by the receiver.

TIME TO INVESTIGATE

Radar systems are on top of towers so that the signal can travel longer distances without being stopped by land features such as hills or valleys.

Engineers use different shapes when building towers. Investigate the strongest shapes.

1. Cut the artstraws in half
2. Make a triangle square and pentagon with the artstraws, securing the corners with split pins
3. Push the top of the shapes and record your observations in the table below.

Shape	Observation
Triangle	
Square	
Pentagon	

Which shape is stronger and why?

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Radar towers

You are part of the first response team to Typhoon Haiyan and have been deployed to set up communications. The terrain is uneven and the highest hill is one metre above your base camp.

Design Challenge

Use tubes to build a tower to hold a 300g radar facility.

Each member of your project team will be assigned a role but you must work together.

Part one

First create an initial design for your radar tower.

The project team should think about:

- The cost of the materials required
- How tall does the radar tower need to be?
- What shapes are strongest? Think about tall building or pylons.

Your project team has £100 to spend on building materials and all purchases should be recorded on Radar support sheet two.

Guidance provided to STEM activity leader

- Split students into small groups of no more than four and give each member of the team a set role.
- Photocopy the roles on radar support sheet one and cut them out. If bigger teams are needed use multiples of the role Production Engineer or create new roles based on the strengths of the students.
- The resource manager should collect radar support sheet two to record the budget and spending.

Guidance provided to STEM activity leader

Allow 15 minutes for designing. The students should design a tower that least one metre tall, with the radar being held one metre above ground. This is so that the radar signal can be transmitted over the hills.

If students are struggling to create an initial idea, you could use Radar support sheet three to show the designs of tall buildings and prompt them with the following questions:

- What shape should the base be to make the tower stable?
- How will the tower hold the weight of the radar? Will it be at the top of the tower or on a ledge?
- How will you reinforce the joints?

Part two

Now your project team need to build the radar tower you have designed.

Purchase materials from the shop and record how much you have spent. Make sure you stay in budget.

Guidance provided to STEM activity leader

Allow at least 45 minutes for building the tower. To keep the groups on task, you could use a timer on the whiteboard and give reminders about the remaining time.

A shop area should be set up in the classroom or school hall for students to purchase the required materials. The resource manager should use the RAF money and radar support sheet two provided in part one of the activity to record the spend of the group.

Students can change their design when building the tower, and go over budget if necessary.

Part three

Create a poster to explain the changes made to your initial idea. Include the following:

- A diagram of your initial design and your finished tower.
- Why was it necessary to make these changes?
- How has the cost changed and why?

Guidance provided to STEM activity leader

If you wish to run this activity as a competition, then the winning team is the group that managed to build the tower that supports the required weight for the lowest cost and with the least amount of waste material.

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We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

We're engaging the public by opening their eyes to the wonders of engineering and inspiring young people to become the next generation of engineers.

ROYAL AIR FORCE Youth STEM

The RAF Youth STEM programme is designed to engage and inspire young people by building their interest in engineering and technical career pathways.

From cyber specialists to aerospace, aviation, electronics, and mechanical disciplines, the RAF is committed to widening participation in STEM, extending opportunities to all, and encouraging greater diversity in this critical area of national skills shortages.

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