

Activity Guide

Includes Activities for all ages
CHALLENGE LEVEL 2

Explore STEM with

NC STATE Engineering

WARNING: These STEM activities have been known to cause extreme excitement.
Some have even reported increased brain activity and a new love for Engineering!

This adventurous guide was brought to you
by North Carolina State University Engineering.

*Activities in this guide will require materials and supervision.



Parental Authorization

(Parent/Guardian must complete and give to the accompanying adult if it is not the parent or some school systems require them to be turned into home room teacher.)

I/We, the undersigned, grant our son/daughter _____ permission
(Name of Student)

to participate in an out-of-school educational activity as part of the **Take Our Daughters and Sons to Work® Day**.

Should a medical emergency arise while my son/daughter is participating in this field trip, the accompanying adult or I will be responsible for initiating medical treatment. I give permission for immediate treatment as required in the judgment of the attending physician.

If there are any changes to the information provided herein, it is the parent's responsibility to provide the updated information.

Signature of Parent or Guardian

Signature of Parent or Guardian

Date

Special Note:

Parents/Guardians of students that are participating in the Take Our Daughters and Sons to Work® Day event should fill-in an Excused Absence Form if your school needs.

What is Engineering?

Have you ever solved a problem? Maybe you have solved a homework problem in math or science. But what about a problem like how to do your chores faster or how to reach something on a tall shelf? Engineers solve society's problems, and their work is all around you!

*Name Something Engineers
Help To Create:*

E— Earphones

N—

G—

I—

N—

E—

E—

R—



NC STATE Engineering

GETTING AROUND – Take a look at your tennis shoes — what do you use them for? Can you list all of the materials in your shoe? Can you find different kinds of tennis shoes and compare their features and tread? How are they different? Engineers develop lighter and stronger materials that allow your feet to breath and design shoes to perform the best for different types of activities like running, basketball and skateboarding.

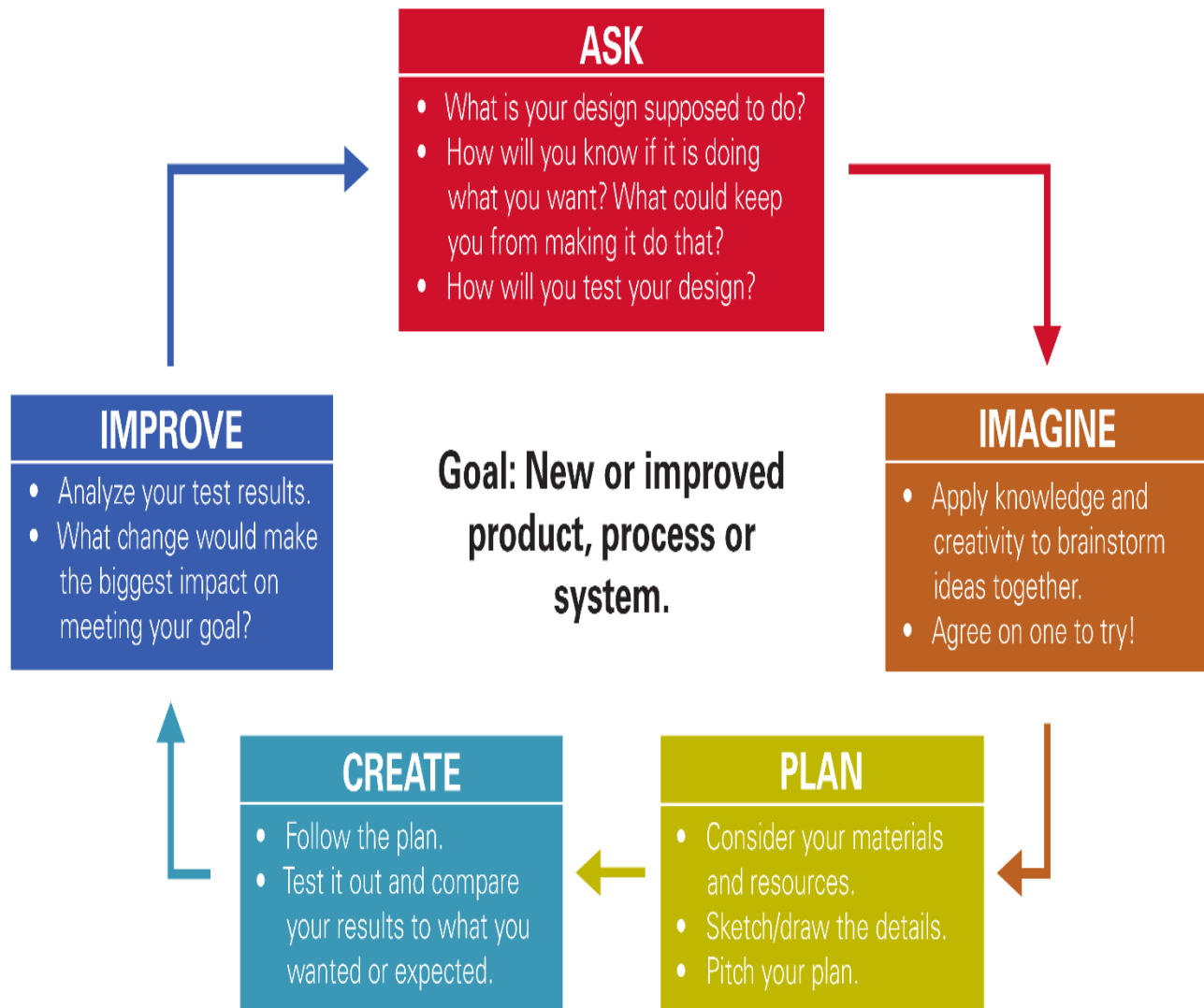
STAYING WELL – Have you ever had an x-ray at the doctor's office or dentist? You probably got to see your tissue and bones! Lots of engineers work to develop the machines that take these images. Engineers also design things like electronic thermometers, hearing aids and tiny robots so small that they can be used for surgery!

YUMMY ON THE TUMMY – We all love a great candy bar or piece of chocolate, but where and how are they made? Engineers design equipment to make your favorite candies and foods, as well as design processes that don't waste ingredients and produce the freshest, best-tasting treats! They might also be involved in developing the packaging that your candy is wrapped in — from the materials to the shape and design!

CHEMICALS AT WORK – Have you ever wondered how that sticker on your apple stays on during shipping and at the store but comes off so easily when you are ready to eat it? Engineers develop new chemicals and materials that make our lives easier — like the stuff in diapers which makes them absorb liquids, glue that can be used on your skin instead of stitches and solar cells that can collect the sun's energy.

GAMES, GAMES AND MORE GAMES – Have you ever played games on a Nintendo Wii™ or a Playstation®? Engineers and Computer Scientists not only designed the box, the guts and the handsets, but they also designed all of the software tools for the graphics, menus, sounds and actions! Next time you play, thank an engineer!

The Engineering Design Process



- The engineering design process is a series of steps that you repeat to develop or improve a product, process or system. You can start anywhere in the process, however, most engineers begin at **ASK** or **IMPROVE**.
- Failure is always a part of the process ... so is learning from failure!

Design process adapted from the Museum of Science Boston "Engineering is Elementary" program.



the engineering place

Ship a Chip

Objective: To design and create an effective and efficient packaging system and creative label for a single potato chip.

Materials:

- Shredded Paper
- Paper
- Masking Tape
- Plastic Bags
- Paper Plates
- Newspapers

Tools:

- Markers
- Scissors
- Rulers



Activity Details: Pringles wants to ship one of their delicious chips to everyone in the country, and they have chosen you to create the package that all of the chips will be delivered in. Remember that the package must be light to save money, protective enough to keep the chip in good condition, and small enough to fit in the average mailbox. Don't forget to include a creative label so that the recipient will know that the package comes from Pringles!

Testing Process: One prototype will be made and tested by tossing them and dropping them. A second set of materials will be purchased and used for the final package. You will mail your packages to the following address:

Cynthia Carpenter
c/o Gateway Technology Center,
North Carolina Wesleyan College
3400 N. Wesleyan Blvd., Rocky Mount, North Carolina 27804

They will be judged by the recipient based on:

- Weight of the package
- Cost of the materials
- The condition of the potato Chip (breakage, freshness)
- Creativity of the label

Ship a Chip - continued

ENGINEERING DESIGN CYCLE

ASK: How does the test process affect your design? What will make the recipient think that your package is the most effective and efficient?

IMAGINE: What ideas do you have for reaching your goal? What is your best idea?

PLAN: The materials and their costs are as follows. Use your materials wisely!

Material	Cost of Material	Quantity of Material	Cost of Quantity
Shredded Paper	\$0.10 per bag		
Sheet of Paper	\$0.05 per sheet		
Masking Tape	\$0.15 per yard		
Plastic Bag	\$0.15 per bag		
Foam Plate (1 max)	\$0.15 per plate		
Newspaper	\$0.15 per sheet		
Total Cost			

Ship a Chip - continued

PLAN (continued): Draw a diagram of your design (including your label) below. What materials did you choose? What are the roles of everyone in your group? What is your plan for finishing in the time allotted?

CREATE: Carry out your plan and test your design. Was it successful? Why or why not?

IMPROVE: What was good about your design? What can you make better?

Snack Attack

Objective: To gain an understanding of the factors involved in designing cost conscious, environmentally friendly, and effective food packaging.

Materials:

- Cardboard
- Aluminum foil
- Wax paper
- Plastic wrap
- Small foam plate
- Toothpicks
- Paper towels
- 2 graham crackers
- 1 piece of chocolate
- 1 large marshmallow



Tools:

- Stapler
- Scissors
- Tape

Activity Details: A new candy company wants to package individually wrapped, ready to heat S'mores that can stay fresh in the wilderness or on a camping trip. Engineers have been working on the problem and developed some designs to be tested. After the first part of testing, the biggest problems are with making the package weather proof. Design a package to protect a S'more from HEAT AND WATER.

Snack Attack - Continued

Test Process: Working in groups of 2 or 3, using the **Experiment and Cost Activity Sheet**, plan a package that your group feels will best protect your S'more from heat and water.

Write down the materials you need figure the total cost per item and then add up the total for the entire package.

Submit your cost sheet to your team leaders, they will assign a 'cost score' to each group, based on the overall expense of the package. The most expensive package gets 1 point, the least gets 8 points (if there are 8 groups) the rest are ranked in order of costs.

Next, take your group's completed material list/cost sheet to the 'store' to 'purchase' the materials you have selected. Construct your package.

After you complete the package, turn to the **Test Instructions Activity Sheet**. Take your package to each test station to be tested. After the testing, unwrap the package and look at the results. Fill in the form based on the results you see.

Snack Attack - Continued

Experiment and Cost Activity Sheet

Team Members : _____

Experiment: Create a package that will keep your S'more cool and dry. It will need to keep your chocolate and marshmallow from melting during the heat test (45 seconds under a hair dryer on high). Your package will also need to keep your graham cracker and marshmallow dry when 1 cup of water is poured over it. Cost is another concern. Engineers want to design good packages at the lowest possible cost. You have a budget of **50 cents** which means you can not spend more than 50 cents on your package, but you can spend less.

Scoring: Your package will be scored in two ways:

Test performance : Your package will be rated from 0 to 40 based on how well it performs in the two tests.

Cost: Your package will get a cost rating from your team leader or the "store manager". The package that costs the least (which is what you want) will get more points. The Package that costs the most will get the lowest number of points. Hand in your cost Sheet to receive your "cost score".

ITEM	QUANTITY	COST PER ITEM	TOTAL COST
Cardboard pieces (3 inch square)		10 cents each	
Aluminum foil (6 inch square)		8 cents each	
Wax paper (6 inch square)		5 cents each	
Plastic wrap (6 inch long piece)		10 cents each	
Small foam plate (cut in half)		15 cents each	
Toothpicks		2 cents each	

	TOTAL	Cannot be more than 50 cents	\$
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Snack Attack - Continued

Test Instructions Activity Sheet

Team members: _____

1. You may place a small piece of tape on the bottom of each package (to prevent movement when blow drying) and place it in the center of the baking pan.
2. Bring your package to the "heating testing station".
3. The team leader will set the top package on a flat surface and hold the hair dryer 6" from the top of the package directly over the package and blow dry on the "high" setting for 45 seconds.
4. Next take the package to the water test station
5. The team leader will hold 1 cup of water 6" from the top of the package, directly over the package, and then pour it over the top of the package.
6. Unwrap the package and look at the results
7. Based on the results of the test, fill in the form below.

Heat Test

Chocolate

Not melted (solid): 10 points
 Partly melted : 5 points
 Completely melted: 0 points
 Points Awarded _____

Marshmallow

No browning: 10 points
 Partly or completely brown: 0 points
 Points Awarded _____

Water Test

Graham Crackers

Dry: 10 points
 Damp: 5 points
 Wet: 0 points
 Points Awarded _____

Marshmallow

Dry: 10 points
 Damp: 5 points
 Wet: 0 points
 Points Awarded _____

Cost Score Points Awarded

(get this from "Experiment and Costs" Activity Sheet

Snack Attack - Continued

ENGINEERING DESIGN CYCLE

ASK: How can we make a cost efficient package that is environmentally friendly and protects the S'more from the elements?

IMAGINE: Describe what your S'mores package will look like. What materials do you think you will need?

PLAN: Draw a diagram of your design below. What are the roles of everyone in your group?

CREATE: Carry out your plan and test your design. Was it successful? Why or why not?

IMPROVE: What was good about your design? What can you make better?

It's Time For the ICE CREAM CHALLENGE!



Purpose: To Make Ice Cream

Materials:

1 quart size Ziploc bag
1 gallon size Ziploc bag
1 $\frac{1}{2}$ cups whole milk
4 handfuls ice cubes
 $\frac{1}{4}$ cup coarse (rock) salt
2 clean plastic spoons
 $\frac{1}{2}$ tsp. Vanilla extract (flavoring)
paper towels
2-3 cups for final product
Condiment cup of sugar or $\frac{1}{8}$ cup
Clean pair of scissors

Procedure:

1. Work with a partner
2. Place ice cubes in gallon Ziploc bag
3. Place milk in second Ziploc bag. Add sugar and Vanilla extract.
4. Add coarse salt in the bag with ice. Seal and shake for 20 seconds.
5. Empty most of the air from the bag with the milk in it. **MAKE SURE THE BAG IS SEALED** and place it inside the bag with the ice mixture.
6. GENTLY shake the sealed bags back and forth in your hands to make sure the ice mixture coats the milk. Shake for 3 to 10 minutes until the milk is an ice cream consistency.
7. Carefully remove the inner bag and place on the paper towels. Wipe the salty water off the ice cream bag.
8. Cut with clean scissors and pour into your cups.
9. Clean up and ENJOY!

Are You Ready to Become an Engineer Today?

(n) Engineering involves the application of creativity in partnership with math, science, social studies, language arts and fine arts to search for quicker, better and less expensive ways to use the forces and materials of nature to meet today's challenges. Engineers are problem solvers who use every resource possible to bring into existence things and ideas they imagine.

Finish These Phrases to learn more about Engineers

1. Engineers work to solve _____ such as _____, clean water, protecting the environment and improving the quality of everyday life.
2. Engineering allows you to use your _____ every day.
3. _____ have the opportunity for rapid advancement in their companies.
4. Engineering _____ remain high.
5. Engineering has more impact on the _____ than any other profession.

PHRASE BANK

Engineers

salaries

national

global problems

world hunger

creativity

world

local

NC STATE Engineering

Are You Ready to Become an Engineer Today? - Continued

ANSWER SHEET



1. Engineers work to solve global problems such as world hunger, clean water, protecting the environment and improving the quality of everyday life.
2. Engineering allows you to use your creativity every day.
3. Engineers have the opportunity for rapid advancement in their companies.
4. Engineering salaries remain high.
5. Engineering has more impact on the world than any other profession.

Exploring Sound with Resonance Chambers

Lesson Plan Developed by: Laura Bottomley

Objective: The students will observe how a resonance chamber can demonstrate the wave nature of sound. They will then use observation skills to explore different pitches and the relationship to frequency of waves.

Overview:

- Scientific Method
- Wave nature of sound
- Energy (sound as energy)

Materials:

- 12 oz plastic cups, one per student
- 10 in or 12 in balloons, one per student
- Pepper, salt and/or other granular materials
- Scissors
- CD player and various types of music
- (preferred) a small piano-type keyboard or some other device capable of producing single pitches, like tuning forks

Background Information: Decide whether you want to pre-cut the balloons or allow the students to do them. If the students have trouble stretching the balloons, it is good to have an extra adult on hand to help. After the chambers are made, it is good to pair them up for the exploration phase.

Activity (Explore):

Begin by talking about energy:

- Sound carries energy.
- Ask the students to brainstorm all the things they know about sound. Make sure that they recognize that sounds have different pitches and different volumes. Make sure they recognize the difference between pitch and volume by making or playing a few different notes at different pitches and volumes. Play or sing a single pitch loudly and softly and ask the students what the difference is between them. Elementary students will sometimes mistake volume changes for pitch changes.
- Note that some sounds do not have a particular pitch associated with them. These are percussive sounds. In speech, percussive sounds include t's and k's. You can make percussive sounds by clapping or rapping two pencils together. (Percussive sounds are really made up of many pitches combined.)
- We are going to investigate sounds by making a resonance chamber—a closed container that will resonate to sound.
- Then we will use the chambers in a short experiment using the scientific method to explore sound.

Exploring Sound with Resonance Chambers -continued

Procedure:

1. Cut the neck off of your balloon just after it starts to open up into the circular part. Discard the neck in the trashcan.
2. Insert the tips of the fingers on both hands into the balloon and stretch it over the open end of the plastic cup. It should fit tightly. If it breaks, get another balloon and cut off a bit more of the neck of the balloon next time. If it is too loose, get another balloon and cut off less next time.
3. You now have a resonance chamber. Put your mouth near the bottom of the cup (that does not have balloon on it), and speak into it. Do you hear your voice bouncing around in there? Sound bounces. That is the reason you can hear someone speak who is around the corner from you. It is also what causes echoes.
4. Place your cup on the desk with the balloon side on top. Put a little bit of pepper or other granular material on the balloon. Talk into the side of your cup and have a partner watch what happens to the pepper. Trade places, and you look too.
5. What do you think will happen to the pepper if you make a high-pitched sound into the cup and a low-pitched sound into the cup? Write down your hypothesis. Then try it, again taking turns observing with your partner. Write down a description of what happened. Try different pitches and different volumes. Try percussive sounds. If you have access to tuning forks, strike one gently on your desk and touch it gently to the side of your cup. Watch what happens.
6. When your teacher turns on the CD player, predict what will happen if you put your cup with the pepper on top in front of the speaker. Try it, and record what you observed.
7. Talk with your partner and explain what happened to the pepper. Use words like pitch and volume in your explanation. If you think it makes sense, draw some pictures of what you observed the pepper doing.

Discussion: The students will observe different things as they go through the activity. The goal is for them to accurately record in writing and/or pictures the different things they see. Most of them will notice that the pepper jumps when sound are made into the cup. The more observant of them will notice that a single pitch sung or played into the cup produces a circular pattern of pepper rings on top of the balloon. Higher pitches make those rings closer together, and lower pitches further apart. Percussive sounds make more random looking patterns on the balloon.

Questions:

Q: What are the steps to the Scientific Method?

A:

1. The Problem - Ask questions and gather facts.
2. The Hypothesis - Make a reasonable guess to the problem.
3. The Experiment - Plan (this includes a material list) and conduct the test.
4. Data - Gather data and compare to the hypothesis.
5. Conclusions—Explain why you got the results you got in your experiment. Confirm that you really tested what you meant to test.
6. Investigate Further - Determine if data can be replicated or if others found similar results.

Closure: Scientists use the Scientific Method every time they perform an experiment.

Directions for Completing the Take Our Daughters And Sons To Work[®] Day Assignment

Please use the forms (Take Our Daughters and Sons to Work[®] Day Activity Log and the Post-Take Our Daughter And Sons To Work Day Evaluation Form) to document the activities that you participated in on Take Our Daughters And Sons To Work[®] Day. Include the time, activity and the adult who supervised you while involved in the activity. A sample has been completed for you.

Activity Log

Student Name _____

School Grade _____

Workplace _____

TIME	ACTIVITY	RESPONSIBLE ADULT
8:00-8:30	Tour of OFFICE BUILDING	

* (Use if the group leader asks you to).

Evaluation Form

Your Name_____ Date_____

Name of Company_____

Fill in the blanks. Share your answers at home with your family.

1. This is the most unusual or surprising thing I saw:

2. One job I saw was:

3. The job helps people because:

4. The following school work will help in doing this job:

5. This is an example of an important work habit:

6. This is an example of a team project I learned about at the work-site visit:

7. Of all the jobs I saw, I think I would be best at:

Program Form

Let us know what you think about the Take Our Daughters And Sons To Work ® program and you may appear on our Web site. Please answer the following questions and mail this form to the address below.

1. What did you learn on Take Our Daughters And Sons To Work Day?
2. Finish this sentence: I love Take Our Daughters And Sons To Work Day because...
3. What did you learn about your parent/sponsor?
4. Finish these sentences:
My future work...

My future family...

My future community...
5. What do you think it would be like to work and take care of a family?
6. What company or organization did you attend and what did you learn about the workplace?

Full Name _____
Parent/Sponsor Name _____
Parent/Sponsor Phone Number _____
E-mail Address _____

Email To: **todastw@mindspring.com**