

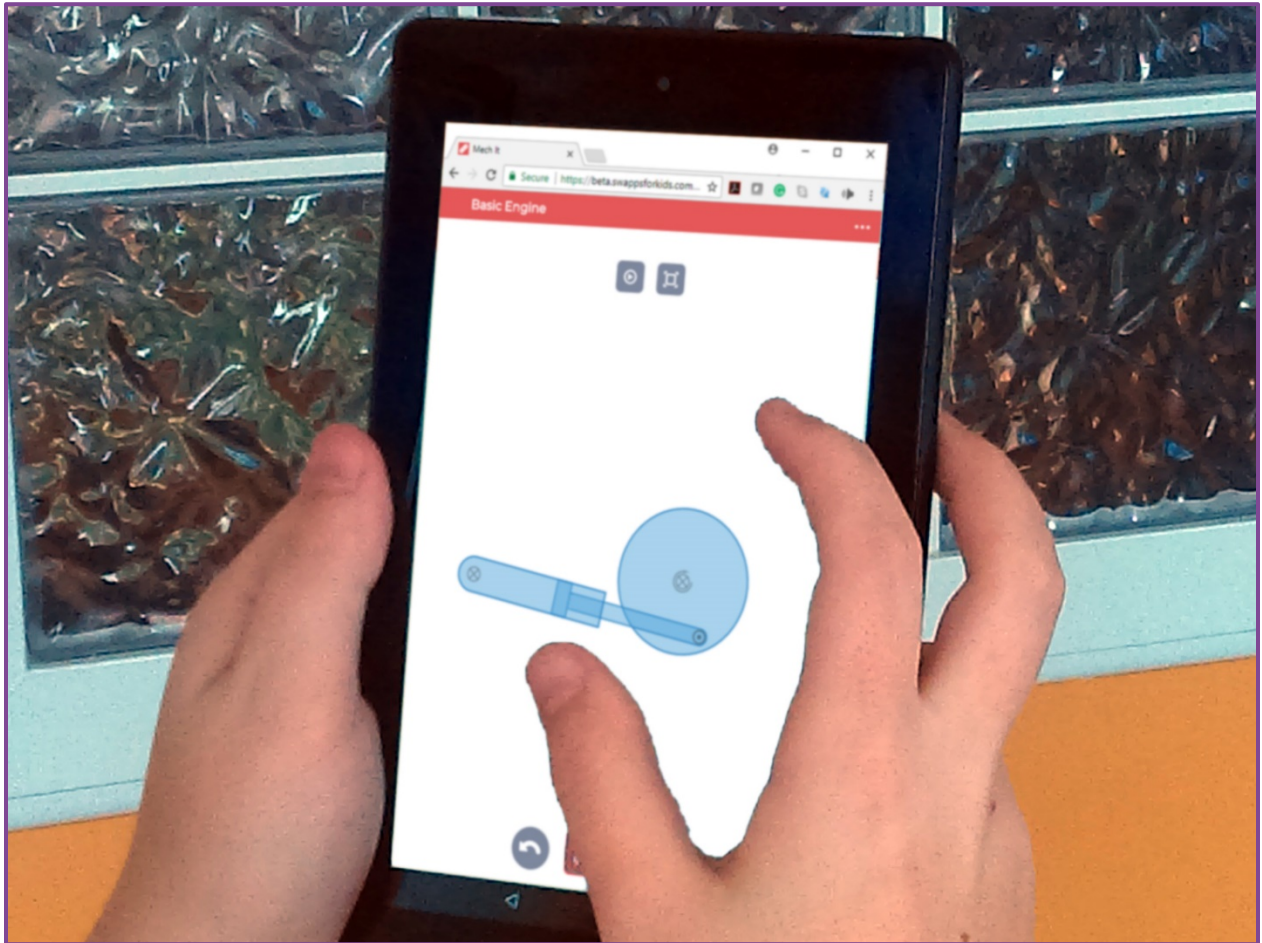
Reimagining the World

Educational Exercises Helping Students See Technology at Work



SOLIDWORKS Apps for Kids are designed to inspire students to create, invent, and shape their futures. Educators can use the following exercise to engage their students, and help them imagine and explore how their abilities can impact the world.

SOLIDWORKS Apps for Kids | Mechanical Models



GETTING STARTED

In this activity, students will use the SOLIDWORKS Apps for Kids to create an animated model of an internal combustion engine. Students can either start from scratch, or use the basic wheel and piston model provided as part of this exercise.

Before introducing the students to the SOLIDWORKS for Kids apps, read the “Consider This” section below to your students, then use the included questions to encourage them to consider how engines turn the motion of moving pistons into circular motion to spin the car’s wheels.



CONSIDER THIS

Have you ever thought about how the engine in your car works? If it's a traditional gasoline engine or diesel engine, it captures the energy from exploding fuel and turns that into circular motion that spins the car's wheels. These types of engines are called internal combustion engines, and they've been around for over 100 years. But while the basic idea has remained the same, today's modern engines use a host of amazing technologies to get the most energy from their fuel.

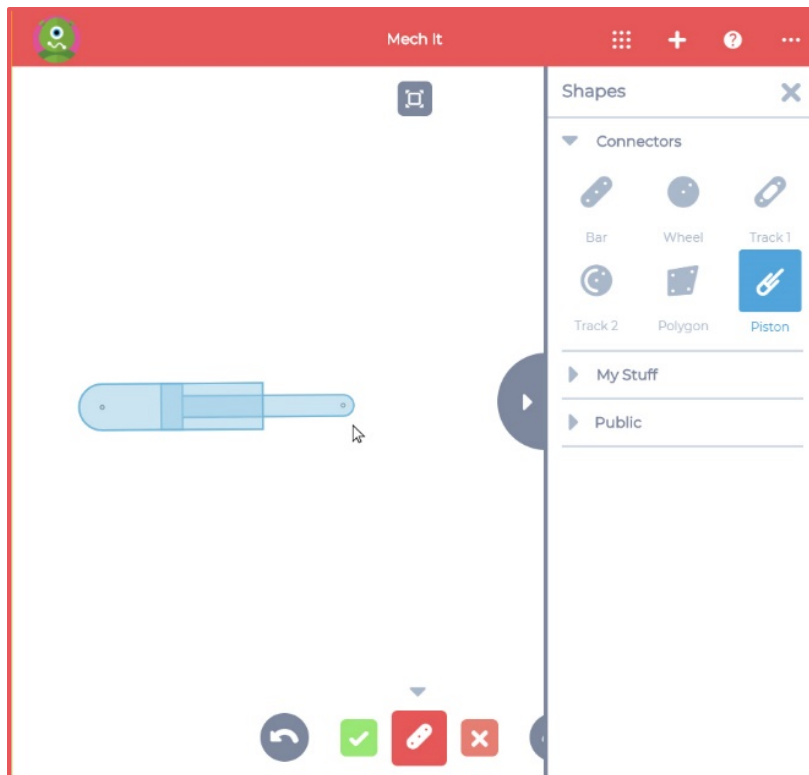
- *What are some examples of machines that have spinning or rotating parts?*
- *How would you describe the way a person gets a bicycle's wheels to spin while riding it?*

TIP: If the students are having trouble expressing how a bicycle turns pedaling motion into spinning motion, it may be helpful to have them raise their legs up in their seats and demonstrate how they would pedal a bicycle.



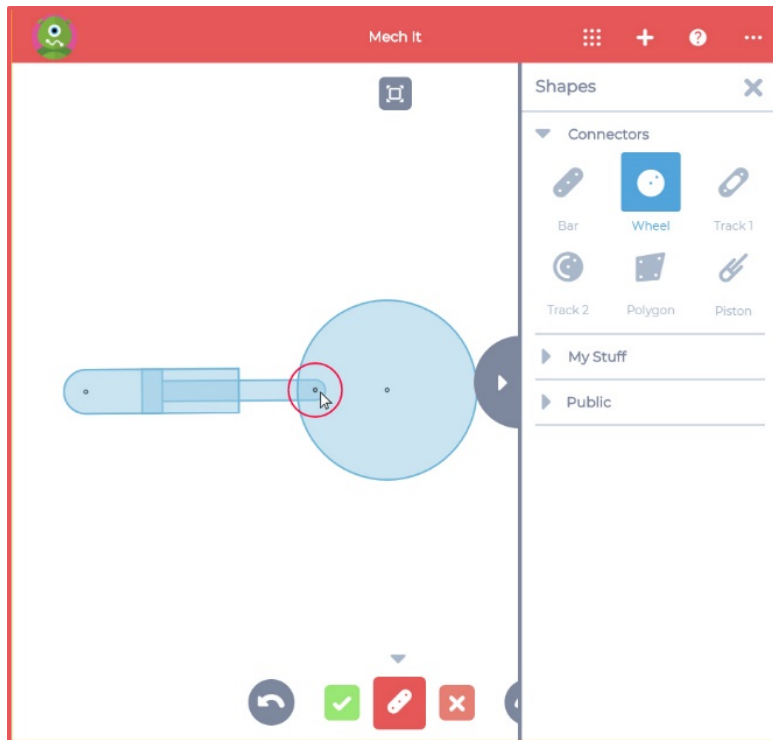
MODELING THE ENGINE

Once students have had time to consider how pedaling makes bicycle wheels spin, have them launch SOLIDWORKS Apps for Kids Classroom. To help the students get started, we've created a few simple animal models for this exercise. You can access the Sample Content in the Sample Lessons section of the Organization tab in your Classroom account. Share this content to your class and the students can use it as a starting point by clicking the "Riff" button on the model they like. Students can also start completely from scratch by launching the **Mech It** app from the plus sign in the main menu at the top of the app.



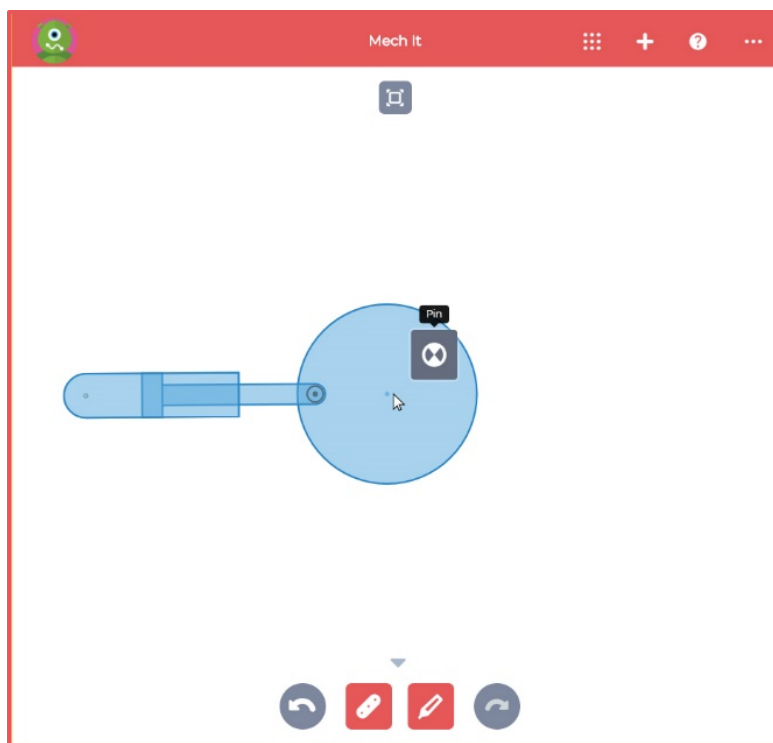
The engine model we're going to work with in the **Mech It** app is a very simple model of a piston connected to a rotating wheel.

To build the model, open the Shapes toolbox by clicking the red Shapes button at the bottom of the app. Then select the Piston from the Connectors section. Click and drag in the work area and make a piston that goes from left to right, like the one shown in this example.

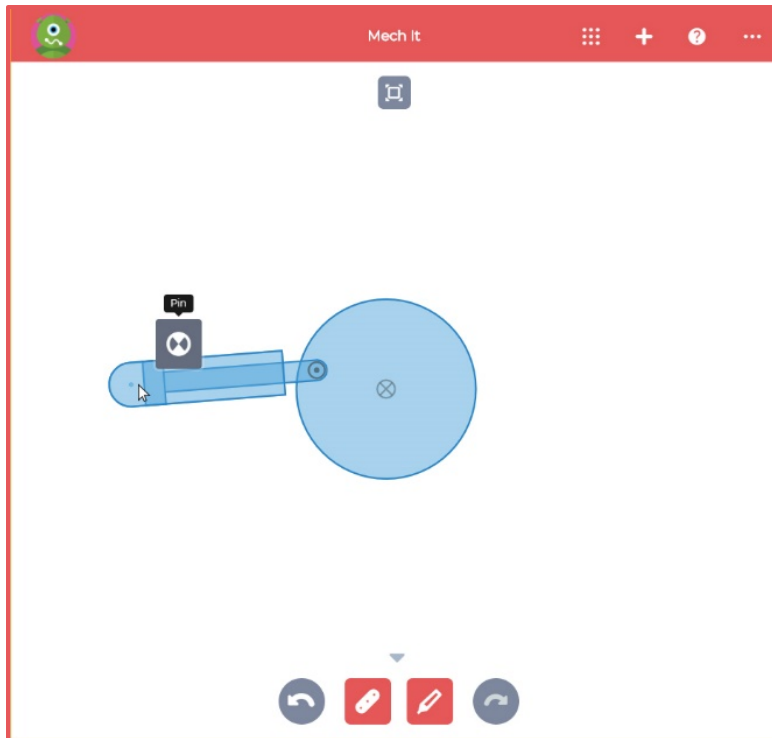


Now, select the Wheel tool and draw a wheel with a center point a little bit to the right of the piston you just drew, like the one shown. When you draw the wheel, you can make it connect to the piston by expanding the wheel to the end of the piston. The app will let you know the two pieces will be connected by showing a red circle around the point they'll connect.

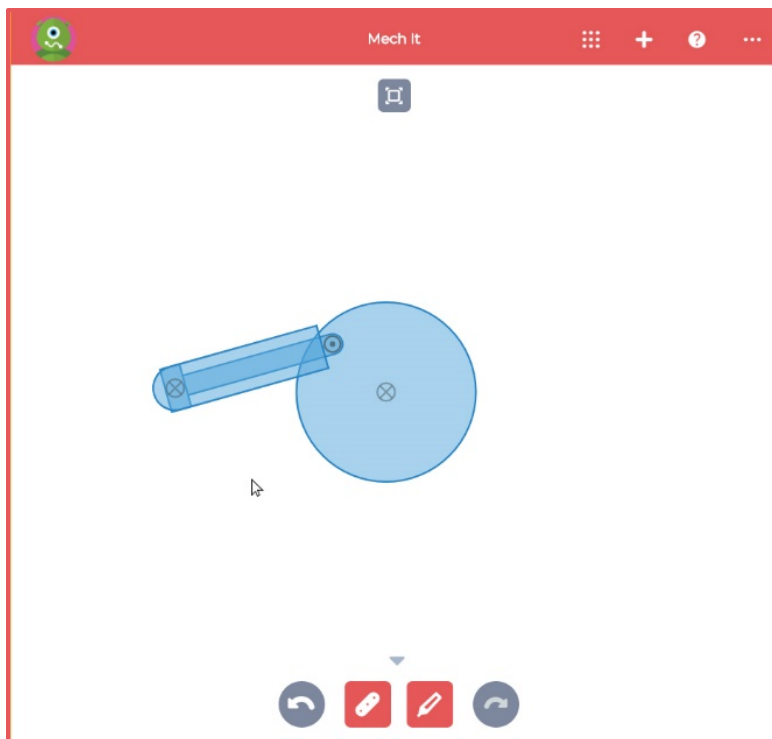
Once you've created the wheel, click the green OK button at the bottom of the app to close the Shapes tools.



Now you need to pin the center of the wheel so it will spin in place. Click on the center of the wheel and select the pin icon to pin the wheel in place, like the one shown.

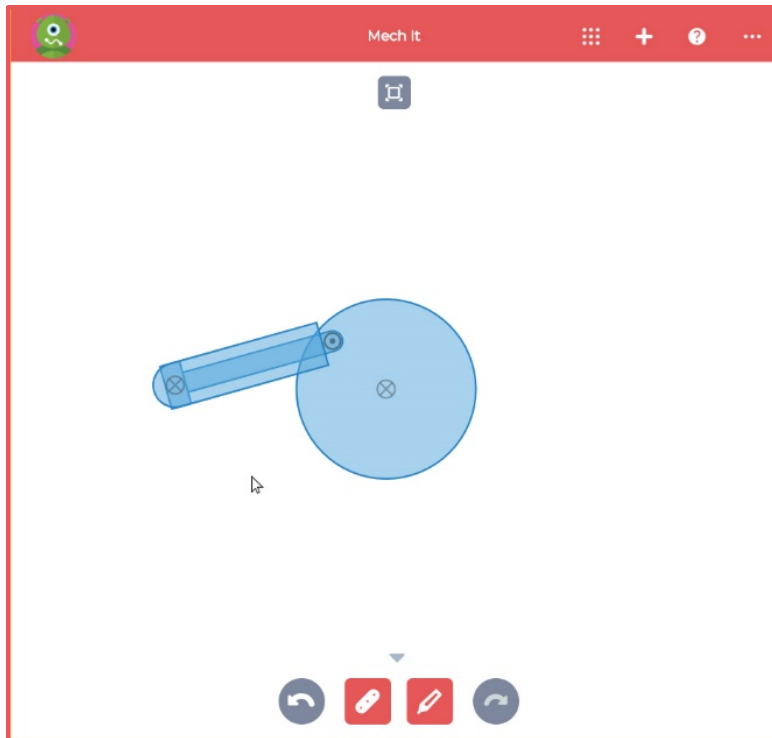


At this point, the wheel is pinned in place, but the piston is not. If you click-and-drag on the wheel, you'll notice the wheel spins, but the piston is pushed and pulled around the work area. To fix this, we need to pin the end of the piston as well. To pin the end of the piston, click on the dot at the end of the piston and choose the Pin icon, like the one shown. Now your wheel and piston are ready to test.



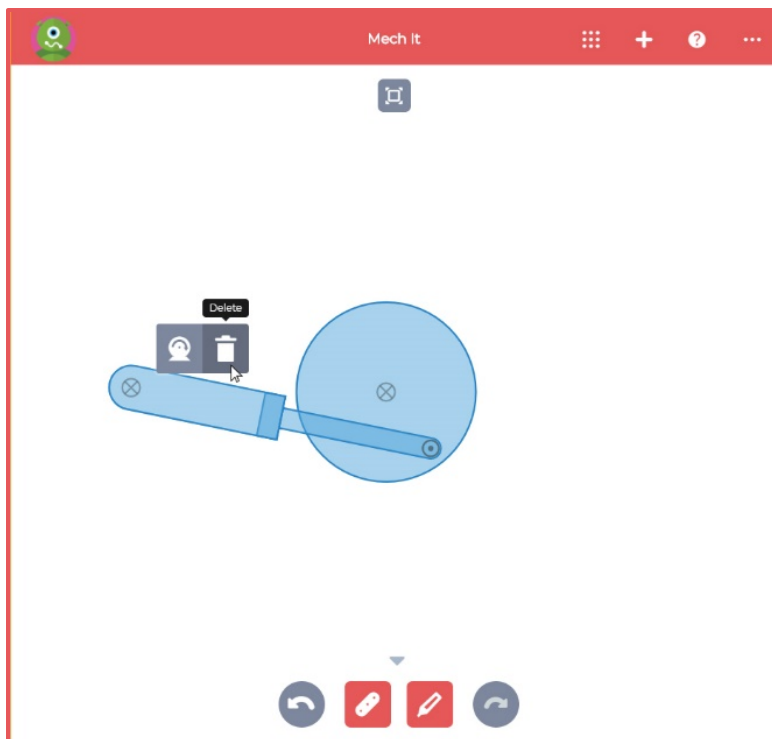
Click and drag on a section of the wheel. If the wheel will spin completely around without getting stuck, then you've designed a mechanism that will work just like a gasoline engine. If the wheel doesn't spin completely around, don't worry, this just means you're piston is either too long, too short, or needs to be pinned in a different place. Making these kinds of changes is exactly why apps like **Mech It** exists.

Engineers use models to simulate how a physical machine will work to save time and money. It's a lot easier to change something like the length or location of a piston in a model, than in a real engine.



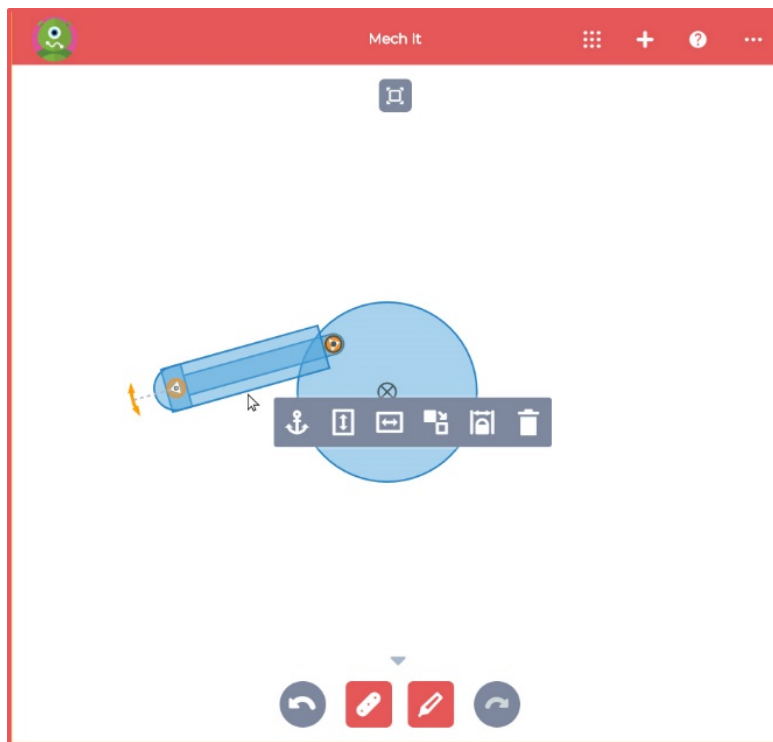
To edit the model, click on the pin at the end of the piston and choose the Delete icon, as shown. In this model, the piston is either too short, or the end is pinned too far away from the wheel.

To move the piston, click-and-drag on an area of the piston to move it. Then, click on the end of the piston and pin the end again. If you re-test the model by spinning the wheel, it should move more freely.



Your piston may also be too long or too short, and need to be lengthened or shortened, like the one shown.

To change the length of the piston, unpin the end of the piston by clicking the end of the piston and choosing Delete from the pin menu.



Now click (without dragging) the piston. Orange circles with white triangles will appear on each end of the piston, like the one shown.

Click on the orange circle on the end of the piston not attached to the wheel, and either lengthen or shorten it as needed.

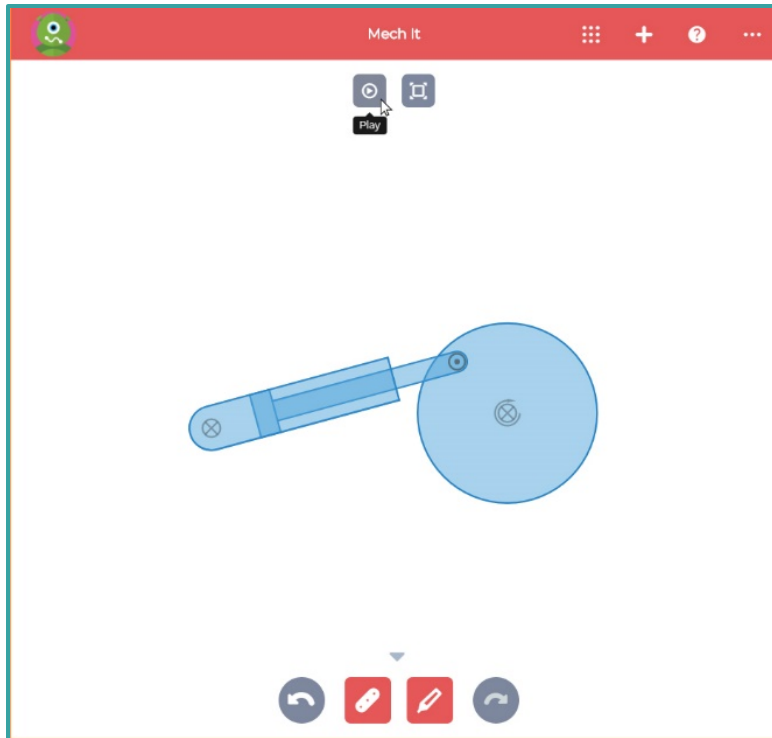
Typically, the piston needs to be a little more than twice as long as the wheel is wide to work properly. Once you have the piston the length, and in the position you want, re-pin the end of the piston.

TIP: You may need to de-select the entire piston to re-pin the end of it. Just click an empty area of the workspace to de-select the piston, then you can select just the end of the piston, and not the entire piston itself.

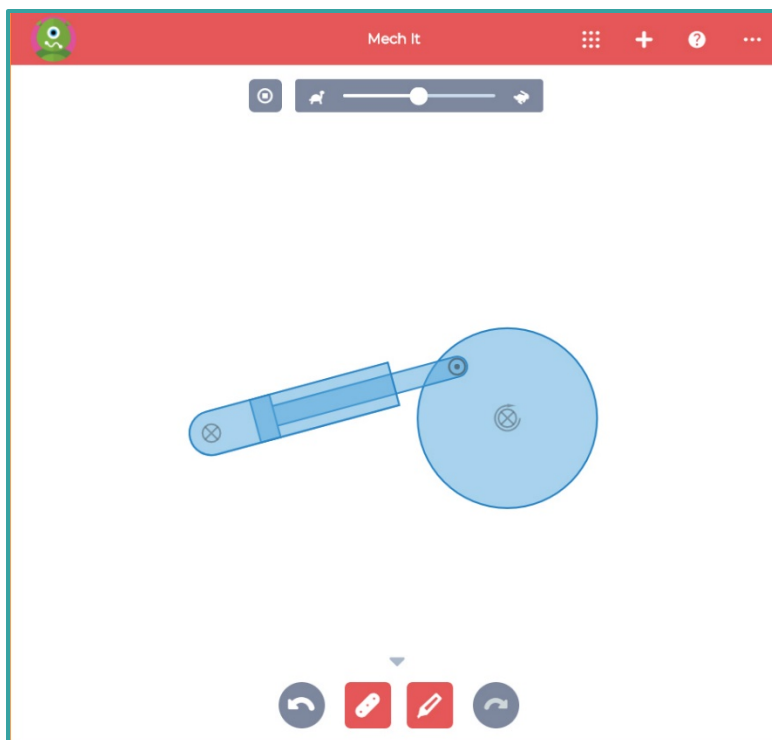


ANIMATING THE MODEL

Once the students have designed their models, they can also animate them and make them move on their own, without having to drag the pieces by hand. Animating the model is a great way to see how the machine will work, and to quickly test new changes made.



To animate the model, click on the pin in the center of the wheel and choose Motor from the pin menu. Once a motor has been added, a gray Play button appears at the top of the app, like the one shown. Click on the Play button to start the animation.



When the animation is running, a Speed control slider will appear at the top of the app. You can change the speed of the animation by sliding the control left or right on the slider. You can also stop the animation by clicking the Stop button at the top of the app.



INTERPRETING THE MODEL

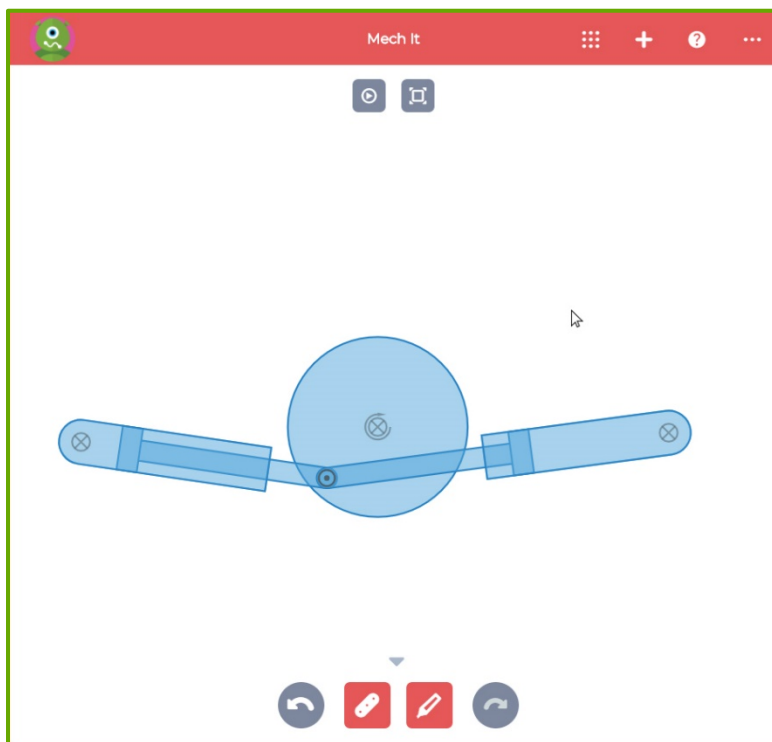
This basic model shows how a gasoline engine turns the energy from exploding fuel into circular motion.

In a real internal combustion engine, the space at the end of the piston fills with fuel and air, then is ignited to cause a small, but powerful explosion. That explosion pushes the other end of the piston out, which causes the wheel attached to it to spin.

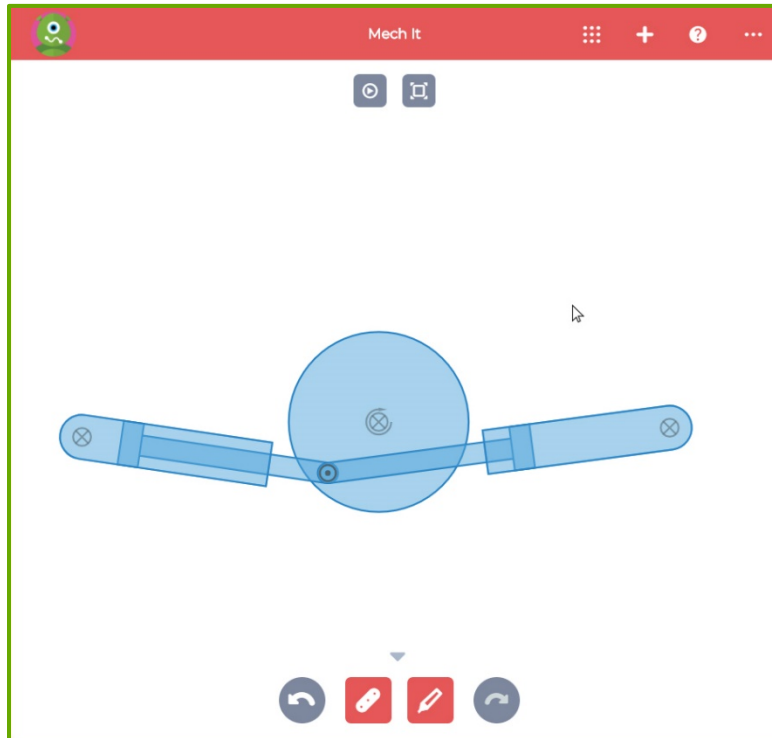


ADDING TO THE MODEL

The model we just created only uses one piston to spin the wheel, but most gasoline engines have several pistons. Adding pistons allows an engine to produce more power, and to run more smoothly.



Students can experiment with their models and add more pistons. The model shown has one extra piston, but students can experiment with many pistons, of different sizes, as they wish.



Students can also use a linkage and a track to change rotating motion to a straight back-and-forth motion. Review the example at left, and experiment with the **Mech It** App to do this yourself.



DISCUSSING ENGINES

After students have built and animated their models, have them consider and discuss the following questions:

- *What are some machines that use wheels and pistons?*
- *Think about the engine model you made. How does a gasoline engine turn exploding fuel into circular motion?*
- *What parts of your model that needed changes to work properly?*
- *Why do engineers and scientists use models to design and test machines like engines?*
- *How could improvements in engine designs change something in the world?*



ENGINES IN THE REAL WORLD

The videos listed below can help students explore and understand how engines and engine designs impact the world. Read the introduction paragraph to the students, then have them view the videos for that topic. After students have viewed the videos, you can use the included questions to encourage discussion on those topics.

Pedal Power

Have you ever thought of your body as an engine? In the following videos, you'll learn how mechanical engineers have taken the concepts behinds engine design and used them to create a new type of pedal-powered transportation. After you watch the video, you'll have a chance to talk about the engineering challenges of this new vehicle.



Power to the Pedal: <http://bit.ly/career4440>

- *How does the Outrider vehicle use a person as an engine?*
- *What are some of the things the Outrider vehicle does better than other vehicles?*
- *What are some other things that could use human power in some way?*
- *How could a vehicle like the Outrider change how people move from place-to-place?*
- *How could a vehicle like the Outrider change what kinds of transportation jobs will be needed in the future?*

This video is provided by PBS LearningMedia.

Keeping Engines Running

Have you ever wondered what happens when a tugboat's engine or a bulldozer quits working? Many large machines use diesel technology to make them move, and if those machines need repairs, it's time to call in a Diesel Engine Specialist. In the following video, you'll learn how diesel mechanics and engine specialists have the skills needed to keep some of the world's largest and most expensive machines moving. After you watch the video, you'll have a chance to talk about how these skills are necessary in our modern world.



Diesel Engine Specialists Career Video: <http://bit.ly/career4930>

- ***What are some machines that might be powered by diesel engines?***
- ***What are some advantages to repairing a broken machine, instead of replacing it with a brand new one?***
- ***Think about all of the equipment needed to construct projects like stadiums, hydroelectric dams, bridges, or skyscrapers. How would these types of projects be different without diesel-powered machines?***

Diesel Engine Specialists are experienced with maintaining and repairing diesel engine technology. They work in a variety of industries. Including, manufacturing, shipping, government, construction, and marine transportation.

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Pedal Power image by US Air Force via Wikimedia Commons under Creative Commons license.

Keeping Engines Running image by US Navy via Wikimedia Commons under Creative Commons license.



EDUCATOR RUBRIC

ITEM	Does Not Meet Expectations	Meets Expectations	Exceeds Expectations
Understanding the Assignment – Consider This	Student does not express opinions, or cannot name machines with rotating parts.	Student is able to name some machines with rotating or spinning parts.	Student can express how pedaling a bicycle causes the wheels to rotate.
Using the Mech It app to Modify or Create a Model	Student was unwilling or unable to construct a basic piston/ wheel mode, or add or adjust shapes in a riffed copy of an existing model.	Student modified an existing model or created a new one by adding or modifying shapes in the model.	Student demonstrated original creativity and/or artistic ability by making substantial modifications or new models that are associated with experimenting with engine design.
Animating the Model	Students was unwilling or unable to animate the model, even with assistance.	Student was able to animate the model with little or no assistance.	Student was able to animate the model and modify the animation speed.
Discussing Engines	Student was unwilling or unable to name machines that use wheels and pistons, and was able to express why engineers use models.	Student was able to name machines that use wheels and pistons, and was able to express why engineers use models.	Student was able to express how changes in engines could impact the world.
Engines in the Real World	Student was unwilling or unable to name any careers involved in mechanized movement, or express how a person is like an engine when pedaling.	Student was able to name some careers involved in mechanized movement, or express how a person is like an engine when pedaling.	Student was able to express how new vehicles could change the world, or express how different the world would be without diesel-powered machines.



STANDARDS ALIGNMENT

This project is most closely aligned with the middle school engineering standards in the Next Generation Science Standards (MS-ETS1-4).

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Students design, develop and then animate their piston model. They test and improve their designs.

In addition, this project addresses cross cutting concepts of structure and function, cause and effect, stability and change and scale proportion and quantity.

The discussion and communication elements of this lesson can lead to instruction on the following standards:

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

4-PS3-4. Energy Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

3-5-ETS1-1. Engineering Design Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy