Chapter Mini-Challenge

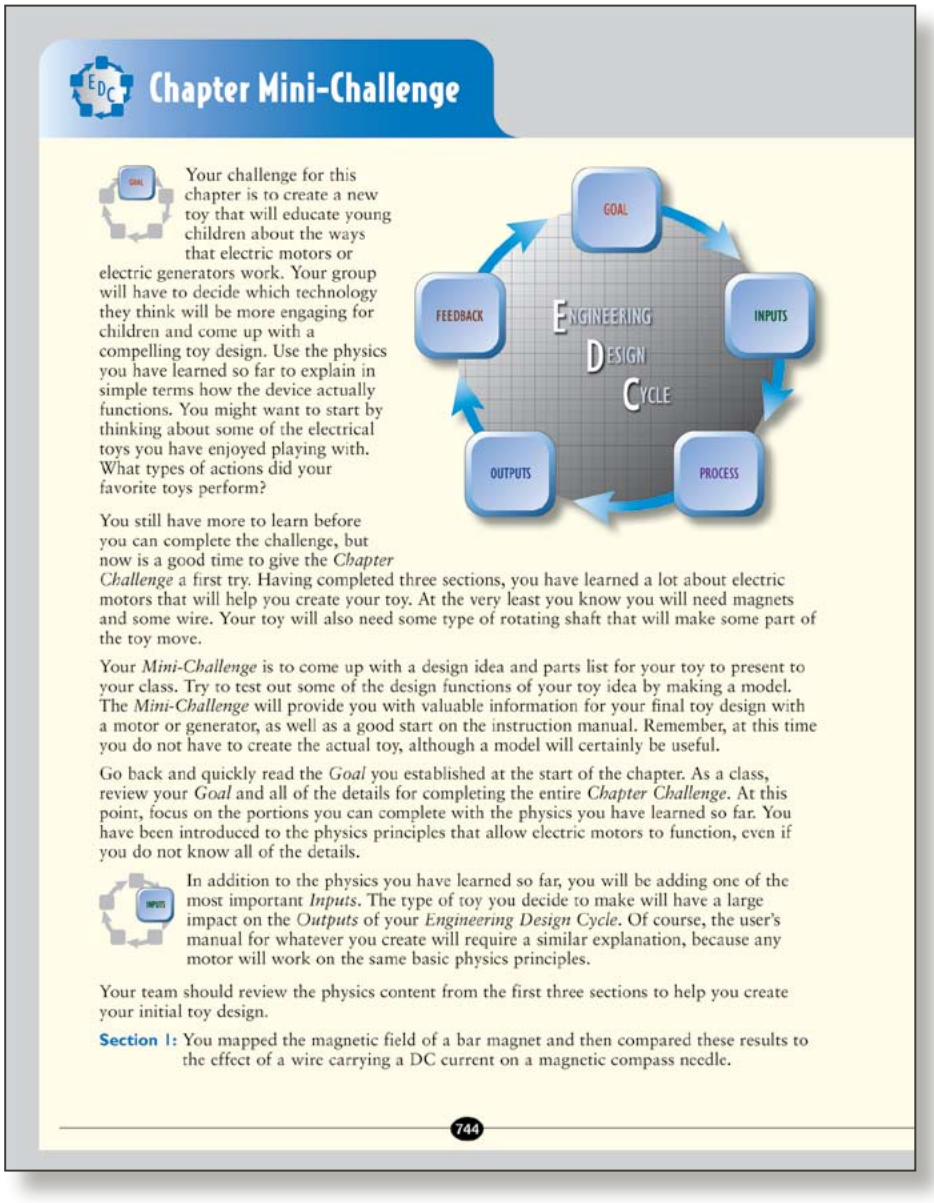
The *Chapter Mini-Challenge* marks a point in this chapter where students should begin to construct their solution for the *Chapter Challenge*. Briefly review the *Engineering Design Cycle*, and have students review their goals and criteria for the *Chapter Challenge*.

Remind students that the *Inputs* have been the information introduced in each section, and in each section they have reflected on how the physics content can be applied to their *Chapter Challenge*. Review the physics content that the class has been introduced to so far by asking them about each section and/or reviewing the list in the student text.

Let students know that the *Mini-Challenge* is part of the *Process* in the *Engineering Design Cycle*. Describe the requirements of the *Mini-Challenge*. Students develop a design idea for a toy and a parts list, try out some of the design functions by constructing a model, and start on the instructions manual. Emphasize that they will need to provide an explanation for the interaction between a current-carrying wire and a magnet, as well as an explanation on how to create an electromagnet.

Discuss the time constraints with your class—about one class period to prepare and another to present. Emphasize that this will require groups to be organized. Use the information in the student text to suggest tasks group members might take on to help a group complete the *Mini-Challenge* and, eventually, the *Chapter Challenge*. While students are preparing, assess their understanding and how they are working within their groups.

Remind students that as they complete the remaining sections of this chapter, they should look for ways to improve their design and the information that will assist them in explaining their design. Encourage students to lead the discussion by having them ask and answer questions, as well as have discussions on ideas for improvement they would like to include in their own design. Discuss revising or updating the criteria and goals for the *Chapter Challenge*.



Chapter Mini-Challenge

Your challenge for this chapter is to create a new toy that will educate young children about the ways that electric motors or electric generators work. Your group will have to decide which technology they think will be more engaging for children and come up with a compelling toy design. Use the physics you have learned so far to explain in simple terms how the device actually functions. You might want to start by thinking about some of the electrical toys you have enjoyed playing with. What types of actions did your favorite toys perform?

You still have more to learn before you can complete the challenge, but now is a good time to give the *Chapter Challenge* a first try. Having completed three sections, you have learned a lot about electric motors that will help you create your toy. At the very least you know you will need magnets and some wire. Your toy will also need some type of rotating shaft that will make some part of the toy move.

Your *Mini-Challenge* is to come up with a design idea and parts list for your toy to present to your class. Try to test out some of the design functions of your toy idea by making a model. The *Mini-Challenge* will provide you with valuable information for your final toy design with a motor or generator, as well as a good start on the instruction manual. Remember, at this time you do not have to create the actual toy, although a model will certainly be useful.

Go back and quickly read the *Goal* you established at the start of the chapter. As a class, review your *Goal* and all of the details for completing the entire *Chapter Challenge*. At this point, focus on the portions you can complete with the physics you have learned so far. You have been introduced to the physics principles that allow electric motors to function, even if you do not know all of the details.

In addition to the physics you have learned so far, you will be adding one of the most important *Inputs*. The type of toy you decide to make will have a large impact on the *Outputs* of your *Engineering Design Cycle*. Of course, the user's manual for whatever you create will require a similar explanation, because any motor will work on the same basic physics principles.

Your team should review the physics content from the first three sections to help you create your initial toy design.

Section 1: You mapped the magnetic field of a bar magnet and then compared these results to the effect of a wire carrying a DC current on a magnetic compass needle.

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Section 2: You built and tested a solenoid that operates as an electromagnet. You also identified the variables that control the strength of the magnetic field a solenoid produces.

Section 3: You explored the force between a current-carrying wire and a nearby magnet. You also made use of that force to construct and operate a simple DC motor.

Once you have an idea of what type of toy you would like to create, making a model of the toy will be very useful. Creating the model will allow you to experiment with different readily available materials and determine how much force your motor can generate. Start by working with the materials that were made available for your class investigations.

By building onto experiments you have already done, you will have a better opportunity at troubleshooting problems. Start with a simple coil and one D-size battery. Remember that batteries added in series will add to the voltage, while batteries added in parallel will add to the total amount of current available at the voltage of only a single battery, 1.5 V.

Build a small model and test some of your design functions. For example, if you are creating a motor, is it strong enough to start the wheels rolling, or to turn a propeller? Remember some of the techniques you learned for increasing the size of an electromagnetic response. Do you need a stronger magnetic field, more turns in your coil, or a higher rate of rotation to get the results you want?

The results of your model testing should help you determine the types of materials that will need to be included in your kit. Chances are a bicycle wheel would be too large for your motor to turn, but a simple test would confirm that. You will have a much better idea of the scale of materials you should be working with following your tests. You may find that toothpicks and cardstock paper are closer to the types of materials of construction you should consider instead of wooden dowels, CDs for wheels, and blocks of wood for parts. Without a model, this distinction will be very difficult to make.

Presenting your information to the class are your design-process *Outputs*. For the *Mini-Challenge* you should have a design idea and parts list for your toy as well as a good start on the instruction manual. You will be able to explain why a magnet and a current-carrying wire can produce a force. You will also be able to explain how to create an electromagnet, if that is part of your toy design.

Your classmates will give you *Feedback* on the accuracy and overall appeal of your presentation based on the criteria of the design challenge. This *Feedback* will become an input for your final design in the *Chapter Challenge*. You will have enough time to make corrections and improvements, so you will want to pay attention to the valuable information they provide.

Remember to correct any parts of your design that didn't meet the design goals of the *Mini-Challenge*. It will be harder to remember what you need to change if you wait until the chapter is complete to go back and correct your mistakes. When you are finished revising, store all of your information in a safe place so that it will be ready to use in the *Chapter Challenge*.

Identify those goals that have not been addressed through research and were therefore not addressed in your *Mini-Challenge*. Look for additional information in the remaining chapter sections that will help you better understand the function of a generator.