Engineering Adventures

Engineering Journal
The Sky’s the Limit:
Engineering Flying Technologies

Your Name:_________________________________
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, or 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!

We have an engineering challenge we think you can help us solve. Jacob has taken up photography. He saw some interesting pictures of landscapes that were taken from above. They’re called aerial photos, meaning they were taken from high up in the air. Jacob wants to take some aerial photos of our yard, but he needs a tower he can climb up. Do you think you can create a model tower that’s at least 10 inches high? The models will serve as inspiration for the tower Jacob builds. The taller it is, the more land Jacob will be able to photograph.

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

Good luck!
India and Jacob
Here are three ways to build 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!
Prep Adventure 1

10 inches and up

7-10 inches

5-7 inches

3-5 inches

0-3 inches
Draw Your Tower

*Use the space below to draw a picture of your tower.*

What parts of your tower design would you change if you could do it again?

For the Record

I think engineering is:

- □ Fun
- □ Exciting
- □ Difficult
- □ ________________
Hi Engineers,

You did a great job engineering an aerial photo tower for Jacob! Now you can help us engineer more technologies.

Do you know that the things engineers create 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 helping people 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 a detective challenge for you today. We sent you some objects and we want you to figure out if they are technologies. Lots of times engineers think about ways to improve technologies. Can you use the Engineering Design Process to imagine ways to make some of these technologies even better?

Talk to you soon,
India and Jacob
What is your group’s object?

Is it a technology?
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!

You’re an engineer. Write or draw how you would make this technology better.

If you could engineer a brand new technology, what would it be? What would it do?
Hi Engineers,

Our friend April has asked us to help her with an exciting challenge, and we knew you were a great bunch of engineers to join us. April works at the Ames Research Lab, which is part of NASA—the National Aeronautics and Space Administration. April is an aeronautical engineer, which means she designs technologies that fly through Earth’s atmosphere, like airplanes and gliders.

Another thing April’s lab does is use the technologies they engineer to take pictures from far above the Earth’s surface. We sent you some example pictures to look at. People might think NASA only explores outer space, but April told us that there are still some areas right here on planet Earth that have barely been explored. Some of these places are hard for people to reach, the land is dangerous to travel over, or the weather is difficult to travel through. That’s where April and her team come in. They have engineered technologies that can help us explore these areas by taking aerial photos—photos from above. NASA’s photos are used by scientists all over the world. They can help us monitor things like weather patterns and where plants grow.

April has a very special assignment. She said if we learn about some different aeronautical technologies, she’ll let us help her take aerial photos. She hasn’t told us where we’re going yet, but she said it’s a place unlike any other!

April is letting us experiment with a vertical wind tunnel, one of the testing tools in her lab. It makes an updraft, which means the air inside flows straight up towards the ceiling. We sent some materials so you can test, too!

India and Jacob
Clouds over the Bering Sea

Over the Norwegian Sea

Photos courtesy of NASA
Where in the World?
Can you find each of these locations on a world map? Do the photographs look like what you would expect?
Adventure 1

Make A Vertical Wind Tunnel

Make your wind tunnel so you can test how different objects interact with moving air.

You will need:
- 1 round table fan, 8-10 inches across
- 1 large transparency sheet, 40 inches by 40 inches
- 1 pair of scissors
- 1 ruler
- Clear packing tape

1. Move the fan so it will blow air vertically (up towards the ceiling), but leave the fan off for now.

2. Tape the transparency sheet around the fan so it makes a tunnel around the air blown by the fan. Do not cover the back of the fan where air is being pulled in.

3. Tape the seam where the sides of the transparency sheet meet.

4. Cut an entry door about 3 inches by 3 inches in the transparency sheet close to the fan.
Test your wind tunnel by placing different objects in the entry door. What happens to different objects? Do the objects that float higher or longest have anything in common?

Draw a picture or write a description of the objects you test below, and what happens to them in the wind tunnel.

________________________________________

________________________________________

________________________________________
Hello Engineers!

India and I had a great time testing materials in the vertical wind tunnel. We learned a lot about how objects react in an updraft of wind.

This got us wondering about what would happen if there isn’t a lot of air moving. How could a technology hover or fly over an area without strong wind pushing against it? April explained that all flying technologies rely on the air around us. Some technologies, like drop copters, are designed so that air pushes against them as they fall. Drop copters spin like helicopters when you drop them. As they fall, air pushes against their blades and slows them down. The more slowly they fall and spin, the more photos we would be able to take for April before they hit the ground.

Speaking of the ground, we still don’t know what part of the world we’ll be helping to take pictures of. April did give us one hint. She said we’ll be on the sand, but not at the beach. Do you have any guesses?

The criteria for your drop copter designs is that they should fall as slowly as possible. India and I sent you some templates you may want to try, but we know you’ll be able to use the Engineering Design Process to imagine, plan, and create drop copters that fall even more slowly than our examples! Try playing around with different materials, shapes, numbers of blades, and even adding paper clips as weights. We can’t wait to hear how it goes!

Jacob
Adventure 2
My Drop Copter

Criteria
What your technology needs to do
Try to design a drop copter that falls more slowly than the template drop copters.

Constraints
Ways that you are limited
You can only use the materials provided at the Materials Table.

Use this space to sketch out any drop copter ideas you have. Be sure to record if you added any paper clips as weights. Circle which drop copters fell most slowly.
Hi everyone!

Jacob and I spent a lot more time engineering drop copters to try to get some that fell very slowly. We feel like we’re drop copter experts. How about you?

We decided to try designing something else that spins. Jacob was thinking about the propellers on a helicopter. April said lift is the force that holds the helicopter up. As the propellers spin and move through the air, they create lift. Jacob showed us a flying disc toy. When you spin it, lift is created and the toy flies up. We want to engineer our own flying discs! Our goal is to design a flying disc that spins and creates lift as it moves through the air.

April was so impressed with all the aeronautical engineering that we’ve done that she finally revealed where we’ll be traveling to take our aerial photos. It’s the biggest sand desert on Earth, and it is called the Empty Quarter. It is in the Middle East and covers parts of Saudi Arabia, Yemen, Oman, and the United Arab Emirates. The desert is 250,000 square miles and the temperatures can reach over 130 degrees Fahrenheit. NASA, scientists, and engineers all over the world are interested in studying the Empty Quarter, since the desert is similar to the environments of some moons and planets. Studying lots of harsh environments will help the scientists and engineers at NASA plan for the technologies they’ll send into space.

Try engineering some spinning discs of your own. Remember your goal: to design flying discs that spin and create lift as they move through the air.

Good luck!
India
There are two ways you can launch your flying discs.

**Launch with your hands**

1. Make your flying disc.
2. Attach your disc to a straw using tape.
3. Hold the stick between your hands.
4. Move your hands back and forth to spin the stick and release.

**Launch with the wind tunnel**

1. Make your flying disc.
2. Slide your flying disc down the string attached to the fan.
3. Hold the top of the string.
4. Turn on the fan.
Criteria
What your technology needs to do
Design a disc that spins through the air.

Constraints
Ways that you are limited
You can only use the materials provided at the Materials Table.

Use this space to imagine and plan your flying disc designs. Circle which ones spun through the air.
Alaska

Photos courtesy of NASA
Hi Engineers,

Jacob and I have arrived! The name Empty Quarter doesn’t begin to describe what it’s like here. Imagine the biggest, hottest, sandiest area you’ve ever been to. Now imagine that a million times bigger, hotter, and sandier! The wind makes beautiful patterns in the sand and you can see for miles and miles.

Our mission is to take aerial photos of this huge desert with many weather patterns, so Jacob and I thought we better break this into smaller challenges. On a map, we blocked off different areas of the Empty Quarter. We’re going to engineer models of different technologies that could fly above each area we marked off. Models are representations of something. It can be really smart with a big project like this to make a smaller model technology first to make sure it works well. Then, April and her crew will make the full-sized version.

You have learned so much about different aeronautical technologies! Jacob and I know you will be able to help us. But, before I sign off there’s one more tiny little hitch. Apparently there’s a big sandstorm brewing. It’s creating some wind patterns that you might need to think about when designing your technologies. Don’t worry, though. Jacob and I will keep you posted!

So, take a look at the map Jacob and I marked off and choose which area you would like to photograph. Engineer a technology that will meet the criteria and constraints for flying in the area that you’ve chosen. Use the Engineering Design Process to help you. Good luck!

Talk to you soon,
India
Hello!

Years ago, aerial photographers went to the Empty Quarter to study the animals that live there. We sent you some images below.

Remember, the higher your aerial photographer and the slower your flying technology falls, the more pictures you will be able to take.

Good luck!

India and Jacob
Circle the area of the Empty Quarter your team is going to photograph.

Think about the criteria and constraints for your technology. *Imagine* and *plan* some designs below.

Test
Once you have *created* your design, test it by dropping it or launching it! Count the seconds it takes for your technology to reach the ground. The longer it takes, the more photos your technology will gather.

Test 1 Time:  
Test 2 Time:
Hey there engineers!

India and I are almost ready to share our model flying technologies with NASA.

We always find ways to improve our designs, and if we aren’t sure what to do, we ask other people. April and her engineering team do this all the time as they design technologies. It can be really helpful to have someone look at your technology and let you know what they think can be improved. We talked to April and some of her friends back at the Ames Laboratory and she gave us a few aeronautical engineering tips. You should do the same with the other groups working around you.

You can help each other by talking about parts of your design that work well and parts that need improvement. Share your ideas with us, too! We can use what you figured out to help us improve our flying technologies. We are excited to see what you came up with!

April warned us there may be one or two more challenges that might come up at the last second. We’ll let you know if we find anything out! Until then, we’ll keep improving. With our technologies as models, we think NASA will be able to take some great aerial photos.

Good luck!
Jacob
Improve your flying technology so it meets your criteria and constraints. Use the questions below to help you.

Which step of the Engineering Design Process helped you the most when you were engineering your flying technology?

Draw your improved flying technology here:

Which step was the most difficult for you?
Hi Engineers!

It’s time to share the model flying technologies you’ve created. With all the great aeronautical engineering work you’ve done, we know NASA will be able to complete this mission and take some great aerial photos of the Empty Quarter.

Today you’ll have the chance to share your model flying technologies with other people. Be sure you also share what you’ve learned about the Engineering Design Process. You know a lot about what to do if your technology isn’t working quite the way you planned it. Sometimes you have to ask new questions and imagine and plan new things to improve your technology.

We can’t wait to see what the NASA photos reveal. You’ve been great aeronautical engineers!

Until next time,
India and Jacob
Think about the questions below when crafting your presentation.

What is your technology?

What were the criteria and constraints for your section of the Empty Quarter?

How would you describe the way your technology moves through the air? How does it work?

Circle the steps of the Engineering Design Process that you used the most.
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 the technology until you think it is ready.

What materials will you use?

_____________________________

_____________________________

_____________________________

_____________________________
Although it is mostly sand, there are also dry lake beds, gravel plains, and some mountains.

Rub‘ al Khali or Rub‘ al Khali is one of the largest sand deserts in the world. Some of its dunes are more than 250 meters high.

A traditional camel caravan