Facilitator Guide

Duration: 90 Minutes
Suitable for ages 7-14

In this program participants are challenged to try out the super powers of a variety of engineers in order to escape the clutches of the evil genius!

Equipment and Materials needed per participant:

- LED
- Battery
- Thick plastic or card stock (.8mm thick)
- 4mm craft foam
- Elastic band
- Plastic spoon
- Pom pom
- Small dowel rod (50-70mm long)
- Alkaseltzer tablet
- Small container with lid (film canister size)

Additional supplies for the group:

- Paper
- Uncooked Spaghetti
- (optional- cooked spaghetti)

Equipment:

Printed resources:

- Engineer Cards (appendix A)
- Activity instruction sheet (Page 4)

Activity 1: Engineer Game

Duration: 20 minutes

This activity uses the printed Engineer cards from **Appendix A.**

Option 1: Quiz

This version is best suited for ages 7-8 or smaller groups < 5

Use roughly half of the deck. Review the types of engineer with the group then divide into teams and ask questions such as which engineer works with chemicals? Or name one thing a mechanical engineer might do. Winning team is the one who gets the most correct answers!

Option 2: "Does/is your Engineer…"

Each participant is given one card and becomes that type of engineer.
Divide the room into two halves. One side is 'yes' and one side is 'No'. The participants should then decide if the statement you read out applies to them (yes) or not (no) and move to that side of the room. Some questions have a definite correct answer as shown on their card and some will require them to think more deeply.

Examples:

Easy	● Use a screwdriver? ● Use a computer? ● Sometimes work outside? ● Design a place to live? ● A man or a woman? (Follow up – do they have to be that gender?)
Medium	● Drive a train? ● Help you turn on the lights? ● Care about the environment? ● Ever wear a hardhat or lab coat? ● Solve problems?
Harder (Age12-14)	● Do something to allow you to brush your teeth in the morning? ● Work in a team? ● Use Math?/Chemistry?/ Physics?

Key learning outcomes

- There are many types of engineers and some have very specific and interesting jobs.
- We use things every day that were designed by engineers, and most things need more than one type of engineer working together.

Activity 2: Escape the evil Genius' Lair!

Duration: 60 minutes

Facilitator note: *This activity has several mini challenges to complete. To follow the story they can be done in order, or they can be done in 'round robin' style, switching each 15-20 minutes. For ages 7-8 one or more challenges may be eliminated to allow more time to complete the others.*

The evil genius has taken you and your team of Super Engineers captive and is keeping you in the cellar of a castle on a top secret island! How can you use your collective engineering skills to escape his evil clutches before he returns and feeds you all to his pet shark?

Activity A: Electronic Engineer

Duration: 15-20 minutes

First things first, it's pretty dark down here in the cellar, we could do with some light to see if we can find a way out! You feel around in the dark and find some light bulbs, a car battery and some foam and plastic pieces.

How can you use these items to create light?

Build a Flashlight

- 1 Light Emitting Diode (LED)
- 1 CR2010 Battery
- 1 x craft foam sheet 50x30x4mm
- 2 x rigid plastic/card sheet 25x30x1mm

Instructions:

Test: A simple flashlight can be made by touching the positive LED leg (the long one) to the positive side of the battery and the negative leg (the short one) to the negative battery terminal (the other side of the coin cell).

1. Cut a hole through the foam layer to fit the battery.
2. Slide the LED legs over the side of the foam to touch the legs to either side of the battery. One leg should NOT touch the battery unless pressed down. Make sure the LED is the correct way around!
3. Glue one piece of plastic to each side of the foam.
4. Squeeze the device to connect the led leg to the battery and turn on the light. Letting go should turn it off again!

Facilitator Notes:

LED's are directional and must be connected the right way round. Long leg is positive. Make sure participants check the orientation with the battery BEFORE gluing everything together! Ensure you have spare LEDs in case of burn out. LED's are very energy efficient which is why more consumer products are replacing inefficient halogen bulbs with them. This helps us save the environment!

Activity B: Materials Engineer

Duration 15-20 minutes

Now we can see around the cellar and discover that there's a locked metal bar door at one side of the room that's the only way out!

Through the bars you can see the key sat on the guards table, but they're just out of reach. Looking around the cellar again you find some more items:

- Spaghetti uncooked
- Spaghetti cooked (optional)
- Paper
- Tape
- Keys

How can you use these materials to retrieve the keys and unlock the door?

Retrieve the keys

Set up:
The keys should be on a flat surface i.e. table 1m (3ft) from the participant. Participants are not allowed to lean over the table.

Try this:
In teams of 3-4 create a device to help retrieve the keys using the materials available in the cellar

Facilitator Notes:

Materials engineers look at how material properties can be changed to work to our advantage. E.g. the uncooked spaghetti is too brittle by itself but can be manipulated by chemical reaction to make it flexible and work differently. By taping several strands together they also gain strength. Flat paper is also not very strong, but rolling it gives it more strength.

If the keys are knocked off the table the participants can continue to try and reach them but must still stay behind the edge of the table (the cell door!)

Activity C: Mechanical Engineer

Duration 15-20 minutes

You race out of the cellar escape from the castle only to find yourself at the castle walls. The evil genius was very smart and always come in by helicopter so there's no gate! The only way to get out is over the wall!

Around the wall you find some wooden beams, an Elastic rope and some Wood logs

How can we use these to get over the wall?

Build a Catapult

Materials needed:

- Plastic spoon
- Pompom
- Elastic band
- Small dowel rod
- Cup/ goal

Position the dowel underneath the spoon handle and attach to the spoon by looping the elastic band back and forth in a figure 8 pattern. That's it the lever is done and you're ready to experiment!

Adjust the position of the pivot to try these:

1. **Find the centre of mass:** get the spoon to balance on your finger
2. **Lift a heavier object:** move the pivot off-centred to one side. Place an object on one side and push down on the other to try to lift it up. Now switch the sides. Which side was easier to move the object? Where would this be useful? *Note: By making distance A bigger we can apply a smaller force A to lift a bigger object on side B.*
3. **Catapulting light objects!** With the pivot still off centre put a pompom on one end and press quickly on the other side.

Use the catapult to try to get your pompom into the goal (cup). Try moving the dowel rod to different positions on the spoon handle. How does that affect the height and distance that the pompom flies? Where is the optimal position to get the pompom into the goal every time?

Facilitator notes: *A simple catapult acts like a lever.*

Levers can be used to exert a large force over a small distance at one end by exerting a small force over a greater distance at the other Force A x distance A = Force B x distance B

If we move the pivot along the length of the beam the distance on the other side also changes. This means that if the same force is applied on side a then a bigger or smaller force is on side B.

Catapulting works by the same principle as lifting, but in reverse. Because we put a big force on a small end it caused the system to become unbalanced and so more force was applied to the pompom than it gave back, causing it to fly away!

Activity D: Chemical engineer

Duration 15-20 minutes

Finally you're all outside the castle walls, but you're still on the island!

On the beach you fit a giant container big enough for your team but how to get it off the island? Lucky for you one of your team often has bad heartburn so keeps some Alka-selter tablets in their pocket!

Build a rocket to fly away from the island

Materials Needed:

- Water
- Alka-Seltzer tablets
- Small plastic craft containers with pop off lids
- Cardboard (to cut wings from)

Chemical reactions

When some chemicals mix they create a strong reaction which can be put to use. When an Alka-Seltzer tablet is added to water it begins to fizz as the sodium bi-carbonate (baking soda) begins to chemically reacting with it giving off CO2. This can be seen by adding a tablet to a glass of water and is a good demo at the beginning of the activity.

Instructions:

Step 1: Design your rocket

Cut wings from the cardboard to help your rocket fly and attach them using tape or glue. Think about how the air will move past the rocket and how you can make it move even easier. Be sure to leave space for the lid and avoid gluing the lid in place!

Step 2: ready for launch.

Add water to the body of the rocket. Very quickly add a quarter of the Alka-Seltzer tablet and close the cap firmly. Place the rocket cap down on a flat surface and step away from the launch to see it blast off.

Facilitator notes: *Rocket launches are better controlled outdoors due to the heights they can reach! Another option is to build a boat to get away from the island. This is the same principle as the rocket except you should also punch a hole into the lid of the container to allow the pressure to release more slowly. Put the container into a bowl of water to see it propelled through the water.*

Activity 3: Reflections

Duration: 10-15 minutes

This activity should be led as much by the participants as possible to help them draw their own conclusions. Where possible draw on examples from the group and ask questions that are most relevant to what you saw from the groups or individuals. The key outcomes of the discussion relate to how they worked together.

Note: for particularly 'squirrelly' groups it may help to have a 'presentation table' where all the objects are placed out of reach prior to starting the discussion to limit the level of distraction!

Questions:	Reflection:
Who escaped from the evil genius?	**This is a good temperature check to see how the group as a whole coped with the activity.**
What was the most challenging activity?	This is most likely to be the key retrieval! What happened and why? **FAIL= First Attempt In Learning.** Engineers don't always get everything right the first time. Experimenting, PROTOTYPING, making mistakes and trying something new is ok!
Would/did you change any part of the design of any of your projects?	If yes, what and why? If no, why not?
How did you work as a group for each activity?	Review how groups worked together to share knowledge once team member got it, or how they incorporated different opinions.
Did all the engineers do the same things?	Yes- design, applying science, yes mechanical and chemical both make something fly but in different ways. No- different skills were needed to complete each challenge.
What was the favourite activity?	This may vary and is useful to see how the idea of diversity has been received.
What kind of skills did you use that would be important for an engineer to have?	The skills will be dependent on the group. Try to reflect on the activity and note any good examples you saw of these. Teamwork, Creativity, Problem solving, Resourcefulness

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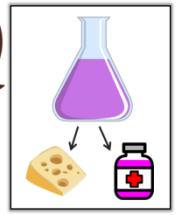
STEPHANIE

CHEMICAL ENGINEER



As a chemical engineer, Stephanie uses science to process raw materials and chemicals into safe products we can use like food or medicines.

SUPER POWER | Chemicals

TOOLS

2

MARK

SOFTWARE ENGINEER

As a software engineer, Mark uses his coding skills to create the 'brains' that bring electronic products or games to life for us to use and enjoy.

SUPER POWER | Code Wizardry

TOOLS </>

3

ALESSIA

CIVIL ENGINEER

As a civil engineer, Alessia designs buildings that give us safe places to live and roads and bridges to connect us to other places.

SUPER POWER | Portals

TOOLS

4

STEVE

STRUCTURAL ENGINEER

As a structural engineer, Steve makes safety a priority so that his large structures and buildings stay up!

SUPER POWER | Supersizing

TOOLS

5

LIZZIE

ELECTRICAL ENGINEER

As an electrical engineer, Agnes creates circuits that send signals and make electronic products, like cell phones and street lights, work.

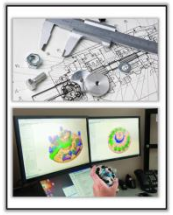
SUPER POWER | Electricity

TOOLS

6

RACHEL

MECHANICAL ENGINEER



As a mechanical engineer, Rachel often designs parts of machines using 3D design software. She builds prototypes to make sure that the parts don't overheat or leak.

SUPER POWER | Assembly

TOOLS

7

BRAD

INDUSTRIAL ENGINEER

As an industrial engineer, Brad helps make everything run smoothly and on-time by improving systems of people, money, materials.

SUPER POWER | Change the future

TOOLS

8

KAREN

AUTOMOTIVE ENGINEER

As an automotive engineer, Karen works in a team of many types of engineers to design and make cars, buses and other vehicles.

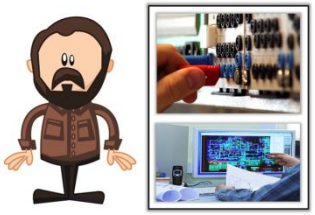
SUPER POWER: Speed

TOOLS:

9

TERRY

ENGINEERING TECHNOLOGIST



As an engineering technologist, Terry applies engineering principles to design, install and maintain new technologies using hands-on methods.

SUPER POWER: Experimentation

TOOLS:

10

DAVE

BIOMEDICAL ENGINEER

As a biomedical engineer, Dave works alongside doctors to design equipment like artificial legs and devices to make people get better.

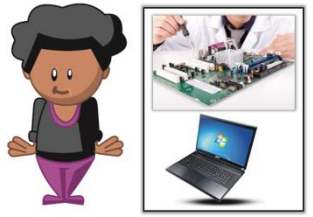
SUPER POWER: Healing

TOOLS:

11

JASMINE

COMPUTER ENGINEER



As a computer engineer, Jasmin works with both electronics and software to create systems from tablets and phones to giant scientific computers.

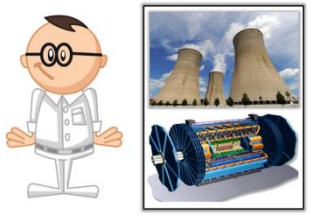
SUPER POWER: Super-computers

TOOLS:

12

JOHN

NUCLEAR ENGINEER



As a nuclear engineer, John helps design the reactors that provide energy to power our homes and schools.

SUPER POWER: Energy

TOOLS:

13

NICKI

ENVIRONMENTAL ENGINEER

As an environmental engineer, Nicki works to solve problems like pollution and providing clean water to keep people and the planet healthy.

SUPER POWER: Nature

TOOLS:

14

GABRIELLE

FORENSIC ENGINEER

As a forensic engineer, Gabrielle works as a detective to find out why things, like bridges, fail and how we can make them better.

SUPER POWER: Detecting

TOOLS:

15

BOB

MILITARY ENGINEER

As a military engineer, Bob is involved with weapons design, minefield clearing and temporary bridge construction to protect soldiers in warzones.

SUPER POWER: Explosions

TOOLS:

16

JEREMY

GENETIC ENGINEER

As a genetic engineer, Jeremy uses biology to alter genes to change plants and make them grow faster and stronger or taste better.

SUPER POWER: Cloning

TOOLS

17

ELSA

MINING ENGINEER

As a mining engineer, Elsa finds ways to get useful metals and other materials out of the ground without damaging the environment.

SUPER POWER: Tunnelling

TOOLS

18

MIKE

MATERIALS ENGINEER

As a materials engineer, Mike uses science to improve materials we use every day to make them work better- like making planes lighter!

SUPER POWER: Strength

TOOLS

19

ED

SYSTEMS ENGINEER

As a systems engineer, Ed turns ideas like how to get water from the lake to your tap or move people through a hospital into real systems.

SUPER POWER: Efficiency

TOOLS

20

KYLIE

MECHATRONICS ENGINEER

As a mechatronics engineer, Kylie uses electronics, mechanics and software to create robotic systems.

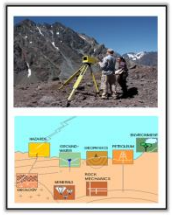
SUPER POWER: Robots

TOOLS

21

EMMA

GEOLOGICAL ENGINEER



As a geological engineer, Emma finds ways to use the earth's resources wisely and protect people from natural disasters like volcanoes and earthquakes.

SUPER POWER: Earthquakes

TOOLS

22

GEORGE

COMMUNICATIONS ENGINEER

As a communications engineer, George helps us stay connected with each other through our phone and the internet networks.

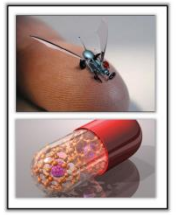
SUPER POWER: Communicating

TOOLS

23

NANCY

NANOTECHNOLOGY ENGINEER



As a nanotechnology engineer, Elisha develops new technologies that are 100 times smaller than a hair to solve problems like getting medicine into the body faster.

SUPER POWER: Shrink Ray

TOOLS

24

VICKY

PRODUCT DESIGN ENGINEER

As a Product Design Engineer, Vicky uses her creativity to design and manufacture safe and useful products that people use at home, like pet toys or kitchen tools.

SUPER POWER | Imagination

TOOLS

25

HUGO

QUALITY ENGINEER

As a quality engineer, Hugo checks that products or systems work as they were designed so that they are safe to be used.

SUPER POWER | Knowledge

TOOLS

26

VANESSA

TECHNICIAN

As a technician, Vanessa applies science and engineering for drawing, installing, inspecting, maintaining and repairing important equipment.

SUPER POWER | Repair

TOOLS

27

JOE

RENEWABLE ENERGIES ENGINEER

As a renewable energies engineer, Joe finds new, reliable energy sources that don't hurt the environment.

SUPER POWER | Solar Rays

TOOLS

28

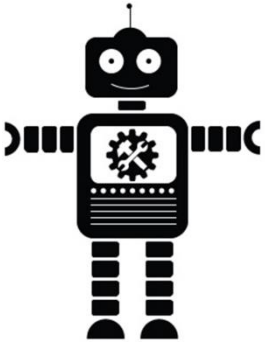
SAM

AERONAUTICAL ENGINEER

As an aeronautical engineer, Sam helps design and test new aircraft to make them faster and safer.

SUPER POWER | Flight

TOOLS



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