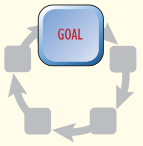
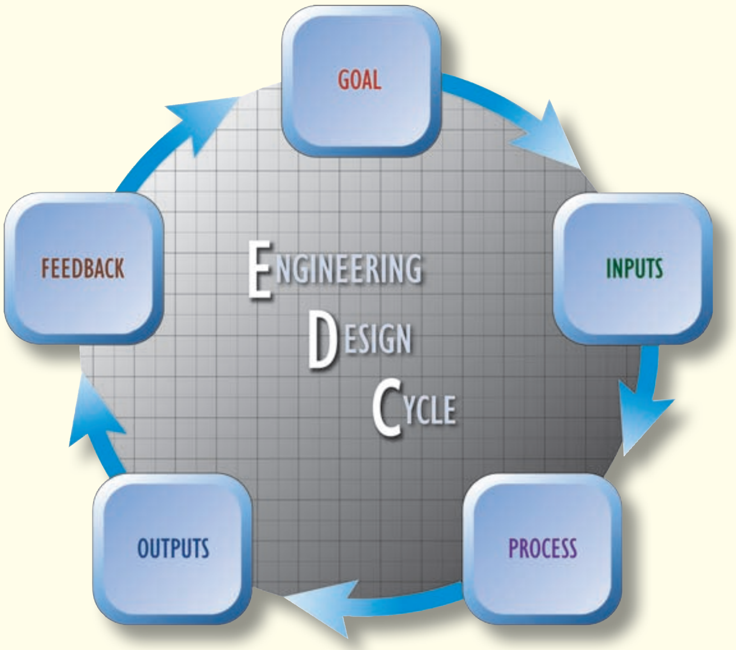
Chapter Mini-Challenge



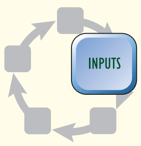
Your challenge for this chapter is to create a new toy that will educate young children about the ways that electric motors or electric generators work. Your group will have to decide which technology they think will be more engaging for children and come up with a compelling toy design. Use the physics 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.

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.