AIMING FOR AWESOME

1918 — 2018

Code breaking

Teacher's Guide

ROYAL ACADEMY OF ENGINEERING

RAF 100

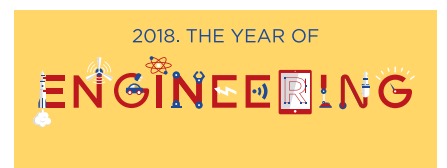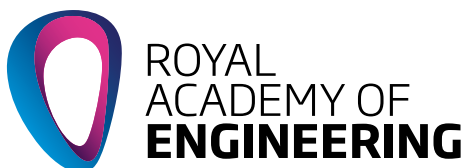2018. THE YEAR OF ENGINEERING

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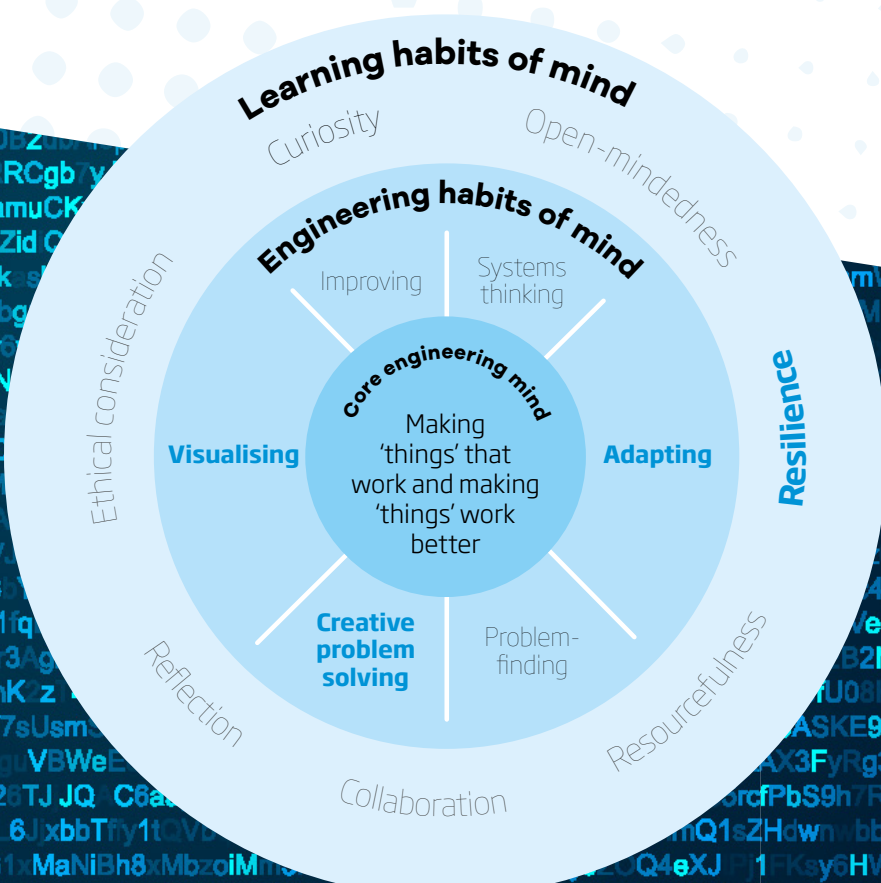
Curriculum links

England

Activity	Key Stage	Subject	National Curriculum
Time to make	KS2	*History*	A study of an aspect or theme in British history that extends pupils' chronological knowledge beyond 1066.
Time to make	KS3	*History*	Challenges for Britain, Europe and the wider world 1901 to the present day.
Stretch and challenge	KS3	*Mathematics*	Reason mathematically.

Scotland

Activity	Subject	Topic	Experiences and outcomes
Time to make	*Numeracy and Mathematics*	Number and number process	MNU 2-03a
Stretch and challenge	*Numeracy and Mathematics*	Number and number process	MNU 2-03a

Learning habits of mind

Curiosity · Open-mindedness

Engineering habits of mind

Ethical consideration

Improving · Systems thinking

Core engineering mind

Making 'things' that work and making 'things' work better

Visualising · Adapting

Resilience

Creative problem solving · Problem-finding

Reflection · Collaboration · Resourcefulness

Wales

Activity	Key Stage	Subject	National Curriculum
Stretch and challenge	KS3	*Mathematics*	Developing mathematical reasoning: identify process and connection

Northern Ireland

Activity	Key Stage	Subject	National Curriculum
Time to make	KS2	*Mathematics and numeracy*	Recognise general patterns and relationships and make predictions about them.
Stretch and challenge	KS3	*Mathematics and numeracy*	Developing pupils' knowledge, understanding and skills: the creative use of technology to enhance mathematical understanding; creative thinking in their approach to solving mathematical problems

Preparation

» Ensure all materials and equipment needed are 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 60 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 student:

» Cardboard

» One copy of code breaking support sheet one

» One split pin

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

Description	Product code	Pack size	Supplier
RVFM Paper Fasteners	06-0904	200	www.rapidonline.com
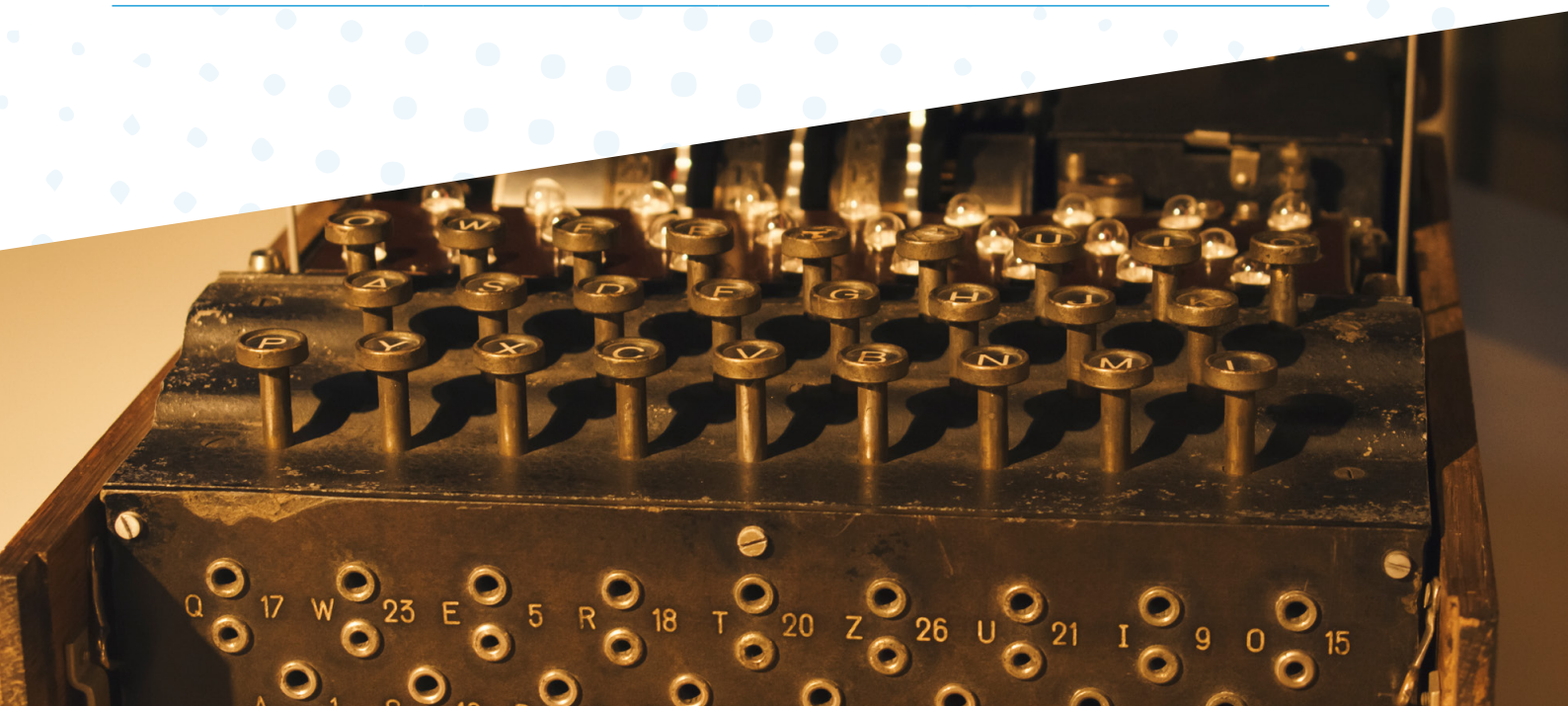
Espionage

Following the Second World War, tension increased between the Eastern Bloc (the Soviet Union and its satellite states) and the Western Bloc (the USA and its NATO allies).

This period was called the 'Cold War' because there was no fighting between the two sides. The Cold War started after the Second World War and lasted into the 1990s. However, its height was in the 1960s.

Secrecy and spying, or espionage, were a big part of the tension in Europe during this period. There are three main features to the espionage operations that took place during the Cold War:

》 The collection of documents and evidence by the spies.

》 Counter intelligence.

》 Covert operations.

In films and television, spies are shown as glamorous individuals who have exciting adventures. In reality, spies were people who led ordinary lives, and did not stand out from the crowd. They did not want to draw attention to what they were doing, especially as they usually worked on or had connections with top secret work.

》》 TIME TO MAKE

There are many ways to code, or encrypt, a message to keep it a secret from your enemies.

One way to encrypt your message is to use a substitution cypher, which replaces one letter with another. There are many ways that you can use this cipher but the easiest is substituting for the next letter in the alphabet, this is called Caesar Shift 2. For example, 'a' becomes 'b', 'b' becomes 'c' and so on.

If you wanted to encrypt the word 'engineering' using this cipher it will become 'fohjoffsjoh'.

》 Try encrypting your name using this cipher.

》 What would your name be if you encrypted using a Caesar shift 2, where each letter is substituted with the letter two places along in the alphabet?

Working out each letter individually is very time consuming. To speed up the process you could encrypt the alphabet first.

To make a machine to encrypt the alphabet you will need:

》 Card or cardboard

》 Split pin

》 Code breaking support sheet one

Method

1. Stick the support sheet onto card or cardboard and then cut out the code wheels.

2. Fix the smaller wheel inside the larger wheel, securing it with a split pin.

3. You can now spin the inner wheel so that it matches a different letter on the outer wheel.

4. Write a message you would like to send to a friend.

5. Find the letters for your message on the inner wheel. Use its partner on the outer wheel to write it in code.

Use Caesar Shift 14 to send your coded message to a friend. Can you decode the message they sent to you?

To decode the message, you must find each letter in the outer wheel and write down its partner in the inner wheel.

Code breaking

STRETCH AND CHALLENGE

To ensure easy transfer of messages, the same encryption would be used for all messages in a day.

The encryption would change each day at midnight to stop the other side from working out the encryption and decoding all the messages.

You have intercepted a message that says:

D NZIO TJP V AJJY KVXFVBZ WT XVM

Work out what the message says and therefore the encryption code.

Now you know today's encryption key, you can decode all the messages for the day. What do these messages say?

1. OCZ XVM RDGG YZGDQZM OCZ KVXFVBZ OJ NXCJJG

2. OCZ AJJY KVXFVBZ XJOVDIN V HVK

3. OCZ HVK RDGG NCJR OCZ GJCVODJI JA OCZ NZXMZO GVWJMVOJMT

With today's encryption key, you can now send false messages to confuse enemy spies. Code a message with today's encryption key and send it to a friend to make them think that the delivery location has changed.

Decoding each message letter by letter can be time consuming. Use Excel to create an automatic decoder.

AIMING FOR AWESOME
Code breaking – Support sheet 1
Cipher wheel
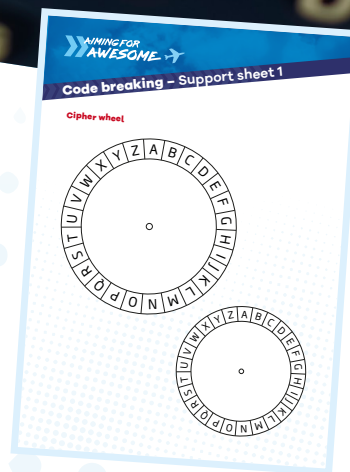
Guidance provided to STEM activity leader

The Caesar Shift is +21. The first coded message should read:

I SENT YOU A FOOD PACKAGE BY CAR

You could prompt students to decode the one letter words first, and look for any repeating letters in words like AJJY.

The messages decoded read:

1. THE CAR WILL DELIVER THE PACKAGE TO SCHOOL

2. THE FOOD PACKAGE CONTAINS A MAP

3. THE MAP WILL SHOW THE LOCATION OF THE SECRET LABORATORY

You can download an example of an Excel decoder from **www.raeng.org.uk/education**

ROYAL ACADEMY OF ENGINEERING

Royal Academy of Engineering

As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.

We have four strategic challenges:

Make the UK the leading nation for engineering innovation

Supporting the development of successful engineering innovation and businesses in the UK in order to create wealth, employment and benefit for the nation.

Address the engineering skills crisis

Meeting the UK's needs by inspiring a generation of young people from all backgrounds and equipping them with the high quality skills they need for a rewarding career in engineering.

Position engineering at the heart of society

Improving public awareness and recognition of the crucial role of engineers everywhere.

Lead the profession

Harnessing the expertise, energy and capacity of the profession to provide strategic direction for engineering and collaborate on solutions to engineering grand challenges.

The RAF 100 Youth & STEM programme has been 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 using our centenary celebrations to extend opportunity to all and to encourage greater diversity in this critical area of national skills shortages.

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