Engineering Adventures®

Engineering Journal

In Good Hands: Engineering Space Gloves

Name:________________________________

reply forward archive delete

from: engineeringadventures@mos.org

to: You

subject: Engineering a Tower

10:36 AM

Hi everyone,

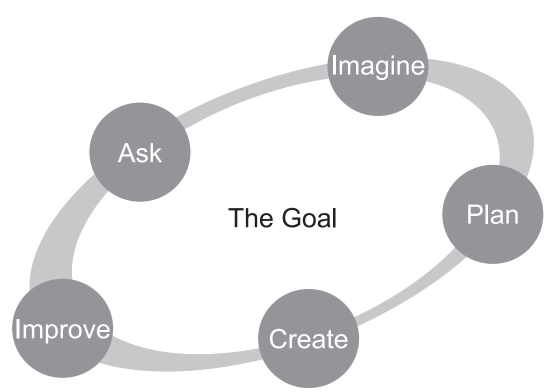
We're so excited to meet you! Our names are India and Jacob. We do a lot of traveling all over the world. We meet interesting people and see some amazing countries. Each place is unique, but we've found one thing in common. Everywhere we go in the world, we find problems that can be solved by engineers.

Engineers are problem solvers. They're people who design things that make our lives better, easier, and more fun! We heard you might be able to help us engineer solutions to some of the problems we find. That means you'll be engineers, too!

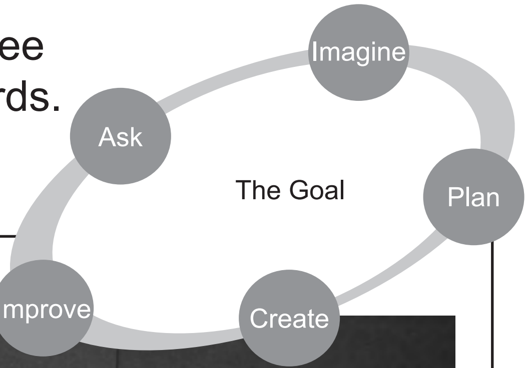
Today, we came across an engineering challenge we think you can help us solve. We're spending time at NASA, the National Aeronautics and Space Administration. NASA is hoping to create a pedestal or tower to hold a sculpture of a very special astronaut. The team asked us to engineer a model of the tower. It needs to be at least 10 inches tall, and it has to hold a statue. Can you engineer a tower to help?

We sent you one tool that we usually find really helpful when we're trying to engineer a solution to a problem. It's called the Engineering Design Process. Take a look at it and see if it can help you!

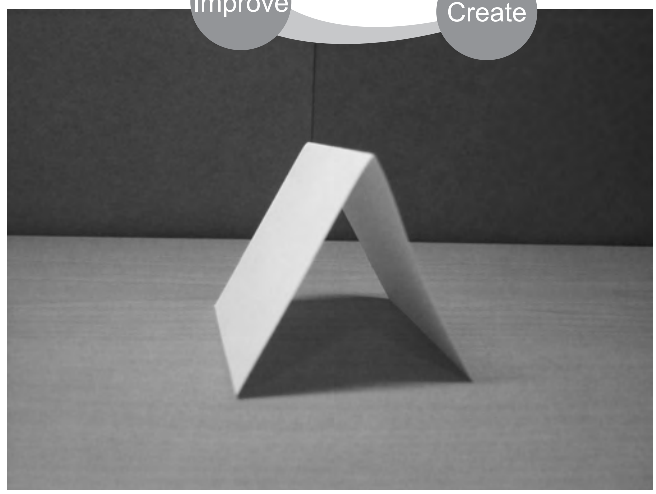
Good luck!
India and Jacob



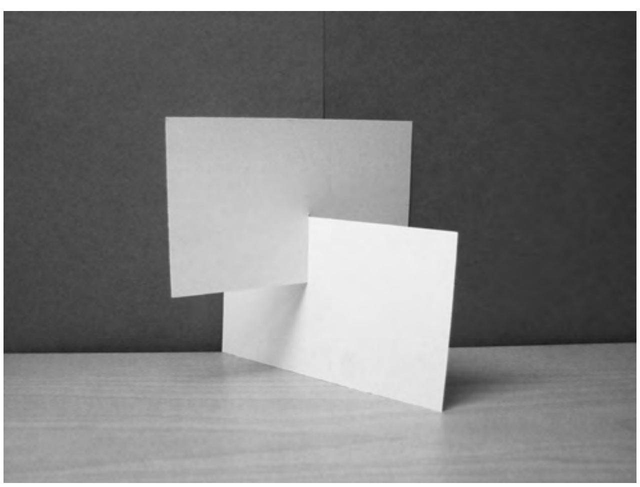
Imagine the structure of your tower. Here are three ways to build the tower's structure with index cards.



Roll it!



Fold it!



Cut it!

Will any of these ideas help your group build a tower? What other ideas do you have?

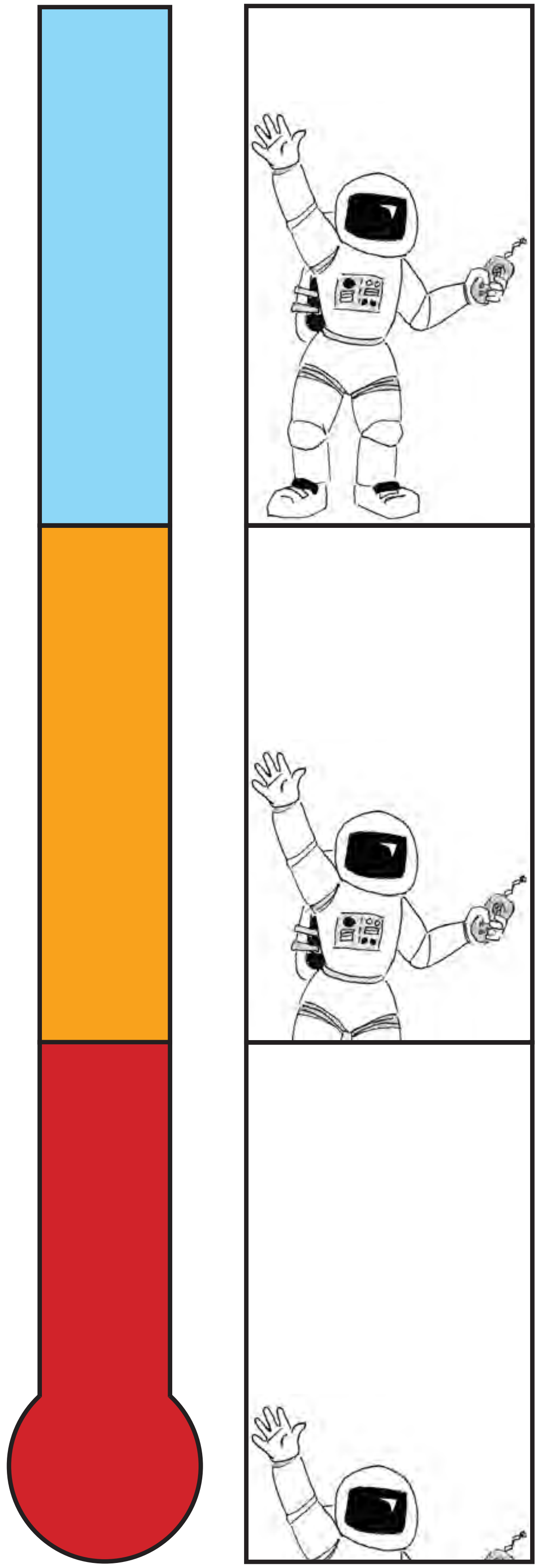
Talk with your group to figure it out!

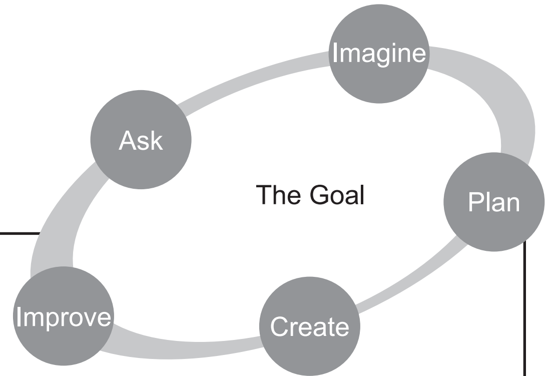
The taller the tower you engineer, the more people will be able to see the astronaut statue.

Lots of people can see
10 inches and up

Some people can see
5–9 inches

Hardly anyone can see
0–4 inches





Plan Your Tower

Use the space below to draw your tower.

Reflect

Which parts of your tower design would you *improve* if you could do it again?

For the Record

I think engineering is:

- ☐ Fun
- ☐ Exciting
- ☐ Difficult
- ☐ ____________________

reply forward archive delete

from:	engineeringadventures@mos.org
to:	You
subject:	What is Technology? 11:23 AM

Hi engineers,

You did a great job engineering a tower to display the stuffed animal so lots of people could see it! Now you're ready to help us engineer even more technologies.

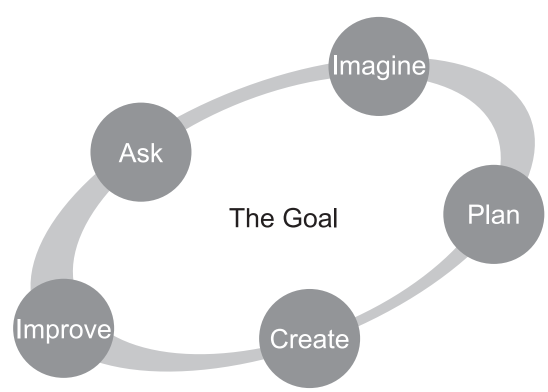
Do you know that the things engineers design to solve problems are called technologies? Most people think technologies have to be electronic, but this isn't true. A technology is actually anything engineered by a person that solves a problem.

Think about an airplane as an example. An airplane is a technology because people engineered it and it solves the problem of needing to travel long distances quickly. But something as simple as a paper cup is also a technology. A person engineered it, and it helps people hold drinks without spilling them everywhere.

We have some more challenges for you today. Can you use the Engineering Design Process to engineer technologies to solve the problems we sent?

Good luck!

India and Jacob



Which Problem Will You Help Solve?	
Send a message The space shuttle commander needs to send a message to an astronaut floating 15 feet away.	Water a plant An astronaut needs to move water from a container to a plant on the International Space Station (ISS).
Carry pens and pencils An aerospace technician needs to carry pens and pencils across the spacecraft.	Protect an astronaut An astronaut needs to be protected from a dust storm on Mars.

You're an engineer!
What can you engineer to solve this problem?

Reflect: Think about what you designed . . .

Did a person engineer it?

☐ Yes ☐ No

Does it help you solve a problem?

☐ Yes ☐ No

If you answered YES to both questions, it is a technology!

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	The Right Material for the Job 2:11 PM

Hi engineers,

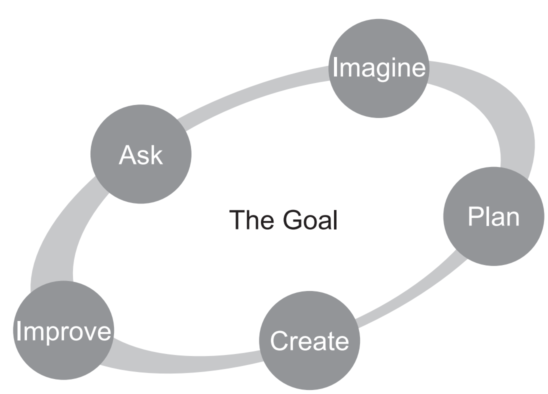
We're in a really cool place—Antarctica! We sent you a map so you can see where we are. We're visiting our friend Maru at a testing site for the National Aeronautics and Space Administration. NASA testing sites are places where engineers prepare for space missions in a safe but realistic environment before they leave Earth. NASA needs to test a lot of things, from big pieces of equipment to little scraps of materials.

Maru is a materials engineer, so she works with metals, fabrics, plastics, and other materials to design spacesuits. Spacesuits have many parts that work together, including helmets, boots, and gloves.

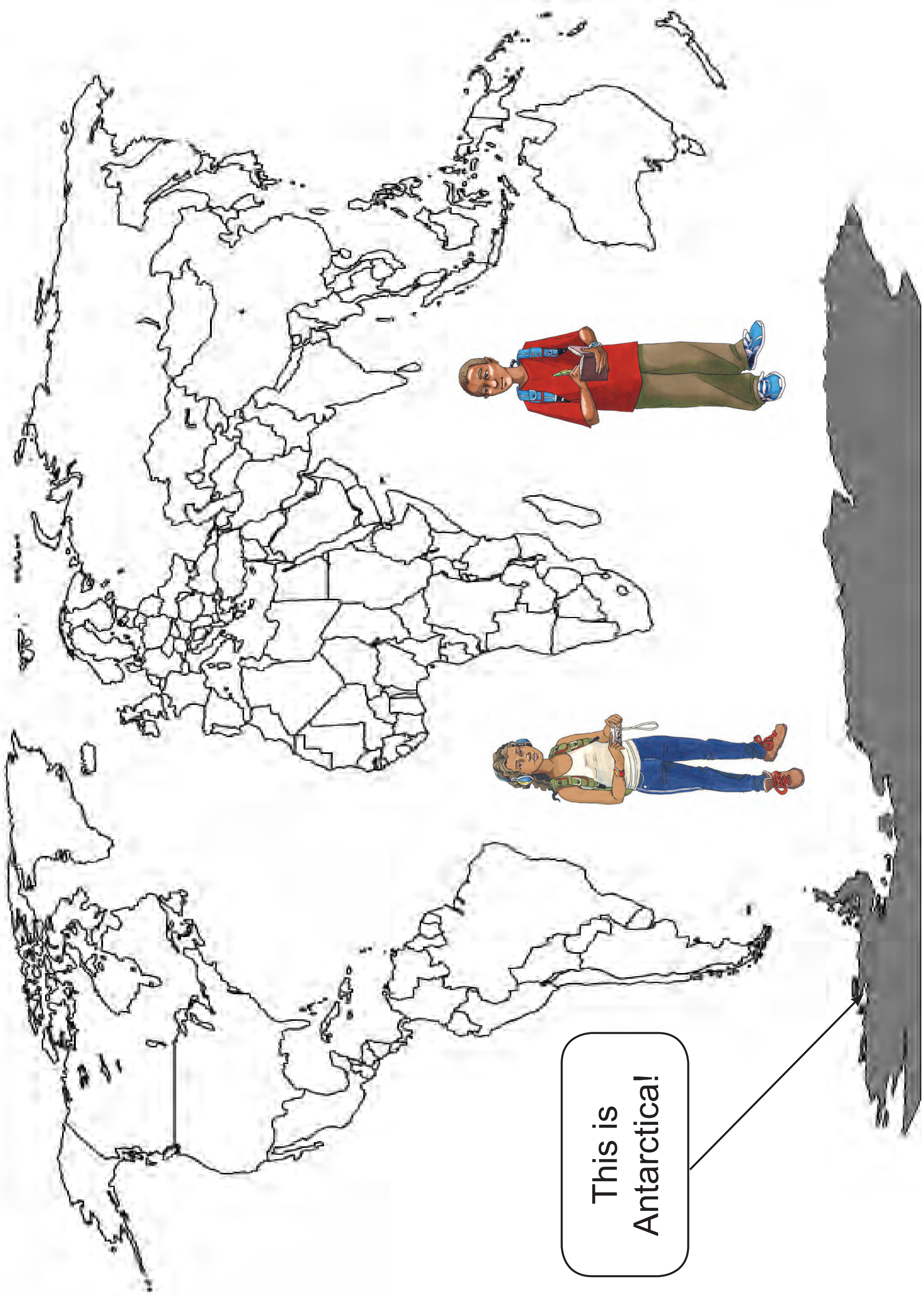
Can you be materials engineers? We sent you some everyday gloves to explore. Can you help us *ask* lots of questions about these wearable technologies? What materials are they made of? What features make them good for some tasks but not for others?

We can't wait to hear what you find out!

India and Jacob



Did You Know?
No country owns Antarctica. The Antarctic Treaty of 1959 subdivided the continent into eight territories. Seven countries conduct scientific studies within these territories.



reply | forward | archive | delete

from: engineeringadventures@mos.org

to: You

subject: Designed for Protection

3:02 PM

Hi engineers,

What did you think of those different gloves?

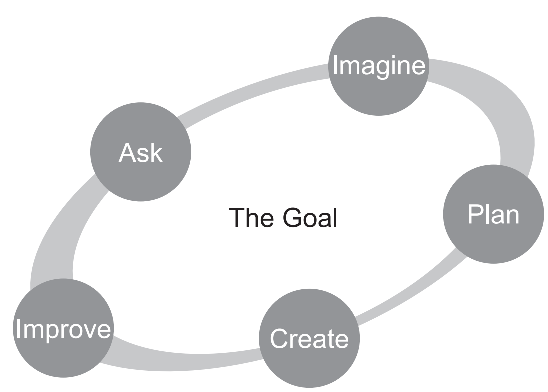
Maru told us that she has to carefully consider the materials in a spacesuit to make sure it can protect astronauts from the hazards, or dangers, of space. She showed us a video from NASA about how they engineer spacesuits, and we wanted to share it with you.

Astronauts, and the gear that protects them, must perform well in all sorts of hazardous conditions, including dust storms, moving space debris, and extreme temperatures—and guess what? NASA is asking us to help design gloves for some of their spacesuits!

Sometimes it helps us to *imagine* some ideas before we *create* our designs. Do you have any ideas about what astronauts could wear to protect themselves from space hazards? You can send your ideas to engineeringadventures@mos.org.

We can't wait to see what you come up with!

India



1. *Imagine* you are an astronaut working in space. Choose one or two hazards that would make it difficult to survive.

2. What do you think you could wear to help protect yourself from these space hazards? Write or draw your ideas below.

Did You Know?
New space gloves are constantly being designed because astronauts can hurt their fingernails very easily in the current gloves. The current gloves are not flexible and cause enough damage that the astronauts' fingernails fall off!

reply | forward | archive | delete

from: engineeringadventures@mos.org

to: You

subject: Deep Freeze

11:42 AM

Hi engineers,

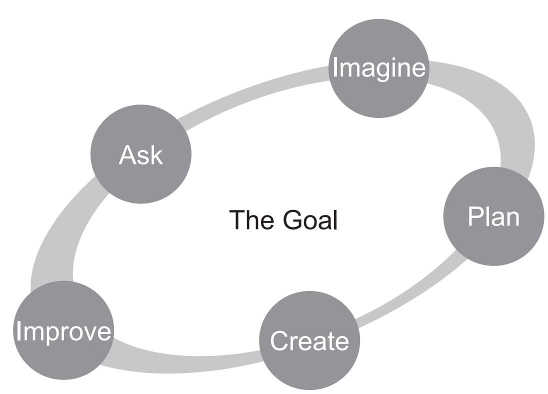
You did a great job investigating the gloves we sent. Are you ready for a new materials challenge?

Remember how we said space can be really hot or really cold? Maru told us that one of the reasons her materials research team works in Antarctica is because the temperatures there are some of the coldest on Earth. The coldest temperature recorded was −89 degrees Celsius (°C). That's −128 degrees Fahrenheit (°F)! These conditions make Antarctica an ideal place to test out new space equipment for astronauts.

It's time to do some materials testing of your own. Can you find out which materials work well to protect against cold temperatures? I've sent you a few materials to try.

Let me know what you find out!

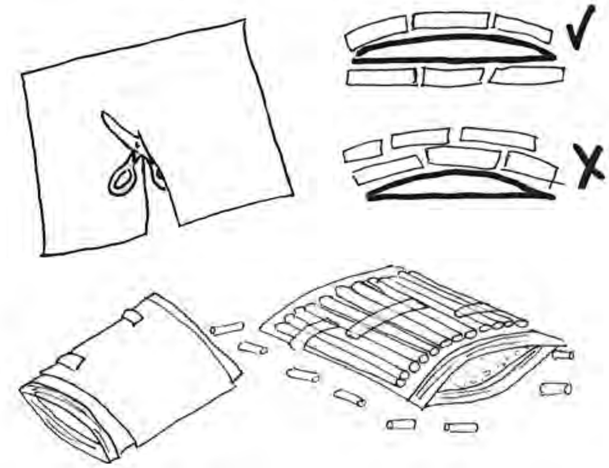
Jacob



1. Cut the material and tape it in **1 layer** on the outside of a plastic bag.

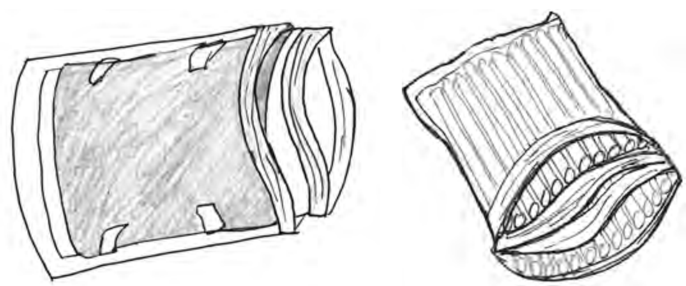
2. Place the plastic bag with the materials inside the other plastic bag.

   The material should now be sandwiched between the 2 plastic bags. This is your mitt.

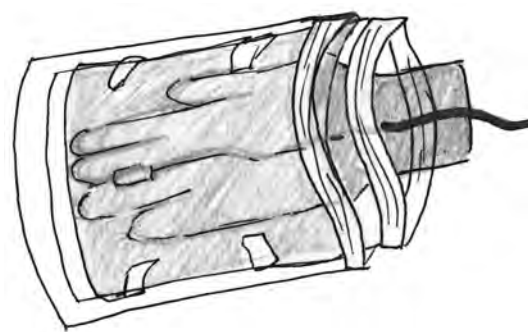


3. Put the model hand with attached thermometer into the inner bag of the mitt.

4. Place the ruler into the corner of the mitt.



5. Record the starting temperature.

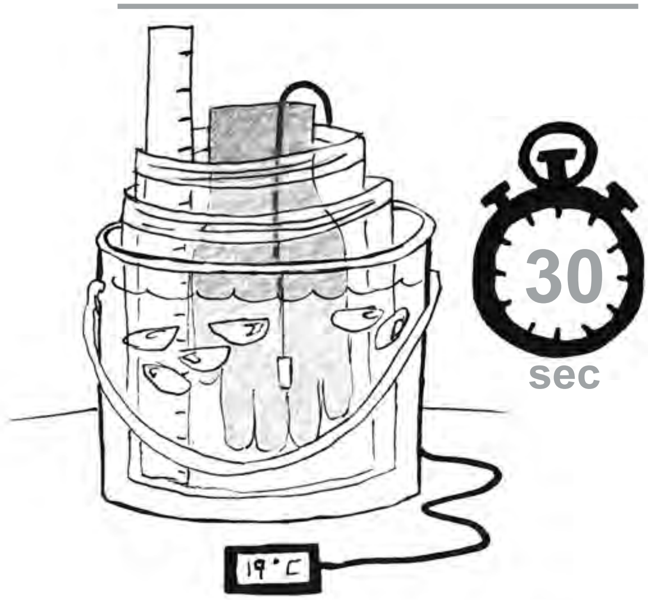


6. Place the mitt straight down into the ice water and start the timer. Use the ruler to keep the mitt under water.

7. Record the temperature after **30 seconds.**

8. Subtract to find the difference in temperature.

9. Record your results on *Temperature Changes*, p. 13 in the Engineering Journal.



Directions:
Record temperatures for the empty mitt and the mitt with your testing material below. Look at the example for the type of information you should include in each column.

Is your material good at protecting against the cold?

Not Good	Good	Great
7 °C or more	3–6 °C	0–2 °C

Test Results

Mitt Material	Starting Temperature	Temperature after 30 Seconds	Difference in Temperature	How well does it protect against cold?
Example	*20 °C*	*17 °C*	*3 °C* *(20 °C – 17 °C = 3 °C)*	*Good*
Empty Mitt				

Reflect

Which materials were great at protecting against the cold?

Why do you think these materials worked well?

Did You Know?
The Celsius temperature scale is often used in science. It is used by almost every country in the world.

reply forward archive delete

from:	engineeringadventures@mos.org
to:	You
subject:	Impact Hazards Ahead

8:45 AM

Hi engineers!

You did a great job *asking* questions about the materials we sent. With your help, Jacob and I learned about which materials work well to protect against super cold temperatures!

Maru told us it’s also really important for astronauts to keep their hands safe from another type of space hazard—impact, or damage, from heavy moving objects. When astronauts work with machines with lots of moving parts, their space gloves need to protect different parts of their hands from getting crushed. Spacesuits are also at risk of being damaged by heavy moving space debris. Space debris can be natural, like pieces of floating rock, or human made, like pieces of old satellites and fragments of spacecraft.

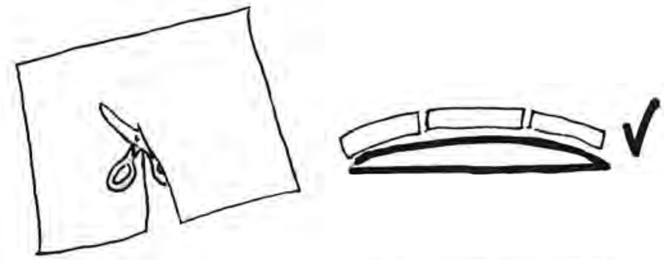
We were surprised to find out that a material can be really good at protecting against one type of hazard but terrible at protecting against another. We sent you the same materials you explored last time. Can you figure out which of these materials are good at protecting astronauts against impact hazards? Are there any materials that can protect against both impact hazards and cold temperatures?

Let us know what you find out!

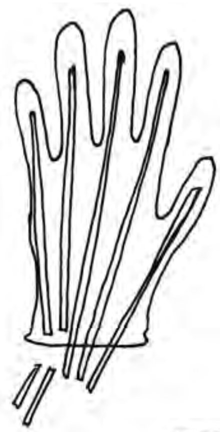
India

Impact Test Procedure

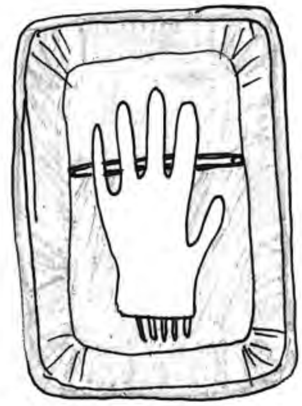
1. Cut your material and tape it in **1 layer** to **1 side of your glove**.



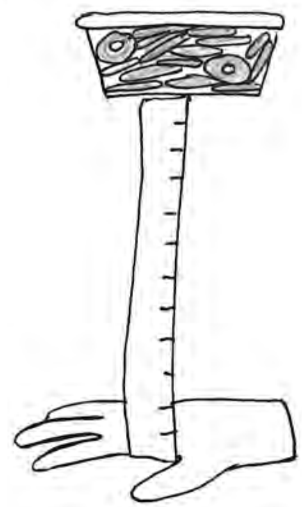
2. Put 1 piece of pasta in each finger of your glove. Snap off excess pasta that may be sticking out from the wrist.



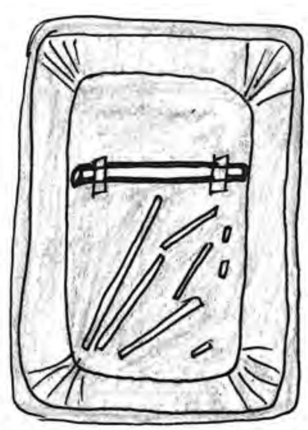
3. Place your glove in the aluminum tray. Make sure that the “fingers” are resting on the wooden skewer.



4. Lift the weight 1 foot above the center of your glove. Make sure the entire weight is above the ruler.



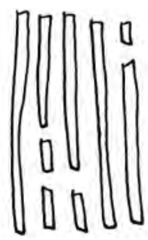
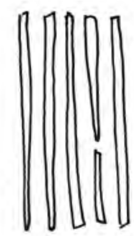
5. Drop the weight.
6. Carefully empty the pasta out of the glove and count the number of pieces.



7. Record your results.
8. Repeat 2 more times for a total of 3 tests.
9. Record the highest number in the “Final” column. How well did your glove protect against impact?

Directions:
Record the number of pieces of pasta after each test. Choose the highest number recorded and write it in the column marked “Final.” Using the chart below, find out how well your glove protected against impact.

Is your material good at protecting against impact?

Not Good	Good	Great
11+ pieces	8–10 pieces	5–7 pieces
		

Test Results					
Material	**Test 1**	**Test 2**	**Test 3**	**Final**	**How well does it protect against impact?**

Reflect

Which materials were best at protecting against impact?

Why do you think these materials worked well?

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Dangerous Dust 3:08 PM

Hi engineers!

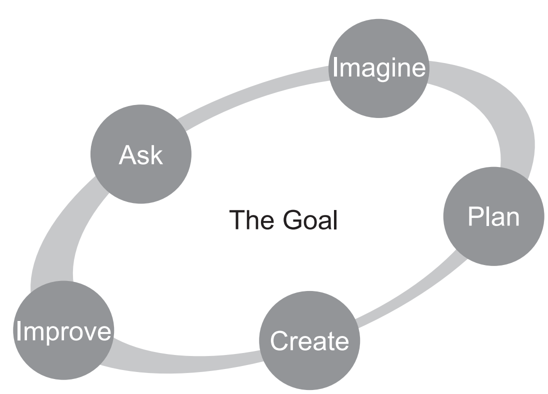
I talked more with our friend Maru, a materials engineer at NASA's testing site in Antarctica. She let me know that engineers also have to think about dust-resistant materials when designing spacesuits. Maru said a dust-resistant material is any material that prevents dust from sticking to it.

It may not seem like much of a hazard to find dust in living and working spaces here on Earth, but dust from the surface of other planets and moons can be a big problem for astronauts. Dust can get into things in the spacecraft that need to stay clean and cause damage to the electronics and equipment inside. On top of that, the dust can be dangerous for the astronauts to breathe. Engineers need to choose materials that dust does NOT stick to so astronauts bring as little of it as possible into their spacecraft.

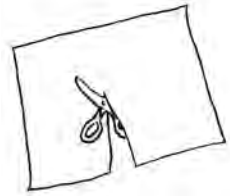
We sent you some materials so you can test how dust resistant they are. Try attaching one layer of these materials to both sides of your glove, test it out, and see if you think it would be a good choice for making a dust-resistant model space glove!

Talk to you soon,

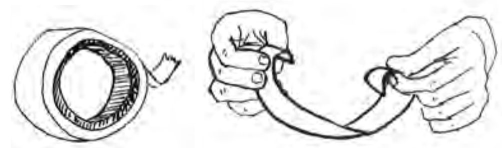
Jacob



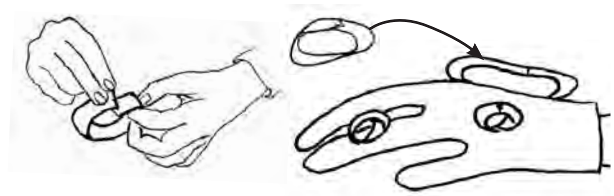
1. Cut your material.



2. Use loops of masking tape to attach **1 layer** of the material to **both sides of the glove**.



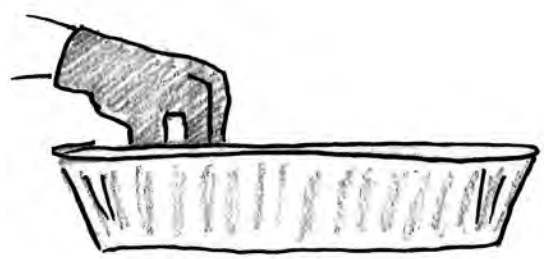
3. Open the plastic bag.



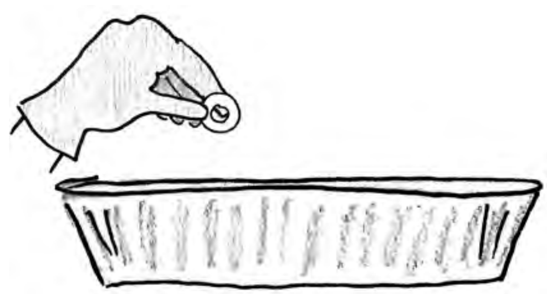
4. Use your glove to dig through the dust and find the 5 metal washers.

5. Use your glove to place the 5 metal washers into the plastic bag.

6. Use a paper towel to wipe off any extra dust from your glove.

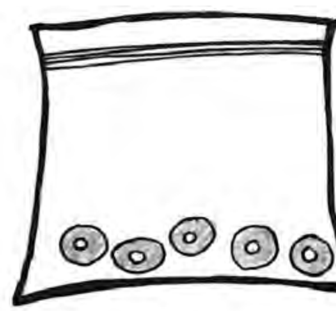


7. Look at the palm side of your glove with the hand lens and black light to find the places that glow. How many areas have glowing dust?



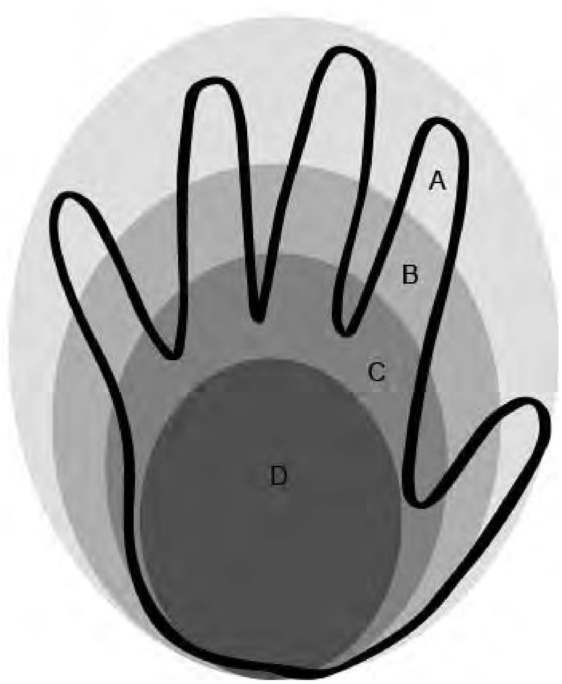
8. Record your results in your Engineering Journal.

9. Reset the station for the next group: bury the 5 metal washers back in the sand and mix the sand using the craft stick.



Directions:
Using the hand diagram below, find out how many areas of your glove's **material** has glowing dust. (*Example: There is glow powder in areas A & C, or a total of 2 areas, so it is "good" at protecting against dangerous dust.)*

Is your material good at protecting against dust?



Not Good	Good	Great
4+ areas	2–3 areas	0–1 area

Did You Know?
Dust on Earth is a mixture of sand, dead skin cells, tiny hairs, dander, pollen, dust mites, and minerals from space.

Test Results		
Test Material	**Number of Areas**	**Is your material good at protecting against dust?**

Reflect
Which materials were great at protecting against dust?

Why do you think these materials worked well?

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Astronauts need your help! 10:15 AM

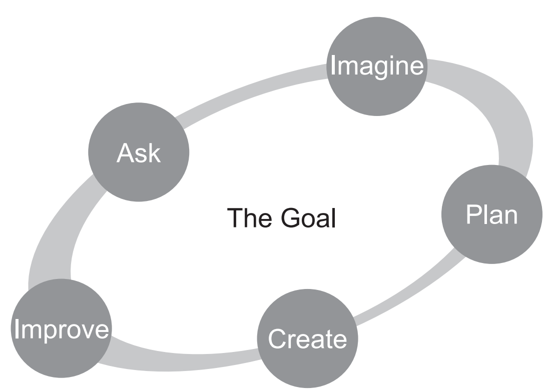
Hi engineers!

You did a great job testing materials to see how well they protect against space hazards! Now it's time to put together everything you've learned about materials engineering to design a model space glove.

Maru told us about three space missions that could use your help. These missions will send astronauts to the Moon, asteroids, and Mars. It's your job to design a model space glove for one of these teams. We sent you some images so you can get an idea of how the gloves will be used and what these places are like. Which materials can you combine to protect from the hazards of your mission?

Since we can't test our gloves in space just yet, we've been using a simulation here at the testing site—a way to model the hazards the astronauts might face on their missions. We've sent you some stations so you can run a simulation on your model gloves.

You won't be surprised by three of the stations—they're the same tests you've been using all along. But don't forget, an astronaut will need to wear and use your glove, so we sent you a final station to see if your glove is strong enough to make it through the entire mission and is easy for the astronaut to use. The data you collect from all of these tests will help you *improve* your design later. We can't wait to see what you come up with!

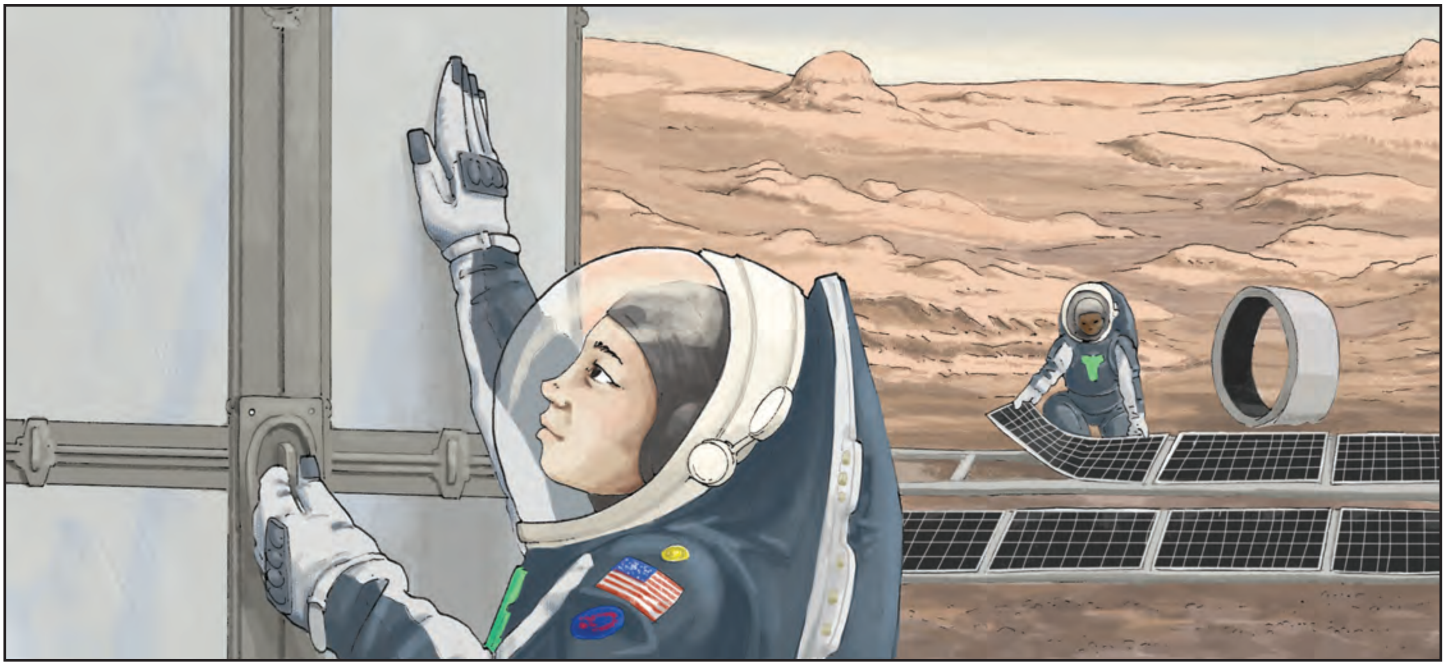


Good luck!

India

Mars

Build a habitat on the planet Mars.

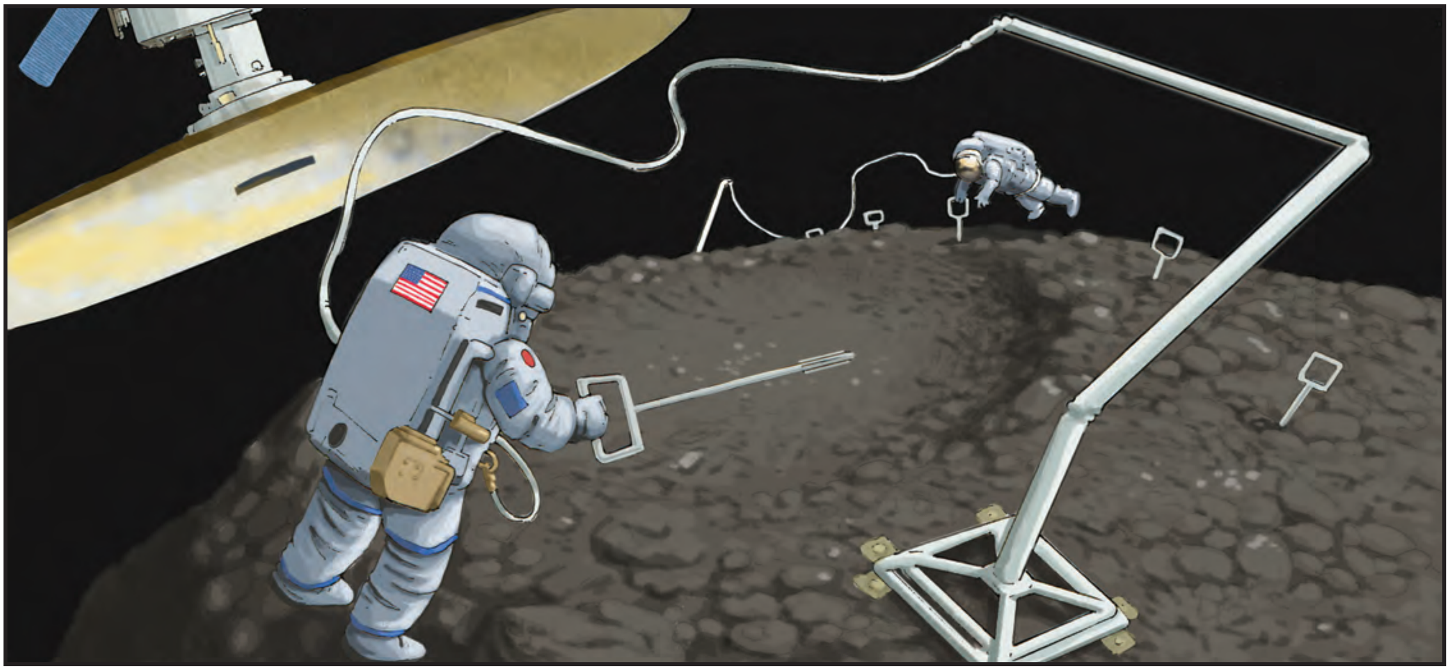


Your model space glove should:	Your model space glove cannot:
• protect from both **dust** and **impact** hazards. • allow you to open a jar and type on a calculator. • be removable.	• use more than 3 materials. • use more than 3 feet of tape. • have any materials or parts fall off after testing.

Did You Know?
Mars is the fourth planet from the Sun. There is so much rust in the rocks that Mars is nicknamed the "Red Planet."

Asteroids

Mine asteroids for their minerals.



Your model space glove should:	Your model space glove cannot:
• protect from both **cold** and **impact** hazards. • allow you to open a jar and type on a calculator. • be removable.	• use more than 3 materials. • use more than 3 feet of tape. • have any materials or parts fall off after testing.

Did You Know?
Asteroids are small, rocky objects that are sometimes called "minor planets." Most asteroids in our solar system are found in the Asteroid Belt between Mars and Jupiter.

Did You Know?
Some asteroids are made of materials that have been around since the solar system formed 4.5 billion years ago.

Moon

Build a radio tower on the far side of Earth's moon.

Your model space glove should:	Your model space glove cannot:
• protect from both c**old** and **dust** hazards. • allow you to open a jar and type on a calculator. • be removable.	• use more than 3 materials. • use more than 3 feet of tape. • have any materials or parts fall off after testing.

Did You Know?
We always see the same side of the Moon from Earth. This is called the "near side." Sometimes the far side is called the "dark side," but it actually gets the same amount of sunlight as the near side!

Which materials will you use to engineer your model space glove? Draw your ideas and label the features of your design.

PALM

BACK

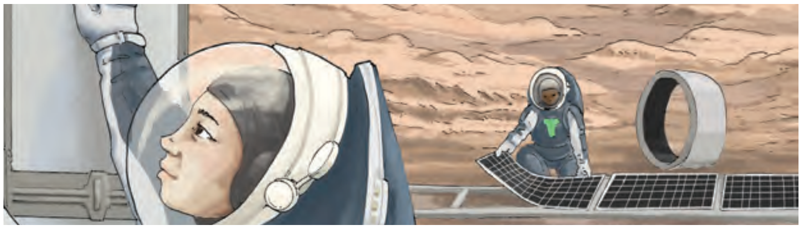
Where will you place the materials?
- on the palm side of the glove
- on the back side of the glove
- inside the glove
- outside the glove

How will you use the materials?
- layering
- combining materials

Why did you choose these materials?

Mars

How well did your glove perform in the tests below?



Dust: Circle how well your model space glove protects against dust.

Not Good	Good	Great
4+ areas	2–3 areas	0–1 area

Impact: Record your results. Circle how well your model space glove protects against impact.

Test 1	Test 2	Test 3	Final

Not Good	Good	Great
11+ pieces	8–10 pieces	5–7 pieces

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

Yes **No**

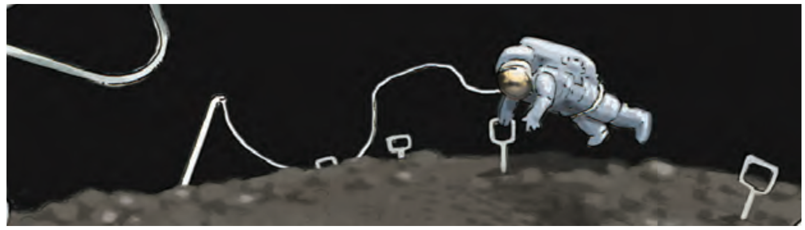
Did your glove stay together after testing?

Yes **No**

Did You Know?
Dust storms are very common on Mars. Sometimes there are storms so large they cover the entire planet!

Asteroids

How well did your glove perform in the tests below?



Impact: Record your results. Circle how well your model space glove protects against impact.

Test 1	Test 2	Test 3	**Final**

Not Good	**Good**	**Great**
11+ pieces	8–10 pieces	5–7 pieces

Cold: Record your results. Circle how well your model space glove protects against the cold.

Starting Temperature	**Temperature after 30 Seconds**	**Difference in Temperature**

Not Good	**Good**	**Great**
7 °C or more	3–6 °C	0–2 °C

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

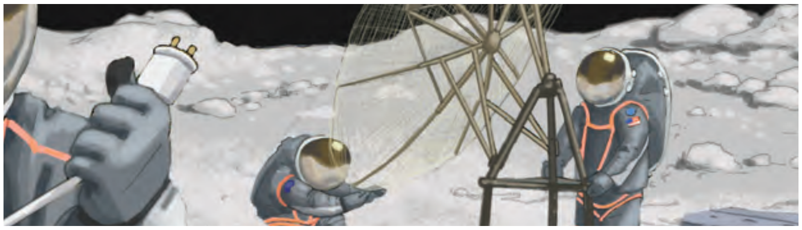
Yes **No**

Did your glove stay together after testing?

Yes **No**

Moon

How well did your glove perform in the tests below?



Cold: Record your results. Circle how well your model space glove protects against the cold.

Starting Temperature	Temperature after 30 Seconds	Difference in Temperature

Not Good	Good	Great
7 °C or more	3–6 °C	0–2 °C

Dust: Circle how well your model space glove protects against dust.

Not Good	Good	Great
4+ areas	2–3 areas	0–1 area

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

Yes **No**

Did your glove stay together after testing?

Yes **No**

Did You Know?
Dust on the Moon comes from small materials from space hitting the Moon's surface.

reply forward archive delete

from:	engineeringadventures@mos.org
to:	You
subject:	Mission Ready? 3:12 PM

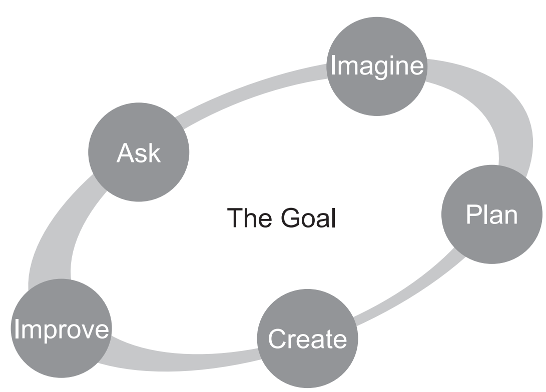
Hi engineers,

We can tell you’ve been working really hard on the model space gloves you’ve been designing for the different missions!

Your model space gloves should combine materials to help protect from different hazards and pass the final test to make sure your gloves are strong enough to last the entire mission and are easy for astronauts to use. Maru explained that engineers have to choose materials wisely to make sure they meet all of their goals as best as they can. That means engineers are always testing and *improving* their technologies. Share your ideas with each other and see if you can *improve* your model space gloves to make them even better!

Next time, you’ll get to share your model space gloves with an audience in the Engineering Showcase. To help you prepare, you can work on any improvements you need to make and do a final Mission Simulation to make sure your designs are mission ready before you show them off. We can’t wait to see your final designs!

India and Jacob



How can you improve *your model space glove to make it even better? Draw your ideas and label the changes to your design.*

PALM

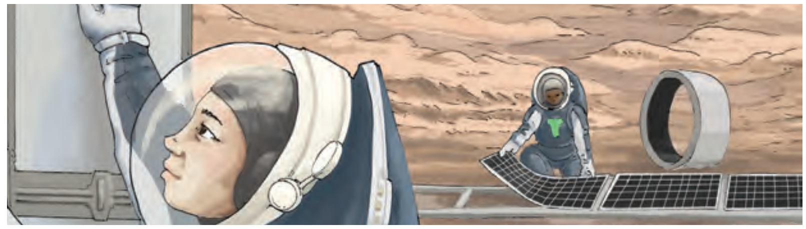
BACK

Will you change where you place the materials?

Will you change the materials?

Why will you make these changes?

Mars



How well did your glove perform in the tests below?

Dust: Circle how well your model space glove protects against dust.

Not Good	Good	Great
4+ areas	2–3 areas	0–1 area

Impact: Record your results. Circle how well your model space glove protects against impact.

Test 1	Test 2	Test 3	Final

Not Good	Good	Great
11+ pieces	8–10 pieces	5–7 pieces

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

Yes **No**

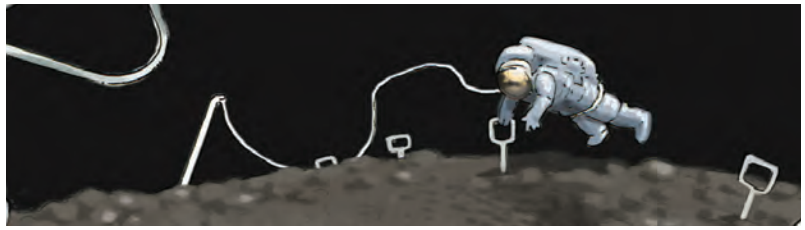
Did your glove stay together after testing?

Yes **No**

Did You Know?
Mars has four seasons, just like Earth.

Asteroids

How well did your glove perform in the tests below?



Impact: Record your results. Circle how well your model space glove protects against impact.

Test 1	Test 2	Test 3	Final

Not Good	Good	Great
11+ pieces	8–10 pieces	5–7 pieces

Cold: Record your results. Circle how well your model space glove protects against the cold.

Starting Temperature	Temperature after 30 Seconds	Difference in Temperature

Not Good	Good	Great
7 °C or more	3–6 °C	0–2 °C

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

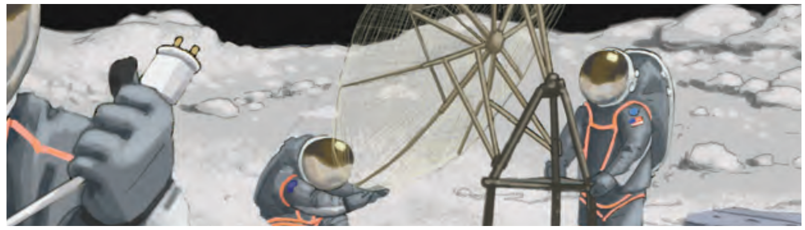
Yes **No**

Did your glove stay together after testing?

Yes **No**

Moon

How well did your glove perform in the tests below?



Cold: Record your results. Circle how well your model space glove protects against the cold.

Starting Temperature	Temperature after 30 Seconds	Difference in Temperature

Not Good	Good	Great
7 °C or more	3–6 °C	0–2 °C

Dust: Circle how well your model space glove protects against dust.

Not Good	Good	Great
4+ areas	2–3 areas	0–1 area

Final Test:

Were you able to open the jar, remove the equation, and type it into the calculator?

Yes **No**

Did your glove stay together after testing?

Yes **No**

Did You Know?
Other than Earth, the Moon is the only place in the solar system where humans have set foot.

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Final Mission Simulation

5:10 PM

Hi everyone,

The model space gloves you designed for your missions are very impressive. We can't wait to show Maru your designs.

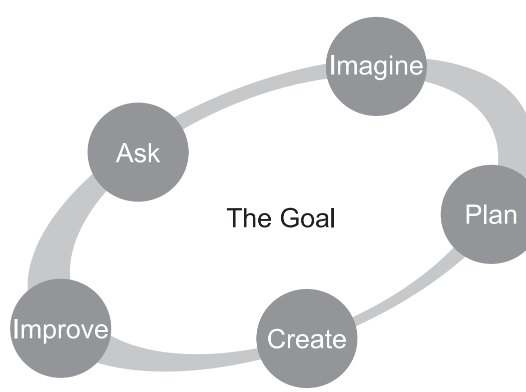
Today, you will get to show everyone all of your hard work. Remember to tell people how you used the Engineering Design Process and what you learned about materials to engineer your technologies. This is your chance to explain to people how your glove is strong enough to make it through an entire mission and easy for an astronaut to use.

Write us back and tell us all about your final design!

Until the next adventure,

India and Jacob

engineeringadventures@mos.org



Use the questions below to *plan* for your presentation.

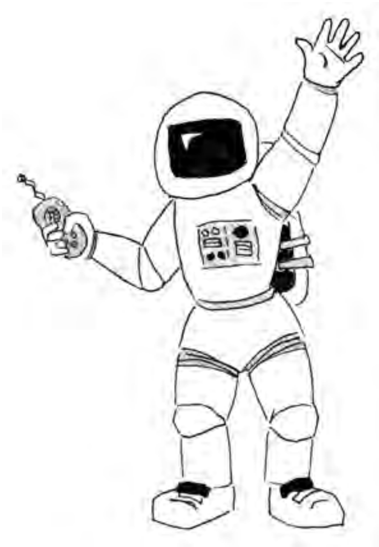
- What is your mission? Which hazards does your model space glove need to protect against?

- Which materials did you use? Why?

- Where did you place your materials on your glove? Why?

- Which steps of the Engineering Design Process did you use to engineer your technology?

- Which parts of your design worked well?



For the Record

I would like to be a materials engineer. ☐ Yes ☐ No ☐ Maybe so

Why or why not?

What do you want to engineer next?

____

Draw your technology here!

My engineering checklist:

- ☐ Find friends to work with.
- ☐ ***Ask*** questions about how to start.
- ☐ ***Imagine*** lots of ideas.
- ☐ Make a ***plan***.
- ☐ ***Create*** and test the plan.
- ☐ ***Improve*** until you think it is ready.

What materials will you use?

Space Glove Glossary

Dust: A mixture of different ingredients, such as grains of sand, dead skin cells, tiny hairs and threads, animal dander, pollen, human-made pollutants, dust mites, and even minerals from outer space.

Dust resistant: A quality or treatment of a material that prevents dust from sticking to it.

Engineer: Someone who uses creativity and knowledge of math and science to design things that solve problems.

Engineering Design Process: The steps that engineers use to design something to solve a problem.

Hazard: A source of danger.

Impact: The act of one thing hitting another.

Insulator: A material that does not allow heat to move through it quickly.

Material: What something is made of.

Materials engineer: A person who uses creativity and knowledge of science and math to solve problems related to materials and their specific properties.

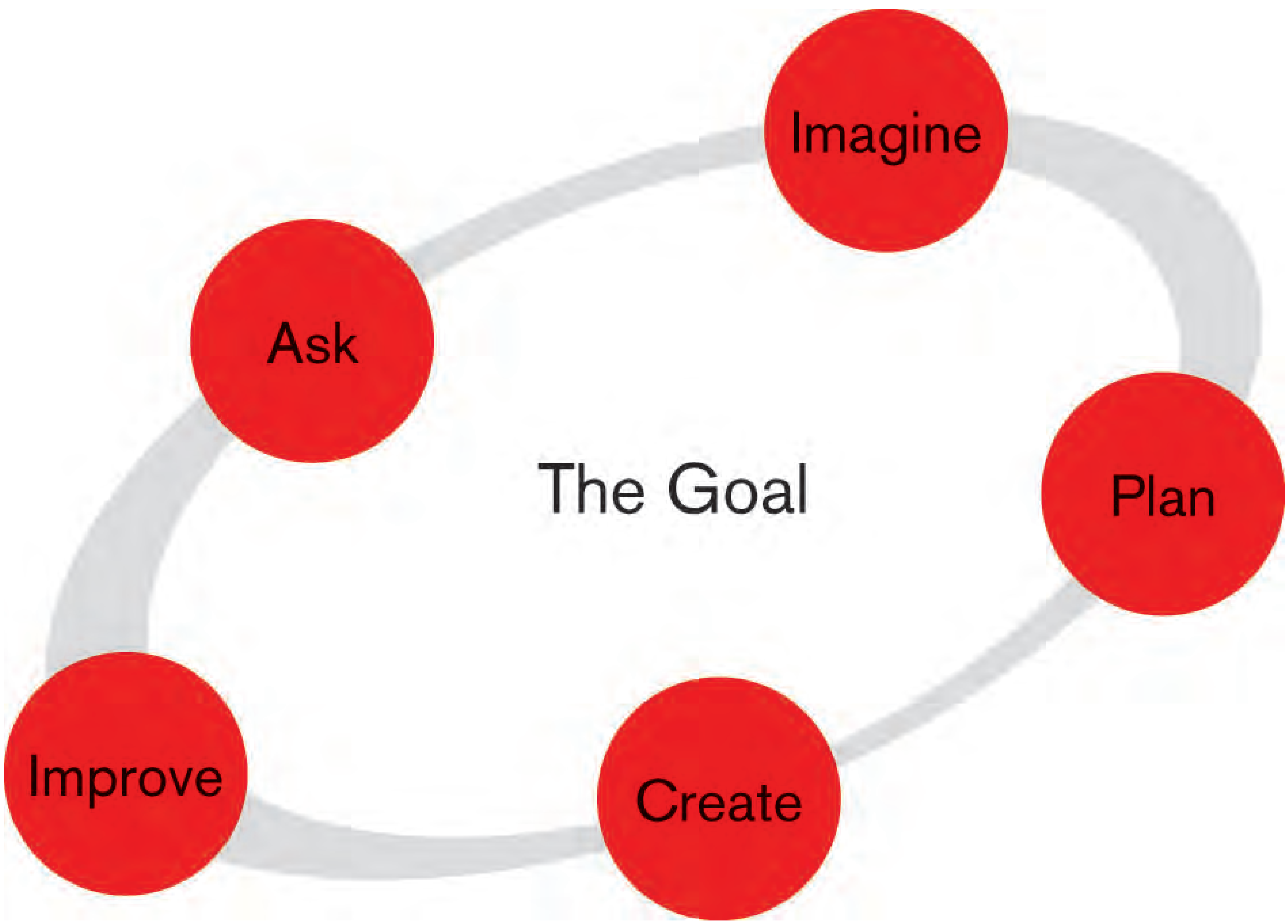
Simulation: An imitation of a real situation or process for the purpose of learning.

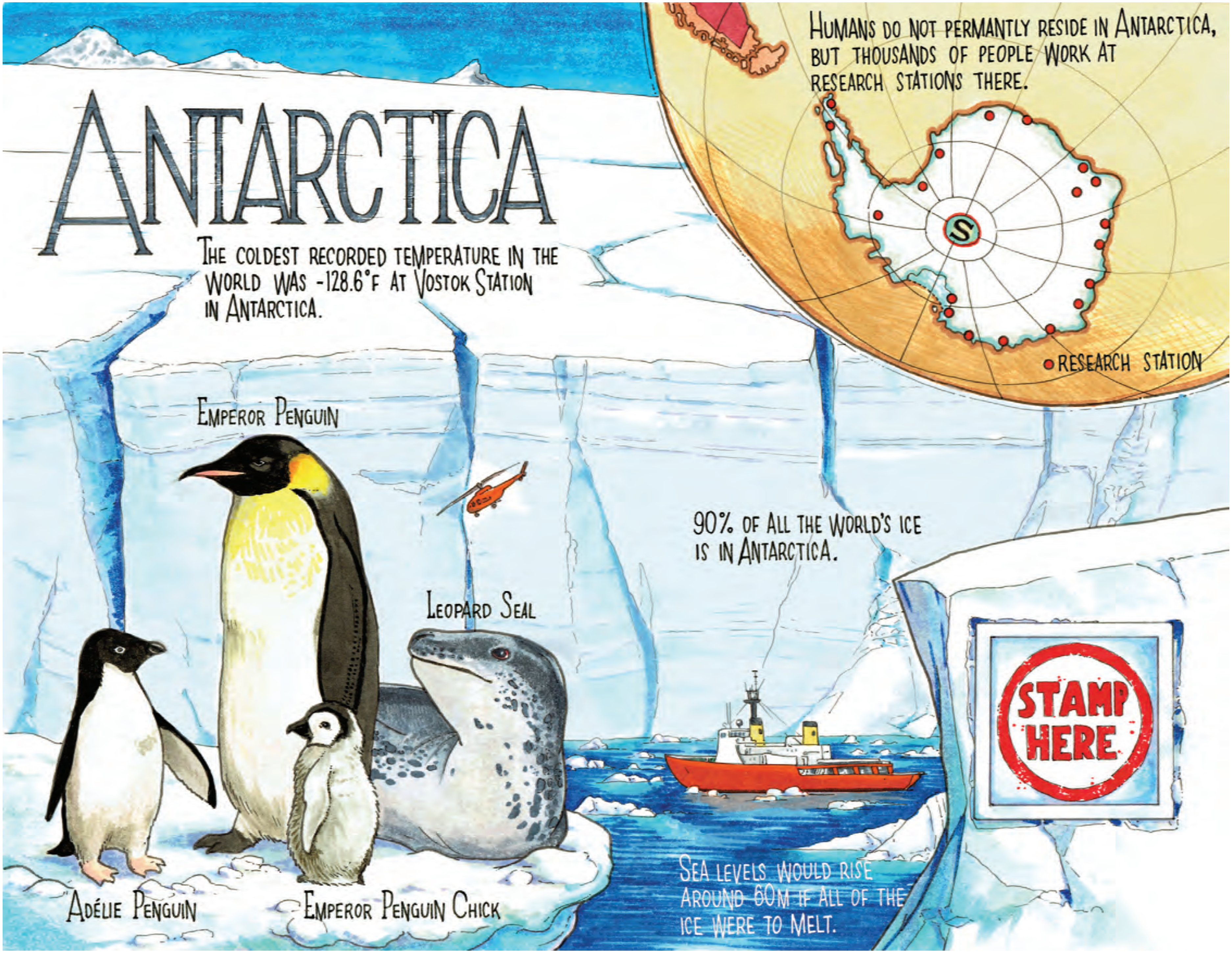
Space debris: Scattered natural and human-made debris, such as broken bits of meteorites, old satellites, and pieces of spacecraft.

Technology: Any thing designed by humans to help solve a problem.

Temperature: A measurement of how hot or cold something is.

The Engineering Design Process




ANTARCTICA
THE COLDEST RECORDED TEMPERATURE IN THE WORLD WAS -128.6°F AT VOSTOK STATION IN ANTARCTICA.
HUMANS DO NOT PERMANTLY RESIDE IN ANTARCTICA, BUT THOUSANDS OF PEOPLE WORK AT RESEARCH STATIONS THERE.
S
RESEARCH STATION
EMPEROR PENGUIN
LEOPARD SEAL
90% OF ALL THE WORLD'S ICE IS IN ANTARCTICA.
STAMP HERE
ADÉLIE PENGUIN
EMPEROR PENGUIN CHICK
SEA LEVELS WOULD RISE AROUND 60M IF ALL OF THE ICE WERE TO MELT.