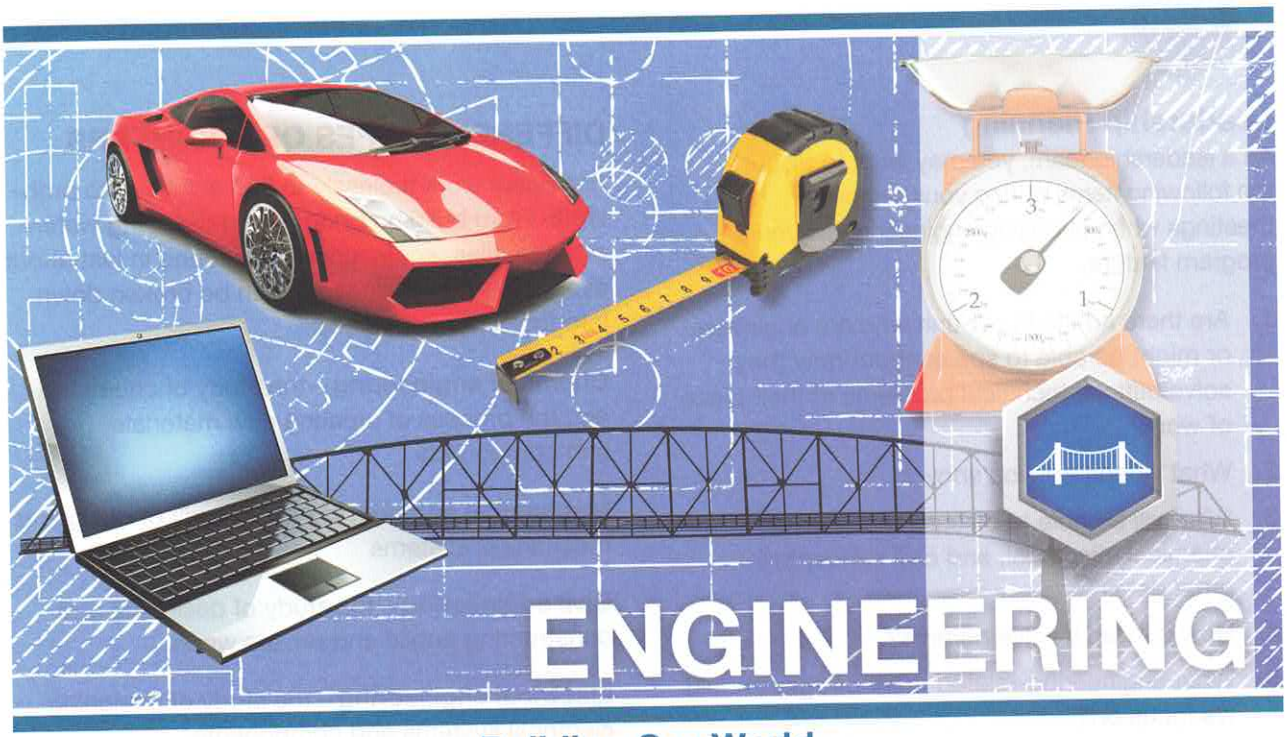


Building Our World

In 62 B.C., the people of Rome were faced with a problem: A wooden bridge spanning the Tiber River had been destroyed by fire, and they needed a way to reach Tiber Island. Their solution was to construct a new bridge, the Pons Fabricius, out of stone so the crossing could not burn down again. Believe it or not, that bridge is still in use to this day—and it isn't even the oldest in the world. Bridges like the Pons Fabricius are great examples of what engineers do every day.

Engineers work to solve the difficult problems that face our society. Whether it's building a bridge to cross a river, creating a new machine to manufacture cars, or fitting a huge amount of technology into a smartphone, an engineer's work can leave a lasting impact on society.

This month, Scouts will have the opportunity to learn about the different disciplines within engineering. The weekly meetings will be full of fun activities that enable Scouts to see firsthand the broad reach of this field across a variety of disciplines.

Objectives

This month's activities should:

- Define the different branches of engineering.
- Help Scouts understand what engineers do.
- Demonstrate key engineering concepts.
- Help Scouts understand the different career paths available to them.
- Demonstrate real-world applications of engineering principles.
- Encourage Scouts to earn the Nova and Supernova awards.

RELATED ADVANCEMENT AND AWARDS

- Architecture, Astronomy, Automotive Maintenance, Aviation, Chemistry, Composite Materials, Digital Technology, Drafting, Electricity, Electronics, Energy, Engineering, Entrepreneurship, Farm Mechanics, Game Design, Home Repairs, Inventing, Mining in Society, Model Design and Building, Nuclear Science, Pioneering, Programming, Robotics, Space Exploration, Surveying, and Welding merit badges
- Nova and Supernova awards

Leadership Planning

As a leadership team, you may want to discuss the following items during your planning meetings when choosing engineering as your program feature.

1. Are there adults in our unit who are engineers or might be able to speak about how they solve difficult technical problems at their place of work?
2. What videos will you show?
3. Who will be able to discuss mechanical, chemical, electrical, and civil concepts in great detail?
4. How can we involve parents?
5. What engineering-related merit badges should we focus on?
6. Is there an amusement park or carnival nearby?
7. Where will we host our main event?
8. Will the main event be an overnighter?
9. To meet our needs, what should we change in the sample meeting plans?

PARENTS CAN HELP WITH THE ENGINEERING PROGRAM FEATURE BY:

1. Sharing their expertise
2. Providing transportation and supervision for the main event
3. Providing materials for the different games and activities
4. Mentoring Scouts as they work on advancements
5. Maintaining current Youth Protection certification, which is required of all adults providing transportation for or participating in outings.

DIFFERENT TYPES OF ENGINEERS

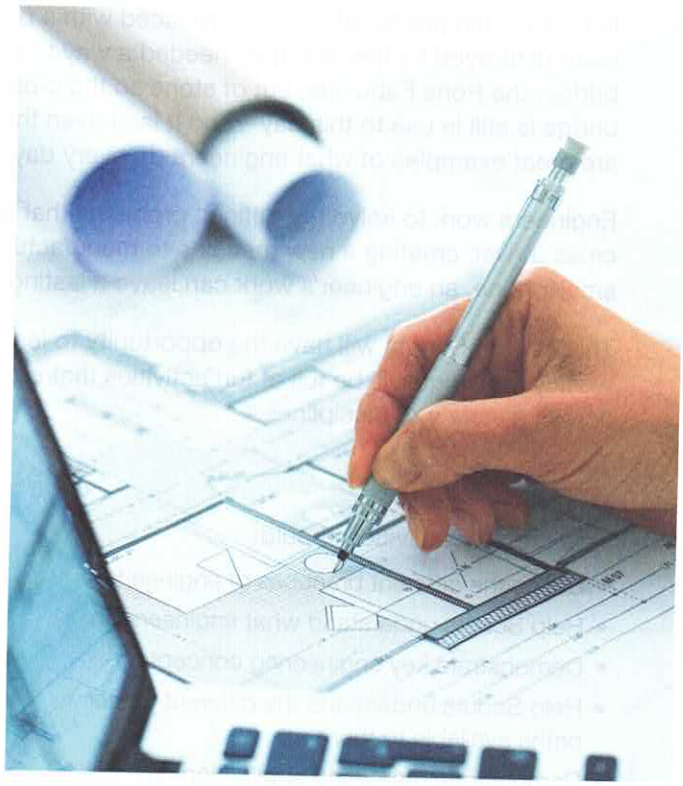
Engineers work tirelessly to find solutions to problems. From building bridges to developing waterproof textiles, engineers can be found in just about every industry. Engineering can be broken down into four major branches:

Chemical engineering—the study of chemicals and the process of creating new materials and compounds

Mechanical engineering—the study of designing mechanical systems

Civil engineering—the study of designing and constructing public and private works

Electrical engineering—the study of designing electrical systems and components



SUBDISCIPLINES WITHIN THE ENGINEERING BRANCHES

Chemical Engineering

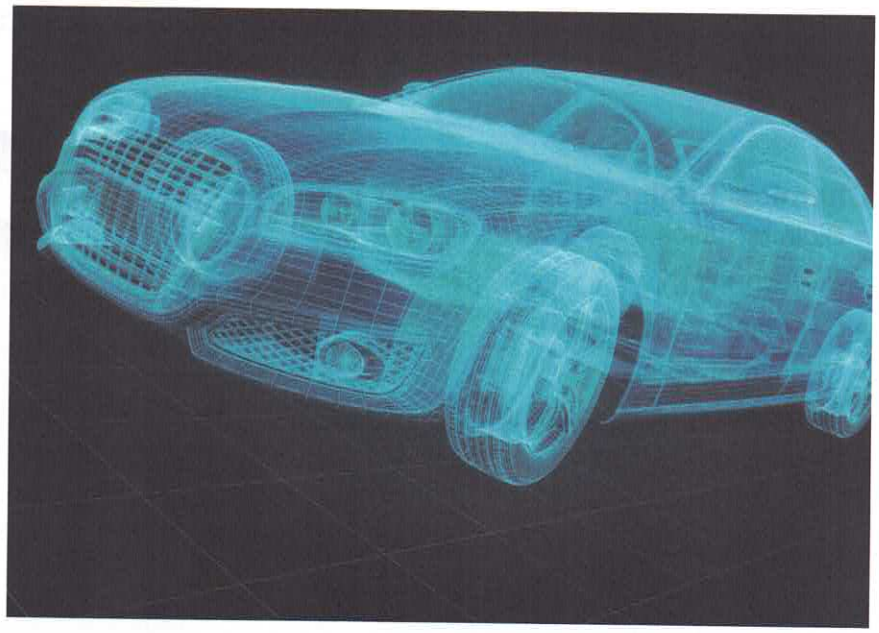
- Bioinformatics
- Biotechnology
- Ceramic engineering
- Cheminformatics
- Environmental engineering
- Fluid dynamics
- Molecular engineering
- Nanotechnology
- Polymer and plastics engineering
- Textile engineering

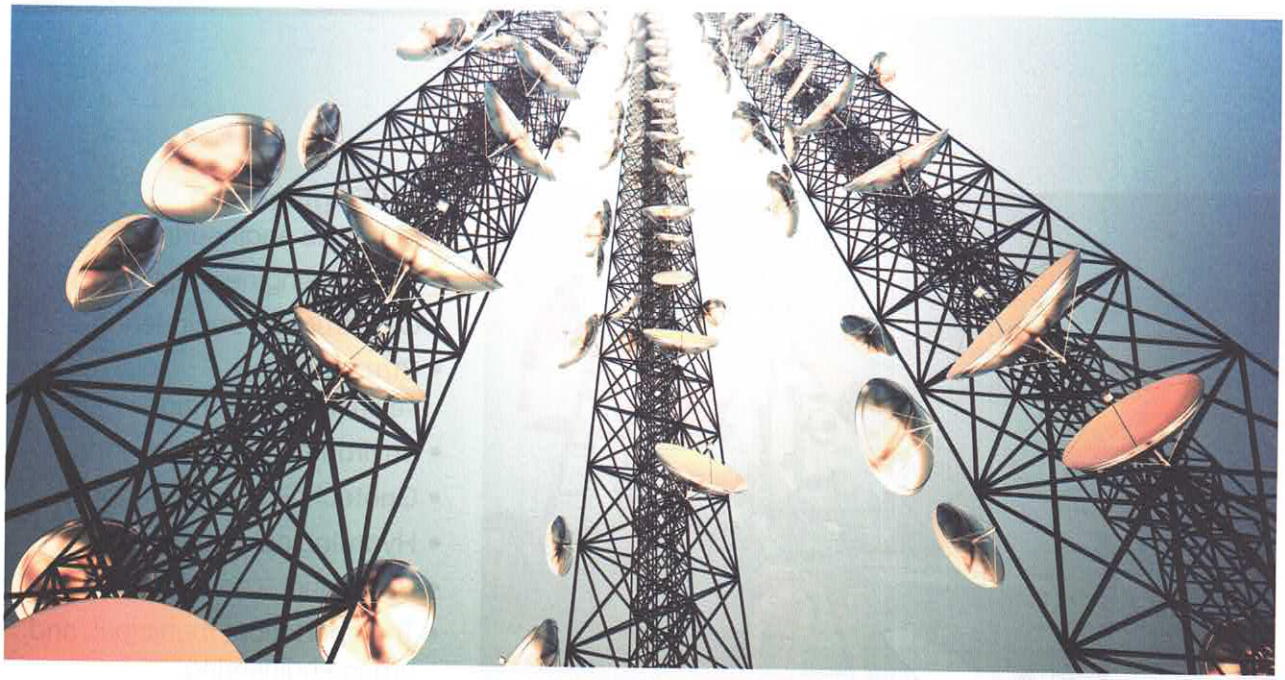
Civil Engineering

- Materials engineering
- Coastal engineering
- Construction engineering
- Structural and seismic engineering
- Environmental engineering
- Geotechnical engineering
- Hydrological engineering
- Surveying
- Transportation, municipal, and urban engineering

Mechanical Engineering

- Biomechanics
- Mechatronics
- Acoustical engineering
- Aerospace engineering
- Manufacturing engineering
- Automotive engineering
- HVAC engineering
- Process engineering
- Robotics engineering





Electrical Engineering

- Power engineering
- Control engineering
- Electronic engineering
- Microelectronics
- Signal processing
- Telecommunications engineering
- Instrumentation engineering
- Computer engineering
- Lighting engineering
- Solar engineering

ENGINEERING GAMES

Paper Tower

Equipment: Measuring tape, newspaper, clear tape

How to play: Give each Scout two full sheets of newspaper and 5 minutes to construct a tower. The tallest tower that can stand longer than 30 seconds wins.

Variation: Follow the same instructions, but give each Scout 8 inches of clear tape. See how much taller the towers can become with this added support.

Parachute Races

Equipment: A plastic bag or lightweight fabric, scissors, string, a small object to act as the weight

How to play: Give teams of Scouts 5 minutes to design a parachute for the weighted object. Explain that their objective is to create a parachute that is the last one to touch the ground when all are released from a given height.

Scoring: The last parachute to touch the ground wins.

Geocache Scavenger Hunt

Equipment: Two to three GPS units, prizes, paper, pen

How to play: Before the meeting, hide prizes around your meeting area. With each prize, include the GPS coordinates leading to the next prize. Divide Scouts into the same number of teams as there are GPS units. Give each team the coordinates of the first prize. The first team to find all the items wins.

Hot Potato

Equipment: Effervescent tablets (like Alka-Seltzer), small balloons, water

How to play: Have Scouts form a circle (preferably outdoors). Fill a small balloon with an inch of water, and drop a tablet into the water. You may need to break the tablet into pieces. Inflate the balloon, tie it shut, and pass it to a Scout. The objective of the game is to not be holding the balloon when it pops! Have Scouts pass the balloon to the person next to them. The person holding the balloon when it pops is eliminated. Start another balloon around the circle. The winner is the remaining Scout.

E.D.G.E. Ideas

***E**xplain* how it is done—Tell them.
***D**emonstrate* the steps—Show them.
***G**uide* learners as they practice—Watch them do it.
***E**nable* them to succeed on their own—Have them practice/teach it.

EXPLAIN

- Define what engineering is and its history.
- Discuss the major branches of engineering.
- Discuss how an engineer's work can be seen in everyday life.
- Show a video from the internet that demonstrates how something is built using engineering techniques.

DEMONSTRATE

- Show a video of an engineering project underway.
- Invite a speaker, preferably an engineer, to visit your unit and discuss what he or she does and the types of problems he or she works to solve.
- Demonstrate how a simple circuit works.
- Demonstrate a chemical reaction. (Mentos candy in Diet Coke is always a hit.)
- Show how a dam can be used to generate electricity.
- Show how a combustion engine works.

GUIDE

- Have Scouts come up with various approaches to a problem while you supervise.
- Lead a reflection on the different activities Scouts have conducted.
- Watch Scouts design and build the various experiments, offering guidance throughout the process.
- Have Scouts assist in the planning of the main event.
- Help Scouts identify an opportunity to teach and mentor another person.

ENABLE

- Challenge Scouts to improve their problem-solving skills and to learn something new.
- Encourage older Scouts to mentor younger Scouts throughout the activities.
- Have Scouts watch engineering programs to get a better understanding of how things are designed and built.
- Encourage Scouts to talk with some adults about the different engineering-related career paths.

MAIN EVENT SUMMARIES

ESSENTIAL	CHALLENGING	ADVANCED
Day Activity	Day Activity	Day Activity
Amusement park observations—Visit an amusement park or carnival to demonstrate how the disciplines of engineering (mechanical, chemical, electrical, and civil) can create thrilling experiences. See if your unit can arrange for a park engineer to give a tour and explain how the various attractions were conceived and constructed. At the end of the day, have Scouts discuss their observations about different types of engineering work that went into the development of each attraction.	Amusement park design—Visit an amusement park or carnival, and have Scouts keep notes throughout the day on how they would improve the designs of the attractions. At the end of the day, lead a discussion on how the amusement park might incorporate the Scouts' improvements in future attraction designs. See if your Scouts can identify any significant differences (or similarities) between older and newer rides.	Amusement park experiments—Visit an amusement park or carnival when it is offering a "Physics Day." Have Scouts conduct a number of experiments on various rides. At the end of the day, have the Scouts share their observations with one another. Lead a discussion on how an amusement park integrates all the aspects of engineering.

ENGINEERING

Meeting Plan: Introduction and Civil Engineering

Week 1 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Play a video from a TV show such as "Modern Marvels" that demonstrates how a building or bridge is constructed. Alternatively, show a video of how a wastewater treatment plant operates. (Note: Shows such as "Modern Marvels" often post two- to three-minute videos on their websites.)		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 5 minutes	Discuss the following: • The definition of engineering • The different areas within engineering • The basics of civil engineering and the types of work these engineers do		7:10 p.m.
Skills Instruction 45 minutes ●	• Build a water filtration system. • Experiment with numerous materials to see which ones work best at cleaning the water. • Discuss how your local water treatment plant works.		7:15 p.m.
■	• Build a model dam. Experiment with a number of materials and designs to determine which ones work better as the volume of water increases. • Discuss how dams are used to provide water and electricity to municipal areas.		
◆	• Build a cable-stayed bridge that is at least 3 feet long, 2 feet off the ground, and has three or more cables on each side of the tower. • Ensure the bridge is capable of holding up a few toy cars. • Discuss how cable length and the distances between cables help the deck of the bridge stand.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members choose an engineering-related merit badge or Nova Award to work on together. • Review the last main event, and discuss what could have made it better.		8 p.m.
Game 10 minutes	Play Paper Tower (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

ENGINEERING
Meeting Plan: Chemical Engineering

Week 2 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Play a video from a TV show such as "How It's Made" that demonstrates how chemical reactions transform objects.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 5 minutes	Discuss the following: • The basics of chemical engineering and the types of work these engineers do • The definition of compounds, polymers, bases, and acids		7:10 p.m.
Skills Instruction 45 minutes	• Make some goo similar to the details listed at https://sciencebob.com/making-slime-method-1/. • Lead a discussion on polymers and the reaction you just witnessed.		7:15 p.m.
	• Build pop rockets and see which design goes the farthest. Use the experiment outline here: www.acs.org/content/dam/acsorg/education/outreach/2009-cced-spring-edition-air-the-skys-the-limit.pdf?_ga=2.27713276.1554082592.1531859620-954501752.1531859620. • Lead a discussion on the chemical reaction that causes the rockets to pop off the launch pad.		
	• Build a model rocket from a kit available at your local hobby store. Have Scouts experiment with different fin designs and engines. • Lead a discussion on the chemical reaction that is occurring within the rocket engine and how it is similar to or different from the engines used in modern spacecraft.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on an engineering-related merit badge or Nova Award. • Make plans for the main event.		8 p.m.
Game 10 minutes	Play Hot Potato (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

ENGINEERING
Meeting Plan: Mechanical Engineering

Week 3 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Play a video from a TV show such as "Modern Marvels" that demonstrates how an engine works.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 5 minutes	Discuss the following: • The basics of mechanical engineering and the types of work these engineers do • Definition of drag, torque, hydraulics, and other mechanical systems		7:10 p.m.
Skills Instruction 45 minutes	• Have Scouts build string telephones. • Lead a discussion on sound waves and how sound is changed by objects such as water.		7:15 p.m.
	Have Scouts build a Rube Goldberg machine and see which team can come up with the wackiest way to accomplish an everyday task.		
	• Calculate the mechanical advantage of a pulley. • Discuss how pulleys and levers are used to construct a building or lift an elevator. A great example of a similar activity can be found at http://teachers.egfi-k12.org/lesson-pulleys.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on an engineering-related merit badge or Nova Award. • Make plans for participation in main event.		8 p.m.
Game 10 minutes	Play Parachute Race (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

ENGINEERING

Meeting Plan: Electrical Engineering

Week 4 Date_____

ACTIVITY	DESCRIPTION	RUN BY	TIME*
Preopening 15 minutes before meeting	Play a video from a TV show such as "How It's Made" that demonstrates how a computer is built.		6:45 p.m.
Opening Ceremony 10 minutes	Flag presentation Oath and Law Uniform inspection		7 p.m.
Group Instruction 5 minutes	Discuss the following: • The basics of electrical engineering and the types of work these engineers do • What a circuit is and what a resistor, diode, inductor, and capacitor do		7:10 p.m.
Skills Instruction 45 minutes	• Take apart a flashlight, and discuss the components that are used in it to complete the circuit. • Have Scouts assemble their own LED flashlight using an LED, tape, and a CR2032 battery.		7:15 p.m.
	• Disassemble a variety of broken electronics. • Explore how each is designed, the components utilized, and the similarities in design. • See if Scouts can diagnose the problem that may have caused the item to stop working.		
	Have Scouts assemble their own USB charging kit.		
Breakout Groups 15 minutes	• New members practice basic Scout skills. • Older members work on an engineering-related merit badge or Nova Award. • Finalize plans for participation in the main event.		8 p.m.
Game 10 minutes	Play Geocache Scavenger Hunt (described earlier).		8:15 p.m.
Closing 5 minutes	Announcements Leader's minute Closing		8:25 p.m.
Total 90 minutes of meeting			
After the Meeting 15 minutes	Leadership team reviews plans for the next meeting and for the main event.		

*All times are suggested.

ENGINEERING

Main Event: Amusement Park Observations

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: Day

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Essential (Tier I)

Visit an amusement park or carnival to demonstrate how the disciplines of engineering (mechanical, chemical, electrical, and civil) can create thrilling experiences. See if your unit can arrange for a park engineer to give a tour and explain how the various attractions were conceived and constructed. At the end of the day, have Scouts discuss their observations about different types of engineering work that went into the development of each attraction.

Equipment List	• Uniform as decided upon • Lunch (decide on individual or group) • Pen and paper for taking notes • Camera • Spending money • Scout Basic Essentials (Review the list and take what you need.)
Activity	• Decide which amusement park, carnival, or fair your unit will visit. • If possible, see if a tour can be arranged with a park engineer who can discuss the design and safety measures of various rides. • Encourage Scouts to keep notes throughout the day on common engineering themes they see in the rides. • At the end of the day, have the Scouts share their observations with one another. Lead a discussion on how an amusement park integrates all the aspects of engineering.
Safety	• Always use the buddy system. Have a cellphone and numbers available for emergencies. Keep a first-aid kit on hand, but also know where medical assistance is available. Don't forget the sunscreen. • Two-deep adult leadership is required for all activities.

Notes

ENGINEERING
Main Event: Amusement Park Design

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: Day

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Challenging (Tier II)

Visit an amusement park or carnival and have Scouts keep notes throughout the day on how they would improve the designs of the attractions. At the end of the day, lead a discussion on how the amusement park might incorporate the Scouts' improvements in future attraction designs. See if your Scouts can identify any significant differences (or similarities) between older and newer rides.

Equipment List	• Uniform as decided upon • Lunch (decide on individual or group) • Pen and paper for taking notes • Camera • Spending money • Equipment for experiments • Scout Basic Essentials (Review the list and take what you need.)
Activity	• Decide which amusement park, carnival, or fair your unit will visit. • Have Scouts keep notes throughout the day on their suggestions for improving the designs of the rides. • At the end of the day, have the Scouts share their observations with one another. Lead a discussion on how the amusement park might incorporate the Scouts' improvements in future attraction designs. See if your Scouts can identify any significant differences (or similarities) between older and newer rides.
Safety	• Always use the buddy system. Have a cellphone and numbers available for emergencies. Keep a first-aid kit on hand, but also know where medical assistance is available. Don't forget the sunscreen. • Two-deep adult leadership is required for all activities.

Notes

ENGINEERING

Main Event: Amusement Park Experiments

Date_____

Logistics

Location: _____

_____

Departure time: _____

Return time: _____

Duration of activity: Day

Budget: Completed _____ Approved _____

Camping: Duty roster_____ Menu _____

Transportation: Group _____ Self_____

Advanced (Tier III)

Visit an amusement park or carnival when it is offering a "Physics Day." Have Scouts conduct a number of experiments on various rides. At the end of the day, have the Scouts share their observations with one another. Lead a discussion on how an amusement park integrates all the aspects of engineering.

Equipment List	• Uniform as decided upon • Lunch (decide on individual or group) • Pen and paper for taking notes • Camera • Spending money • Equipment for experiments • Scout Basic Essentials (Review the list and take what you need.)
Activity	• Decide which amusement park, carnival, or fair your unit will visit. • Many amusement parks offer "Physics Day" experiments. Pick a few experiments for Scouts to conduct while on the rides. • Have Scouts fill out their experiment reports after each ride. Encourage Scouts to note throughout the day the many different kinds of engineering themes they see in the rides. • At the end of the day, have the Scouts present their results. Lead a discussion on the engineering principles they experienced throughout the day.
Safety	• Always use the buddy system. Have a cellphone and numbers available for emergencies. Keep a first-aid kit on hand, but also know where medical assistance is available. Don't forget the sunscreen. • Two-deep adult leadership is required for all activities.

Notes

RESOURCES AND REFERENCES

Books

Architecture and Landscape Architecture, Astronomy, Automotive Maintenance, Aviation, Chemistry, Composite Materials, Digital Technology, Drafting, Electricity, Electronics, Energy, Engineering, Entrepreneurship, Farm Mechanics, Game Design, Home Repairs, Inventing, Mining in Society, Model Design and Building, Nuclear Science, Pioneering, Programming, Robotics, Space Exploration, Surveying, and *Welding* merit badge pamphlets

Andrews, Beth. *Hands-On Engineering: Real-World Projects for the Classroom*. Prufrock Press, 2012.

Latham, Donna. *Bridges and Tunnels: Investigate Feats of Engineering With 25 Projects*. Nomad Press, 2012.

———. *Canals and Dams: Investigate Feats of Engineering With 25 Projects*. Nomad Press, 2013.

Moomaw, Sally. *Teaching STEM in the Early Years: Activities for Integrating Science, Technology, Engineering, and Mathematics.* Redleaf Press, 2013.

Professional Organizations

American Institute of Chemical Engineers
Website: www.aiche.org/

American Society of Civil Engineers
Website: www.asce.org/

American Society of Mechanical Engineers
Website: www.asme.org/

Institute of Electrical and Electronics Engineers
Website: www.ieee.org/

Websites

Civil Engineering: It's Everywhere!
Website: www.asceville.org/files/ASCE_civeng_7-8.pdf

DiscoverE
Website: www.discovere.org/

Engineering Science Fair Projects
Website: www.education.com/science-fair/engineering/

Engineers Week (Engineers Ireland)
Website: www.engineersweek.ie/

Mechanical Engineering Career Information
Website: www.asme.org/career-education/k-12-students

Television Shows

"Build It Bigger"
Website: www.sciencechannel.com/tv-shows/build-it-bigger/

"How It's Made"
Website: https://www.sciencechannel.com/tv-shows/how-its-made/

"Modern Marvels"
Website: www.history.com/shows/modern-marvels

"MythBusters"
Website: www.discovery.com/tv-shows/mythbusters/

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Acknowledgments

We are grateful to Ed Wolf, San Francisco, California, who helped develop the Engineering program feature.