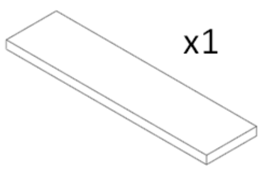
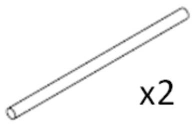
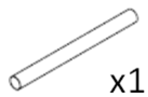
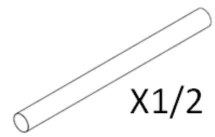
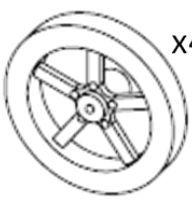
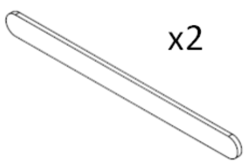
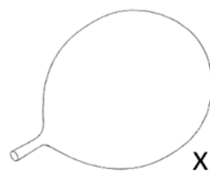
Facilitator Guide

Duration: 90 minutes
Suitable for ages 7-14

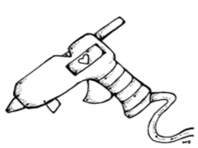
Humans have begun colonizing Mars. With this colonization comes a series of engineering challenges that must be addressed for the people to survive and thrive. One of these challenges is how to transport our team of astronauts around the red planet to collect samples and supplies.

Equipment per team:

 x1 Base 40x115x2mm approx.	 x2 Wheel Axle 3mm x 65mm	 x1 Drinking Straw 4mm diameter approx.	 X1/2 Milkshake Straw 10mm Diameter approx.
 x4 Wheel 34mm Diameter approx.	 x2 Popsicle stick	 x1 Balloon	 Paper/card 1-2 sheets

Each team also needs some small object to act as a passenger e.g. a golf ball or egg.

Additional supplies:

 Hot Glue (optional but recommended)	 Tape	 Scissors	 Pens/pencils (optional)

Printed Resources

- Engineer Flashcards (Appendix A)
- Instruction sheets (page 5)

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.

Rover Power

Duration: 5 Minutes

You have landed on the surface of Mars with your team of astronauts. Now you need a way to get around and explore!

In your rocket you found all the materials you need to build a small rover. The only problem is you couldn't find a motor or enough fuel to make it run. Instead you did find a large balloon.

How can a balloon help you power your rover?

Potential energy!

Ask participants (or a volunteer) to stretch up as tall as they can on their toes. Explain that this is like the way the rubber on the balloon stretches when the balloon is filled with air. This is called potential energy, which is a store of energy waiting to be released. Ask participants to relax, did anyone stay in the same position? As they relaxed their position changed and they released the energy they were storing as movement, or kinetic energy, to move back to a position that is more comfortable. This is the same as the balloon does when we let go of one end causing the balloon to deflate.

Forces (Ages 9+)

Why does the balloon fly away, why does the release of the balloons potential energy cause movement? The potential energy could be converted to another type of energy like heat or sound.

By relaxing back to its natural position the balloon forces the air out in one direction. The air moving is applying a force on the balloon. Forces have three things- a mass, a speed and a direction, and for every force that is applied here is an equal force pushing in the opposite direction.

To demonstrate participants can put their hands together and push equally hard with each hand. Neither hand moves. If one hand is relaxed and the other keeps pushing then they move in the direction that the force is applied with a certain speed, which balances out the forces. For the balloon when the air is pushed out in one direction the balloon must move in the opposite direction to balance out the forces and this creates the speed and movement.

Rover Building activity

Duration: 45 minutes

Participants should be split into groups of 2-3 and provided with a set of materials and an instruction sheet to build the basic rover.

For ages 9+, in addition to the basic rover, teams should devise a way to secure a payload to the rover. Allow 5-10 minutes extra should be allowed for this.

Split the activity into three sections. Keep a careful eye on the time for best results.

15 Minutes	**Prototyping.** Participants should be separated into teams of 2-3 and provided with **one** rover kit and instruction sheet. They should be given 15-20 minutes to assemble the kit. If a team has not finished in the time limit – no panic! They can finish it in stage 3.
5 minutes	**Strategy planning.** Now that they know how the parts fit together they should be given 5 minutes to discuss as a team and determine the most efficient way to build another 2-3 rovers in the SAME time limit so that each team member can get around the planet separately. They should consider what worked/ didn't work last time and the resources they have i.e. human resources-people, equipment – 1 glue gun, 1 roll of tape etc. To add more challenge, they must also figure out how to safely transport a passenger on their rover using just the materials they have to hand (kit packaging/paper/tape) No work should be done on their existing unit during this time!
20 Minutes	**Mass Production**. Give the teams the additional parts and another 15 minutes and let them begin assembling using the process they just determined.

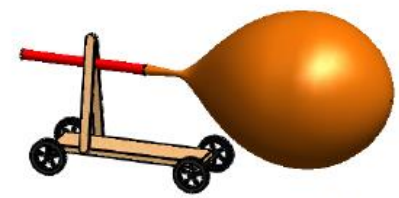
Aim

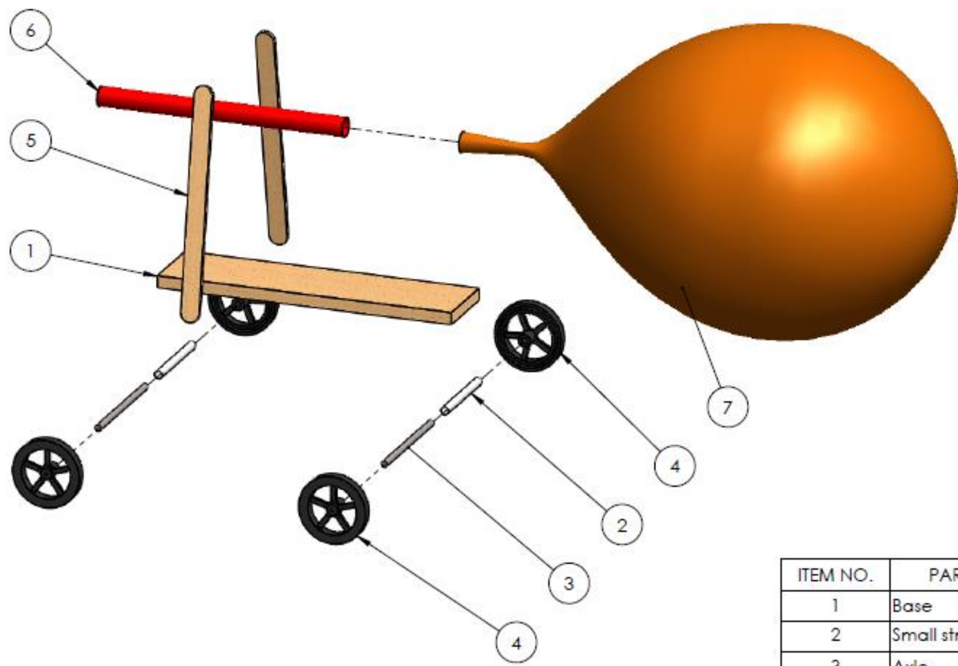
Make your rover travel as far as possible without the need to refuel.

Rules:

1. Only the materials provided can be used- any additional materials will take six months to reach Mars from Earth!
2. For safety the passenger and/or payload should be secure on the rover when it is moving
3. The rover must be reusable so the passenger and/or payload must be able to be removed from the rover at the end of the journey without destroying any part of the rover.

Groups are allowed to deviate from the provided example design if they wish i.e. they can determine an alternative power source or use the materials provided in any way they choose, so long as they achieve the overall project aim and do not break any rules! (this may be necessary if they pop their balloon since supplies from earth will take 6 months to reach them!)





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Base	37.5x115x2mm wooden base	1
2	Small straw	4mm x 45mm plastic straw	2
3	Axle	3mm x 65mm metal rod	2
4	Wheel	34mm Plastic Wheel	4
5	Posicle Stick	9mm wide wooden popsicle stick	2
6	Large Straw	10mm x 125mm Milkshake straw	1
7	Balloon	Party balloon	1

MISSION TO MARS	Title: **Planetary Rover**	Drawn by: Engineers of Tomorrow	Date: March 2015	**SCALE 1:2**

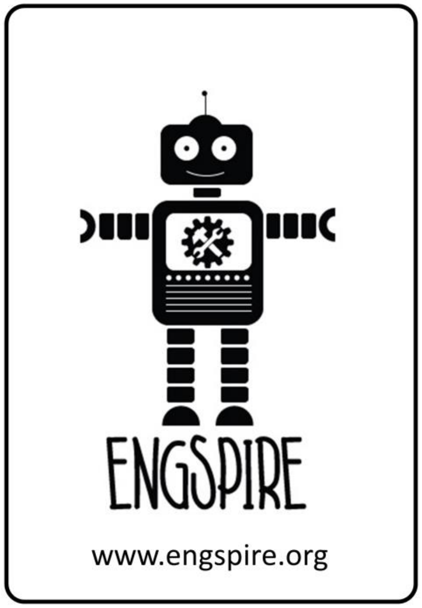
Rover Race and Wrap Up Discussion

Duration: 10-15 minutes

Set up a standard start line and have a volunteer from each group present their rover design to the whole group and demonstrate it. Mark the landing position of each group with a sticker to determine which rover went the furthest. Optionally, if time allows, hold elimination rounds!

For larger groups it is possible to have all the groups line up at the start and 'race' their rovers.

Questions:	Reflection:
What were the differences between the rover that went the furthest distance versus the one that went the shortest distance?	the aim is for the participants to see that the amount the balloon is blown up determines how far the rover goes. The more air in the balloon the greater pressure on the rubber and the more force the rubber exerts to push the air out when the rover is released. There may also be some design issues that help/hinder such as additions made by different teams for aerodynamic shaping.
What passenger holder designs worked/ didn't work?	Multiple different designs works, there is no single right answer- engineering allows room for creativity! Engineers are concerned with people's safety, it's a key part of their job.
Did any teams change their rover design during building?	Often engineering requires design changes, Engineers do a lot of iterative design to make their products better. They also learn from their mistakes so being wrong the first time isn't a bad thing! FAIL= First Attempt In Learning
Could you use this type of rover on earth? i.e. to get to and from school? Would it work the same or would you need to make changes to it?	This might be a cheap method of transport for developing countries as it doesn't use any non-renewable fuel sources, which makes it a clean technology and better for the environment. May need to add common transport features such as brakes and steering! Protection for the balloon (if you had some pop) might be a good thing to add.
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- Working together as a team to build the rover. Creativity-To come up with ideas for the package carrier Problem solving- To figure out why the rover isn't working and fix it Resourcefulness- Being able to use the materials provided Helping others- Without the engineer we wouldn't be able to explore the planet! Hands on skills-Being able to build something from scratch.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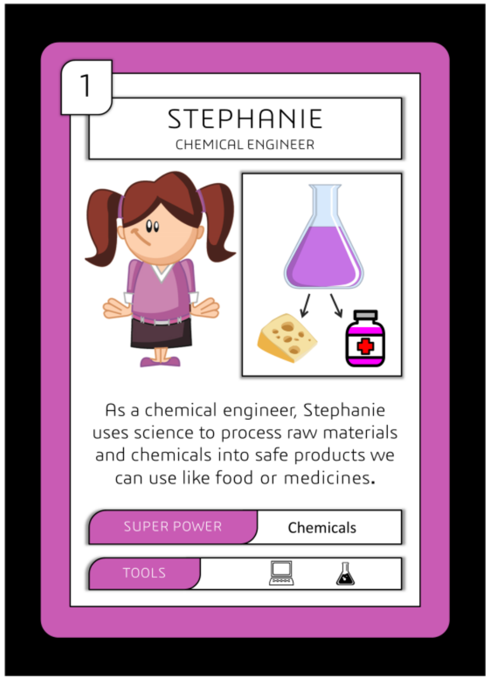
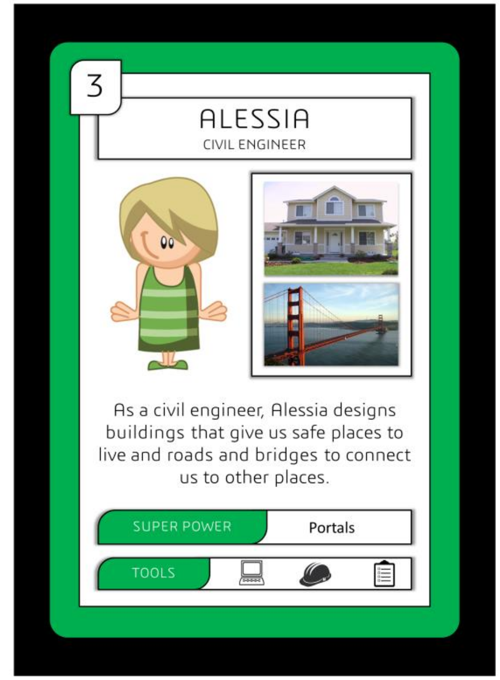
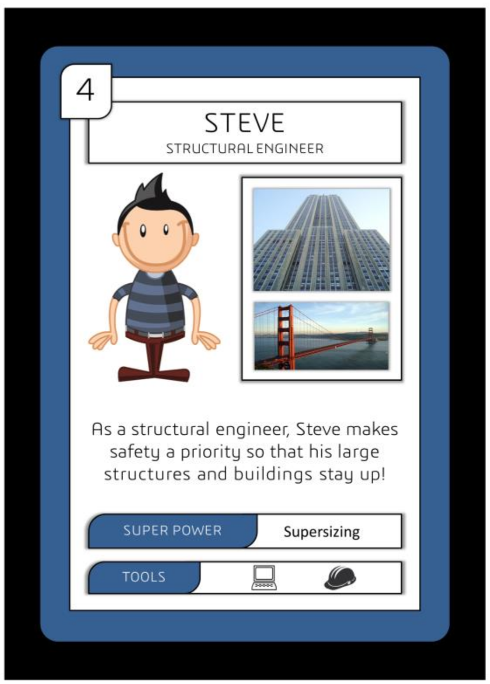
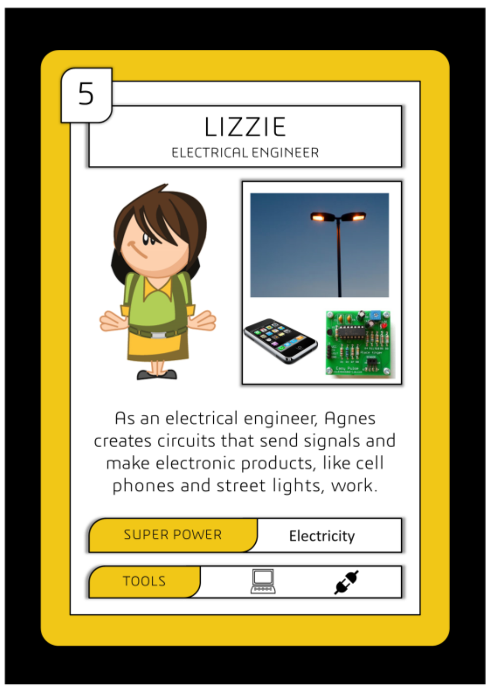
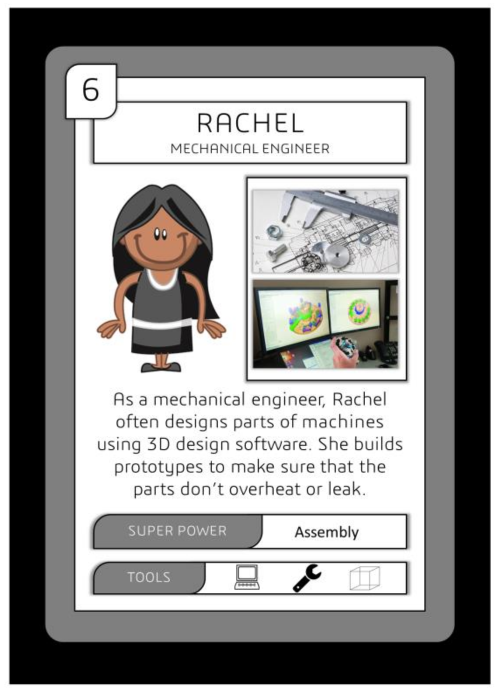

1
STEPHANIE
CHEMICAL ENGINEER
As a chemical engineer, Stephanie uses science to process raw materials and chemicals into safe products we can use like food or medicines.
SUPER POWER
Chemicals
TOOLS

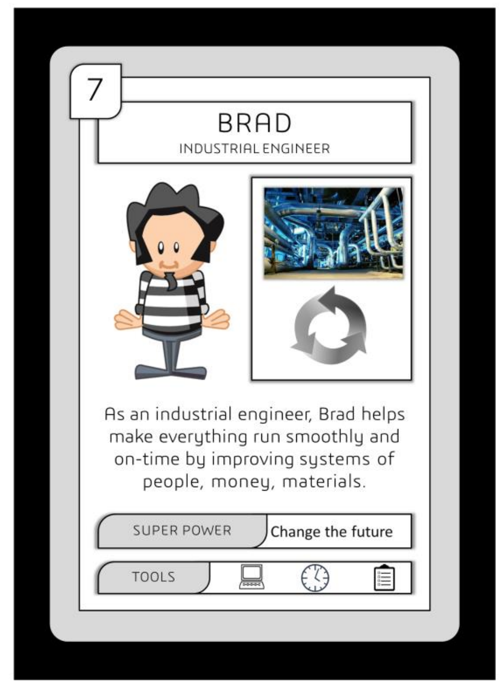

2
MARK
SOFTWARE ENGINEER
As a software engineer, Mark uses his coding skills to create the 'brains' that bring electronic products or games to life for us to use and enjoy.
SUPER POWER
Code Wizardry
TOOLS
</>


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

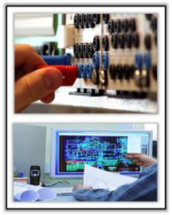
As an automotive engineer, Karen works in a team of many types of engineers to design and make cars, buses and other vehicles.

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

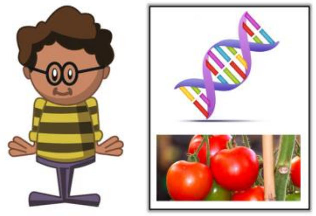
BOB

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

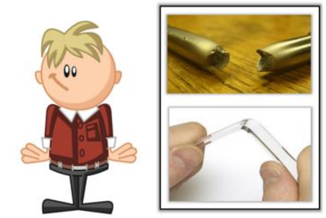
17
ELSA
MINING ENGINEER

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

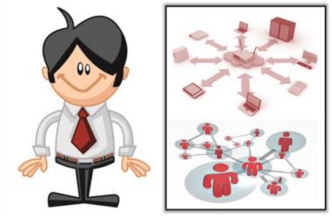


As a materials engineer, Mike uses science to improve materials we use every day to make them work better-like making planes lighter!

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

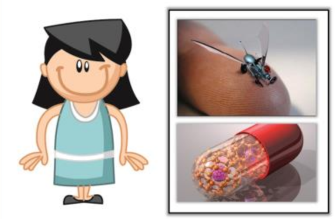
22
GEORGE
COMMUNICATIONS ENGINEER

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

SUPER POWER: Communicating

TOOLS

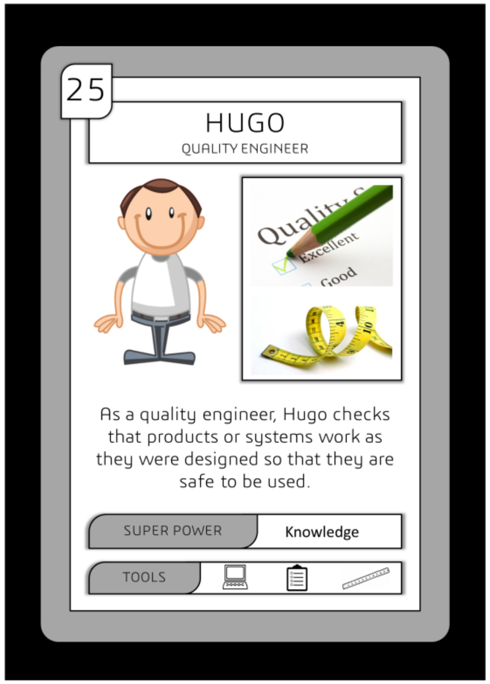
23
NANCY
NANOTECHNOLOGY ENGINEER

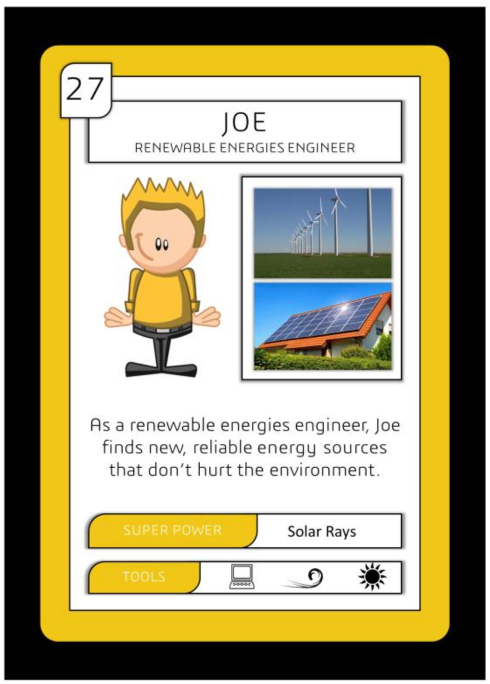


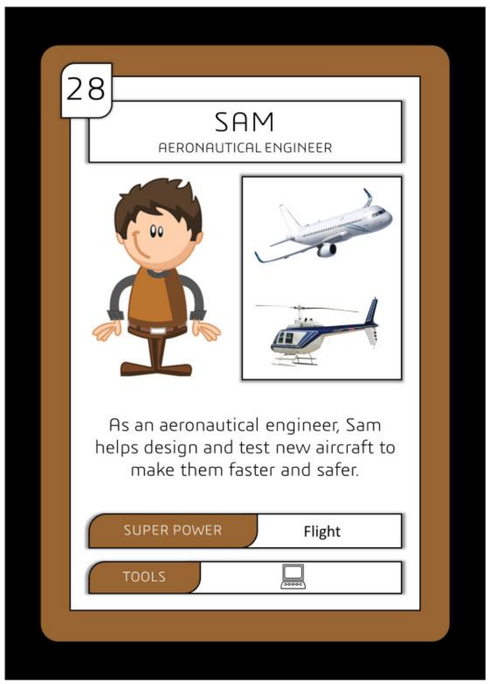
As a nanotechnology engineer, Elisha develops new technologies that are 100 times smaller than a hair to solve problems like getting medicine into the body faster.

SUPER POWER: Shrink Ray

TOOLS







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