

LEGO® MINDSTORMS® Education EV3

Maker Activities – Years 5-8



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mINDSTORMS
education **EV3**

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1. Introduction to the Maker Lessons



The LEGO® MINDSTORMS® Education EV3 Maker Lessons have been developed to engage and motivate students in Years 5-8, piquing their interest in learning design, engineering, and coding using motorised models and simple programming.

Each lesson provides an initial brief as a starting point. The open ended prompts allow for unlimited answers and enable students to express a wide range of creative solutions as they sketch, build, and test prototypes of the designs they create.

The teacher's role in these lessons is to provide students with the tools and necessary freedom to connect with and define a problem, make a solution, and share what they have made.

Use your creativity to adapt these activities to suit the needs of your students.

"The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge."

– Seymour Papert

Classroom Management Tips

Required Materials

- LEGO® MINDSTORMS® Education EV3 Core Set
- Lesson plan
- Student Worksheet for each activity
- Inspirational images for each activity
- Modelling materials already available in your classroom

How much time do you need?

Each lesson is designed to take 90 minutes. If you work in shorter class periods, you can break this down into two 45 minute sessions.

Preparation

It is important to establish student groups. Groups of two work well. Ensure that each student has a copy of the Student Worksheet for recording their design process, or alternatively, they can use their own preferred method for recording their design journey. They will also need the LEGO MINDSTORMS Education EV3 Core Set (one set for every two students is recommended).

The LEGO® Education Maker (Design) Process



Defining the Problem

It is important that students define a real problem to solve, or find a new design opportunity from the start. The “Connect” images are provided to help students think about designing their solutions. At this stage of the process, it is important that you not show examples of a final or sample solution.



Brainstorm

Brainstorming is an active part of making. Some students will find it easier to explore their thoughts through tinkering (hands-on experimentation) with the LEGO® bricks, and others will prefer to record sketches and notes. Group work is essential, but it is important to allow time for students to work alone before sharing their ideas with their groups.



Define the Design Criteria

Discussing and reaching an agreement about the best solution to build can involve a lot of negotiation and may require different techniques that are dependent on the students' skills. For example:

- Some students draw well.
- Others may build part of a model, and then describe what they mean.
- Other students may be good at describing a strategy.



Encourage an ethos where students can share anything, no matter how abstract it might sound. Be active during this phase and ensure that the ideas the students choose are achievable.

It is important that students set clear design criteria. Once the solution to the problem has been made, the students will return to these criteria, which will then form the basis for testing how well their solution works.



Go Make

Students must make one of their ideas using the LEGO® set, and can use other materials if needed. If they are finding it hard to build their idea, encourage them to break problems down into smaller parts. Explain that they do not have to come up with the whole solution from the start. Remind students that this process is iterative and they must test, analyse, and revise their idea as they go.

Using this Maker process does not mean you are following an inflexible set of steps. Instead, think of it as a set of practices.

For example, brainstorming may be prominent at the beginning of the process. However, students may also need to brainstorm ideas when they are trying to figure out ways to improve their idea, or when they have a bad test result and must change a feature of their design.



Review and Revise Your Solution

To help students develop their critical thinking and communication skills, you may wish to have students from one group observe and critique another group's solution. Peer review and formative feedback helps both the students giving, and the students receiving the feedback to improve their work.



Communicate Your Solution

The Student Worksheet is helpful for basic documentation of the activity. Students can also refer to it when presenting their work in front of the class. You may also wish to use the Student Worksheet as a portfolio for performance evaluations or for student self-evaluation.



Design criteria example:

The design must..
The design should..
The design could..



The LEGO® Education Maker (Design) Process



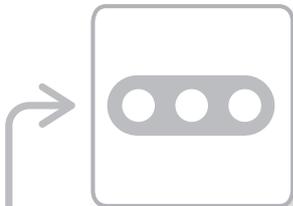
Define the Problem



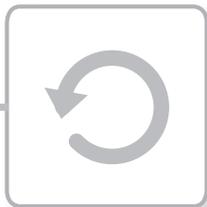
Brainstorming



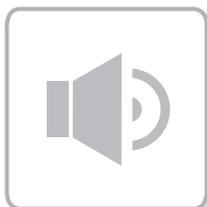
Define the Design Criteria



Go Make



Review and Revise Your Solution



Communicate Your Solution

Assessment

Where can I find the assessment materials?

Assessment materials are provided on the following page for the first three projects.

What learning goals are assessed?

Students use the Student Worksheet assessment rubric to evaluate their design work according to the learning goals. Each rubric includes four levels: Bronze, Silver, Gold, and Platinum. The intention of the rubric is to help students reflect on what they have done well in relation to the learning goals and what they could have done better. Each rubric can be linked to the Australian Curriculum: Design and Technologies.

Australian Curriculum: Design and Technologies

Content Descriptors

ACTDEK019, ACTDEK029, ACTDEK020, ACTDEK031, ACTDEK023, ACTDEK034

Process and Production Skills

ACTDEP024, ACTDEP035, ACTDEP025, ACTDEP036, ACTDEP026, ACTDEP037,
ACTDEP027, ACTDEP038, ACTDEP028, ACTDEP039

Share It

We encourage you to share your students' brilliant projects on the appropriate social media platforms using the hashtag **#LEGOMaker**.

Students can also share their own projects if they are over 13 years old and if it complies with the rules of your school/Maker space.

The Maker Activities

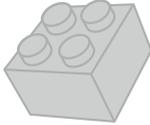
Start your Maker journey with the following three activities:

- Sound Machine
- Security Gadget
- Puppet

 **#LEGOMAKER**

Self-Assessment

Name(s): _____ Date: _____

GOALS	 BRONZE	 SILVER	 GOLD	 PLATINUM
Maker task: Sound Machine Designing Solutions	<ul style="list-style-type: none"> We successfully built and tested one design based upon a single design criteria and design idea. <input data-bbox="533 721 572 761" type="checkbox"/>	<ul style="list-style-type: none"> We successfully used two design criteria and ideas to build a solution to a defined problem. <input data-bbox="812 721 852 761" type="checkbox"/>	<ul style="list-style-type: none"> We met Silver and refined our idea, improving it further through testing, revising, and retesting. <input data-bbox="1090 721 1129 761" type="checkbox"/>	<ul style="list-style-type: none"> We met Gold and successfully met all three design criteria. <input data-bbox="1367 721 1407 761" type="checkbox"/>
Maker task: Security Gadget Defining Problems	<ul style="list-style-type: none"> We understood the design problem. <input data-bbox="533 917 572 957" type="checkbox"/>	<ul style="list-style-type: none"> We defined a design problem and used one design criteria and idea to build our solution. <input data-bbox="812 917 852 957" type="checkbox"/>	<ul style="list-style-type: none"> We achieved Silver and used two design criteria and ideas to build our solution. <input data-bbox="1090 917 1129 957" type="checkbox"/>	<ul style="list-style-type: none"> We achieved Gold and used three design criteria and ideas to build an effective solution. <input data-bbox="1367 917 1407 957" type="checkbox"/>
Maker task: Puppet Obtaining, Evaluating, and Communicating Information	<ul style="list-style-type: none"> We drew and labelled the different parts of our design. <input data-bbox="533 1134 572 1174" type="checkbox"/>	<ul style="list-style-type: none"> We met Bronze and identified the location of the key component parts responsible for making our design work. <input data-bbox="812 1134 852 1174" type="checkbox"/>	<ul style="list-style-type: none"> We met Silver and included a diagram showing how our design works. <input data-bbox="1090 1134 1129 1174" type="checkbox"/>	<ul style="list-style-type: none"> We met Gold and used words and a diagram to explain how our new design works. <input data-bbox="1367 1134 1407 1174" type="checkbox"/>

Notes:

Well done! What will you make next?

2. Lesson Plan: Sound Machine

Use this lesson plan to help structure the flow of each lesson.

Learning Goals

After completing this lesson, students will have:

- Used and understood the design process
- Defined a clear design need
- Developed their ability to iterate and improve design solutions
- Developed their problem-solving and communication skills

Duration

2 x 45 mins (90 mins)

Preparation

Ensure that each student has a copy of the Student Worksheet for recording their design process. They will also need the LEGO® MINDSTORMS® Education EV3 Core Set (one set for every two students is recommended).

Other Materials Required (Optional)

Use craft materials that you already have in your classroom to add another dimension to this activity. Some materials could be:

- Rubber bands
- Pipe cleaners
- Thin cardboard
- Construction paper
- Thin wire
- Thin plastic sheets
- Recycled materials
- Foam

Procedure

1. Introduction/Discussion

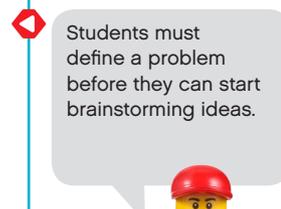
Hand out the Student Worksheets and allow the students to interpret the activity themselves, or read the Maker “Connect” text aloud to set the scene.

2. Defining the Problem

As students look at the “connect” images and questions, facilitate a discussion to steer them toward a problem or new design opportunity. Once they have decided upon a problem to solve, ensure that they record this in some way. They can use the worksheet to help structure their project documentation, or use their own preferred method to record their design journey.

3. Brainstorm

Students should initially work independently, spending three minutes to generate as many ideas as they can to solve the problem. They can use the bricks from the LEGO® set during the brainstorming process, or sketch out their ideas in the space provided on the worksheet.



It is important for students to spend time tinkering with the LEGO® bricks in order to generate ideas. The goal of tinkering is to explore as many solutions as possible. You can use the tinkering examples at the end of these materials for inspiration, or as a means for getting started.

Students can now take turns sharing their ideas within their groups. Once all of the ideas have been shared, each group should select the best idea(s) to make. Be prepared to help facilitate this process, ensuring that the students choose an idea that is possible to make. Encourage diversity, not all groups have to make the same thing.

4. Define the Design Criteria

Students should record up to three design criteria on their worksheets. They will refer to this again as they review and revise their solutions.

5. Go Make

Now the students will make one of their group's ideas using the LEGO® MINDSTORMS® Education EV3 Core Set, and other materials as needed.

Reinforce that students do not have to come up with the whole solution from the start.

During the making process, remind students to test and analyse their idea as they go, making improvements where necessary. If you want students to submit their documentation at the end of the lesson, ensure that they use sketches and photos of their models to record their design journey during the making stage of the lesson.

6. Review and Revise Your Solution

Students will test and evaluate their designs against the design criteria they recorded before they started making their solutions. They can record notes on their Student Worksheets.

7. Communicate Your Solution

Allow time for each student or student group to present what they have made to the class. A good way to do this is to set out a table large enough to display all of the models. If time is short, pair off the groups and have them present to each other.

8. Assessment

Students will use the Student Worksheet assessment rubric to evaluate their design work according to the learning goals. Each rubric includes four levels: Bronze, Silver, Gold, and Platinum. The intention of the rubric is to help students reflect on what they have done well in relation to the learning goals and what they could have done better. Each rubric can be linked to the Australian Curriculum: Design and Technologies.

9. Tidy Up

Ensure that you leave approximately 10-15 minutes at the end of the lesson to break down the models and sort them back into the LEGO® boxes.



Take turns to share your ideas.



Design criteria example:
The design must..
The design could..
The design should...



How well does it work?
What if...?



Additional Teacher's Notes

Optional Materials

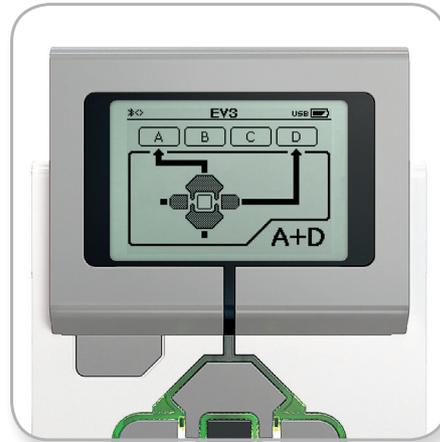
- Plastic or paper cups
- Small musical instruments, such as chimes, bells, and small drums

Prior Learning

Before beginning this Maker activity, it is recommended that students know how to use the on-brick motor control function, and also how to program a motor to move.



Brick app screen



Motor control

Tinkering Examples

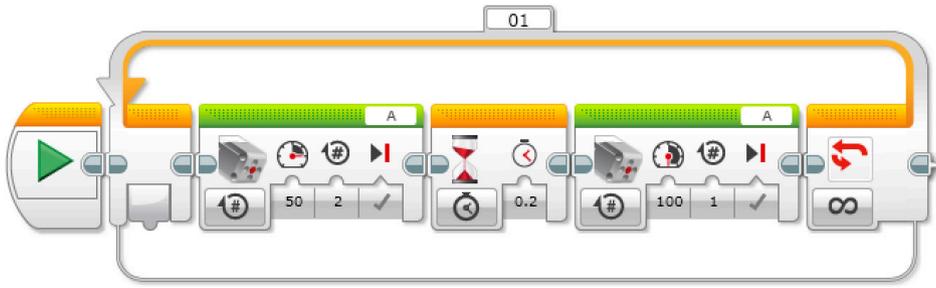
Some students may need a little inspiration and scaffolding to help them get started. Students can remix an existing model, or invent a new design.

Note: You are advised not to share these images with students.



Sound Machine

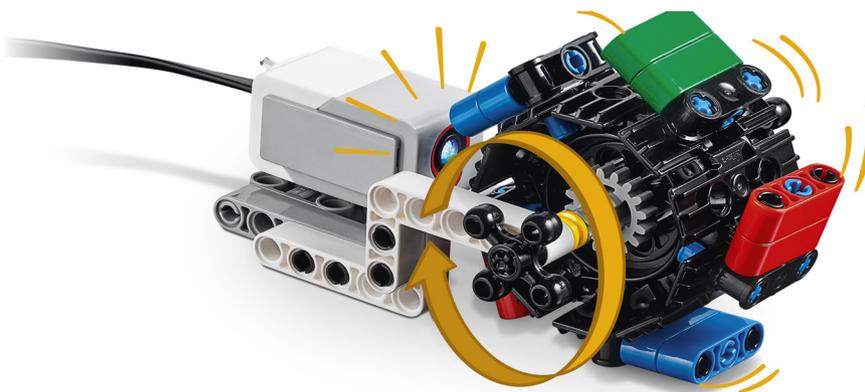
This example program combined with the small model will make a beat and rhythm on any surface when the program is run.



Tinkering Examples

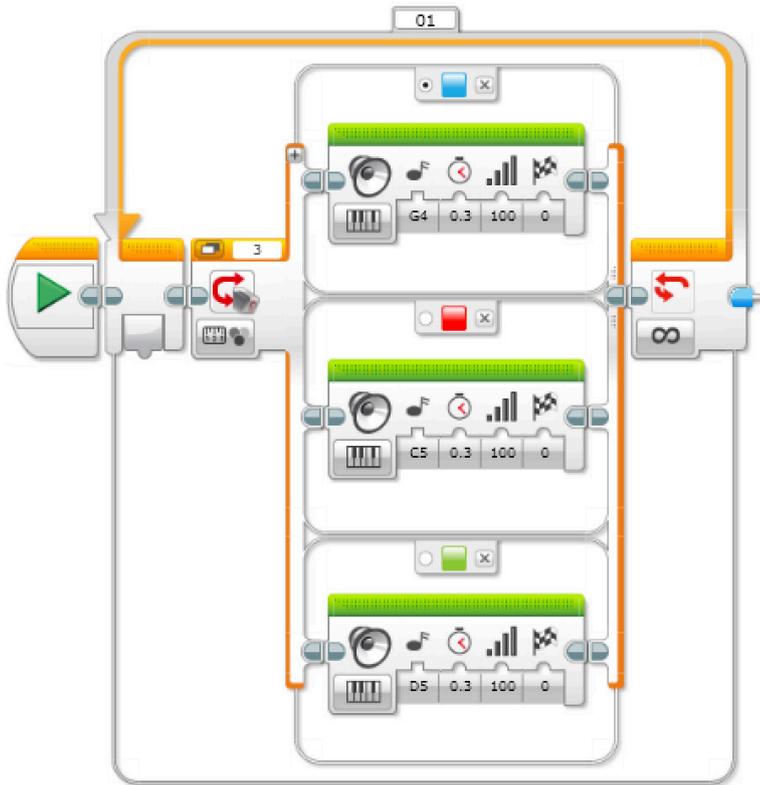
Note: You are advised not to share these images with students.

You can also tinker with the use of sensors.



Sound Machine

This program will play different sounds when the wheel is rotated. The sound is determined by which colour is placed in front of the colour Sensor.





Sound Machine

Maker Connect

Music is made up of a combination of sounds, notes and rhythm. A rhythm is a regular movement or repeated pattern of movements that can be used in many different ways. In mechanical machines, a rhythm can help keep a machine running smoothly. It can also be used to generate different sounds in music.

Look at the photos below and answer the questions.

- What do you see?
- Can you see any new design opportunities?
- What problems can you see?
- How could you make use of the LEGO[®] bricks, Programmable Brick, motors, and sensors?



Student Worksheet - Sound Machine

Name(s): _____ Date: _____

Defining the Problem

What problems can you see in the pictures? Pick one problem and explain it below.

Brainstorm

Individual work: Now that you have defined a problem, take three minutes to generate ideas for solving it. Be prepared to share your ideas with your group.

Group work: Share and discuss your ideas for solving the problem.

Define the Design Criteria

You should have generated a number of ideas. Now select the best one to make.

Based upon your brainstorming discussion, write out two or three specific design criteria your design must meet:

1. _____
2. _____
3. _____



Documenting your work is very important during the design process. Record as much as you can using sketches, photos, and notes.



Use LEGO® bricks and sketches to explore your ideas.



Sometimes simple ideas are the best ideas.



Design criteria example:
The design must...
The design should...
The design could...



Go Make

It is time to start making. Use the components from the LEGO® set to make your chosen solution. Test and analyse your design as you go and record any improvements that you make.

Review and Revise Your Solution

Have you managed to solve the problem that you defined at the beginning of the lesson? Look back at your three design criteria.

How well does your solution work? Use the space below to suggest three improvements to your design.

- 1. _____
- 2. _____
- 3. _____

Communicate Your Solution

Now that you have finished, make a sketch or take a photo of your model, label the three most important parts, and explain how they work. You are now ready to present your solution to the class.



You can use other materials from around the classroom.



Print off your photos, and attach all of your work onto a piece of paper or cardboard.



3. Lesson Plan: Security Gadget

Use this lesson plan to help structure the flow of each lesson.

Learning Goals

After completing this lesson, students will have:

- Used and understood the design process
- Defined a clear design need
- Developed their ability to iterate and improve design solutions
- Developed their problem-solving and communication skills

Duration

2 x 45 mins (90 mins)

Preparation

Ensure that each student has a copy of the Student Worksheet for recording their design process. They will also need the LEGO® MINDSTORMS® Education EV3 Core Set (one set for every two students is recommended).

Other Materials Required (Optional)

Use craft materials that you already have in your classroom to add another dimension to this activity. Some materials could be:

- Rubber bands
- Pipe cleaners
- Thin cardboard
- Construction paper
- Thin wire
- Thin plastic sheets
- Recycled materials
- Foam

Procedure

1. Introduction/Discussion

Hand out the Student Worksheets and allow the students to interpret the activity themselves, or read the Maker “Connect” text aloud to set the scene.

2. Defining the Problem

As students look at the “connect” images and questions, facilitate a discussion to steer them toward a problem or new design opportunity. Once they have decided upon a problem to solve, ensure that they record this in some way. They can use the worksheet to help structure their project documentation, or use their own preferred method to record their design journey.

3. Brainstorm

Students should initially work independently, spending three minutes to generate as many ideas as they can to solve the problem. They can use the bricks from the LEGO® set during the brainstorming process, or sketch out their ideas in the space provided on the worksheet.



Students must define a problem before they can start brainstorming ideas.



It is important for students to spend time tinkering with the LEGO® bricks in order to generate ideas. The goal of tinkering is to explore as many solutions as possible. You can use the tinkering examples at the end of these materials for inspiration, or as a means for getting started.

Students can now take turns sharing their ideas within their groups. Once all of the ideas have been shared, each group should select the best idea(s) to make. Be prepared to help facilitate this process, ensuring that the students choose an idea that is possible to make. Encourage diversity, not all groups have to make the same thing.

4. Define the Design Criteria

Students should record up to three design criteria on their worksheets. They will refer to this again as they review and revise their solutions.

5. Go Make

Now the students will make one of their group's ideas using the LEGO® MINDSTORMS® Education EV3 Core Set, and other materials as needed.

Reinforce that students do not have to come up with the whole solution from the start.

During the making process, remind students to test and analyse their idea as they go, making improvements where necessary. If you want students to submit their documentation at the end of the lesson, ensure that they use sketches and photos of their models to record their design journey during the making stage of the lesson.

6. Review and Revise Your Solution

Students will test and evaluate their designs against the design criteria they recorded before they started making their solutions. They can record notes on their Student Worksheets.

7. Communicate Your Solution

Allow time for each student or student group to present what they have made to the class. A good way to do this is to set out a table large enough to display all of the models. If time is short, pair off the groups and have them present to each other.

8. Assessment

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9. Tidy Up

Ensure that you leave approximately 10-15 minutes at the end of the lesson to break down the models and sort them back into the LEGO® boxes.



Take turns to share your ideas.



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The design must..
The design could..
The design should...



How well does it work?
What if...?



Additional Teacher's Notes

Optional Materials

- Cardboard or paper
- String

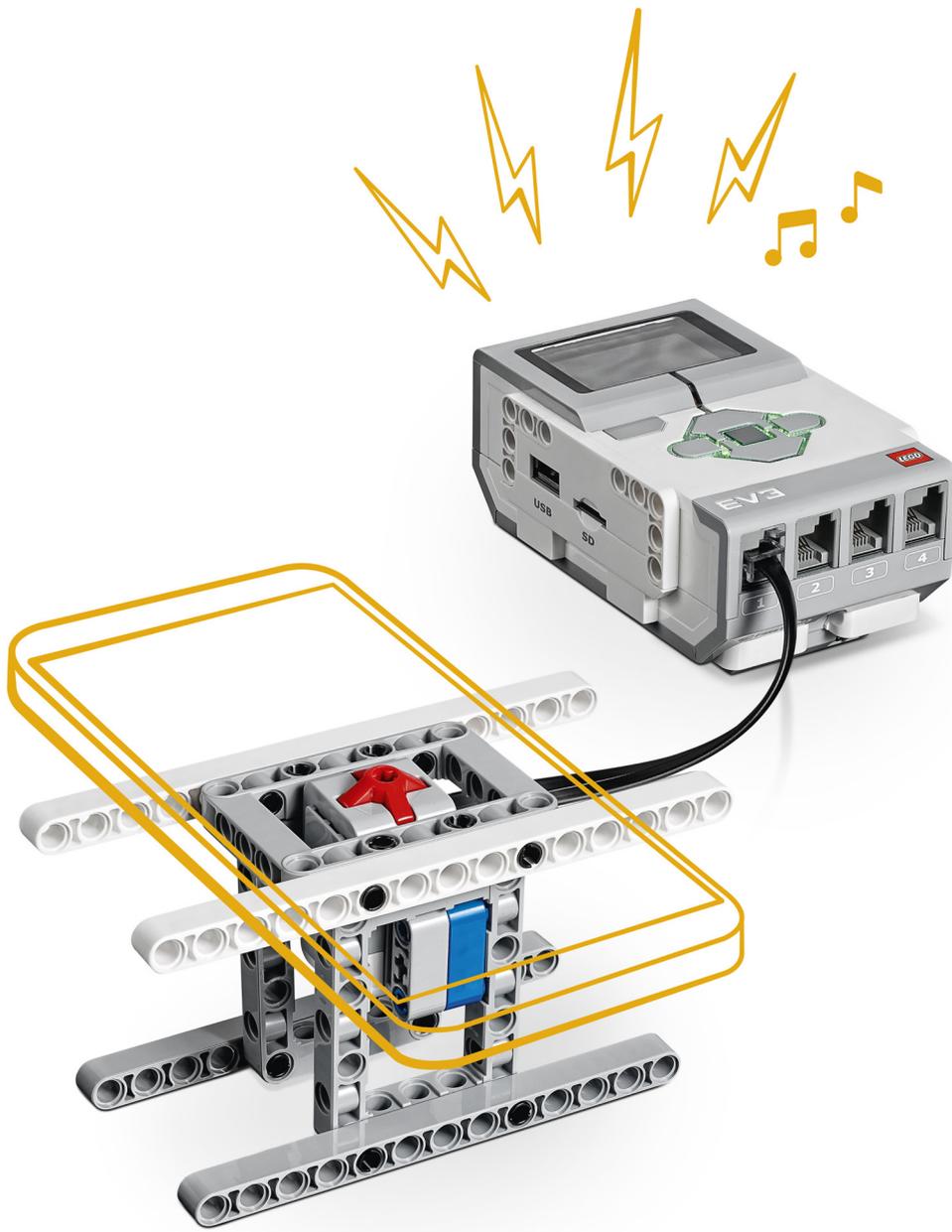
Prior Learning

Before beginning this Maker activity, it is recommended that students know how to use the input sensors.

Tinkering Examples

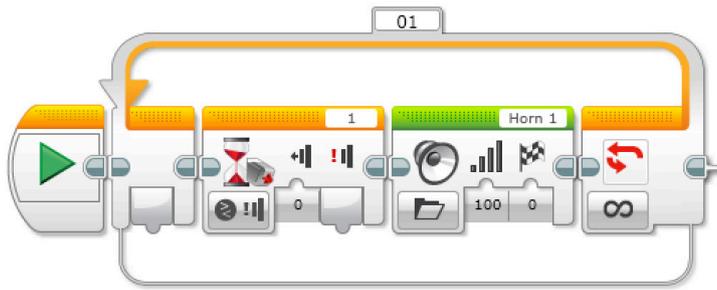
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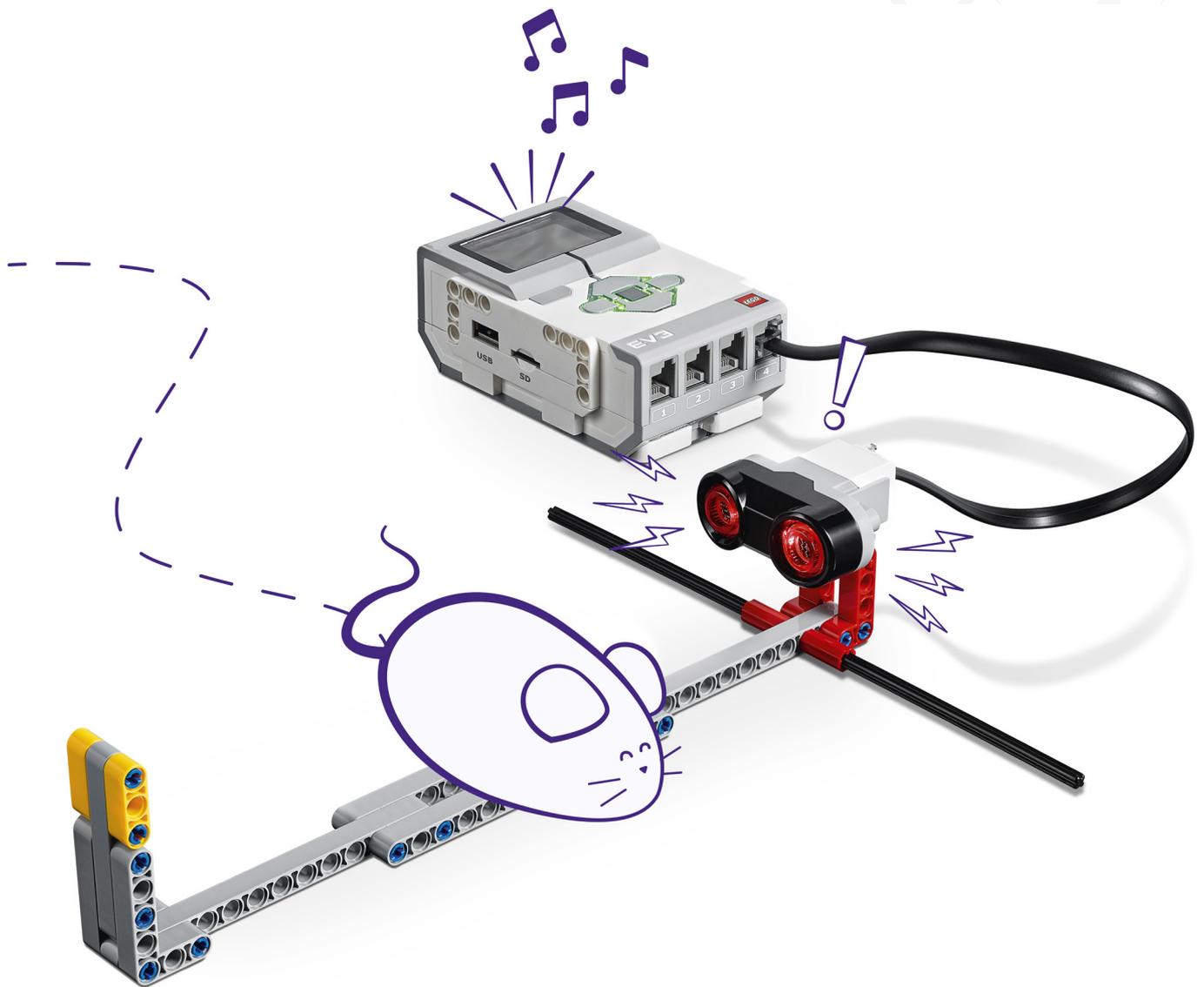
Security Gadget

This program will activate an alarm when an object is lifted from the Touch Sensor.

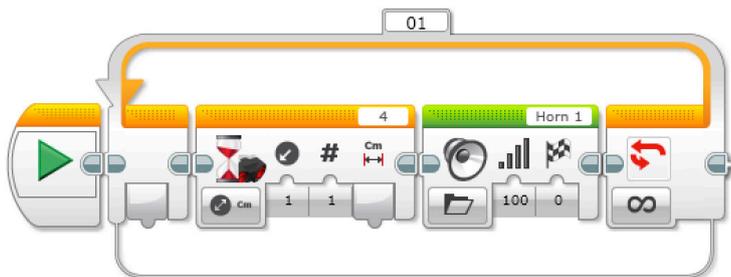


Tinkering Examples

Note: You are advised not to share these images with students.



This program will activate an alarm when an object moves in front of the Ultrasonic Sensor.





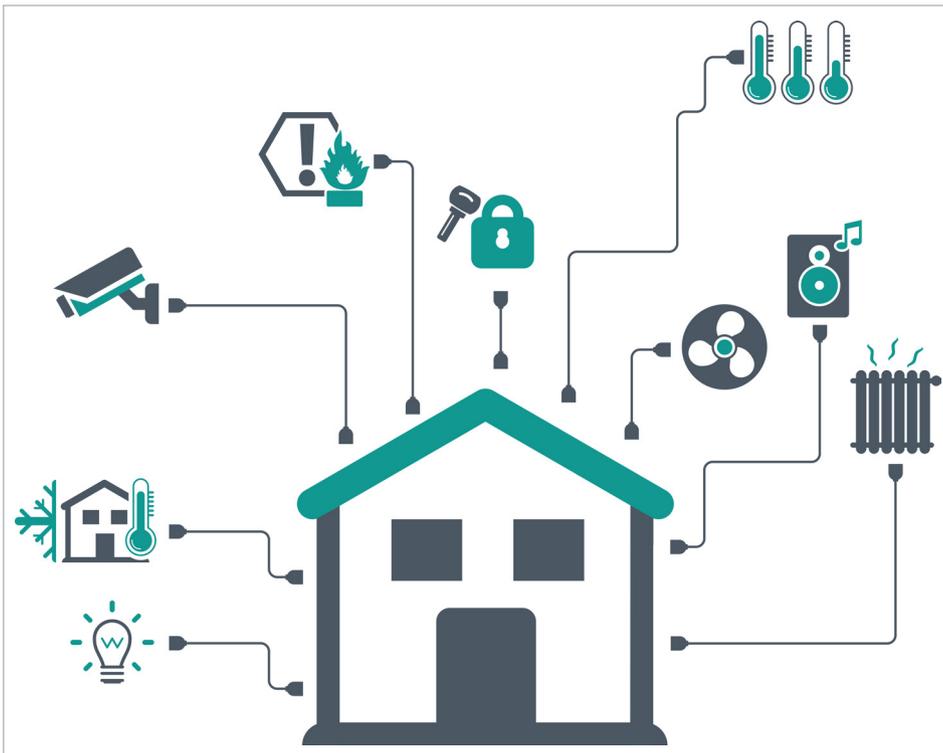
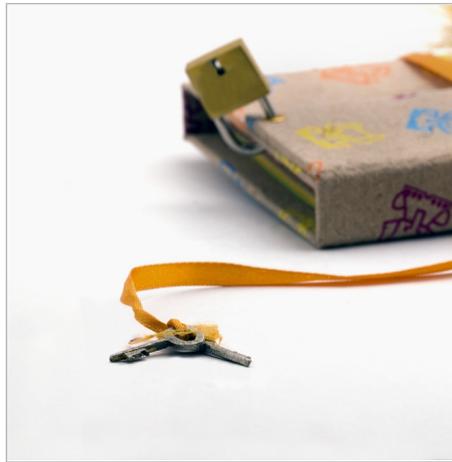
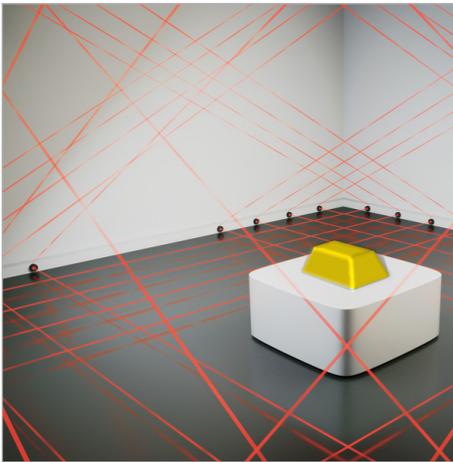
Security Gadget

Maker Connect

Over time, people have come up with many different ways to help protect their personal belongings from theft. These inventions include simple alarm systems and even traps!

Look at the photos below and answer the questions.

- What do you see?
- Can you see any new design opportunities?
- What problems can you see?
- How could you make use of the LEGO[®] bricks, Programmable Brick, motors, and sensors?



Student Worksheet - Security Gadget

Name(s): _____ Date: _____

Defining the Problem

What problems can you see in the pictures? Pick one problem and explain it below.

Brainstorm

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Communicate Your Solution

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4. Lesson Plan: Puppet

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- Defined a clear design need
- Developed their ability to iterate and improve design solutions
- Developed their problem-solving and communication skills

Duration

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Preparation

Ensure that each student has a copy of the Student Worksheet for recording their design process. They will also need the LEGO® MINDSTORMS® Education EV3 Core Set (one set for every two students is recommended).

Other Materials Required (Optional)

Use craft materials that you already have in your classroom to add another dimension to this activity. Some materials could be:

- Rubber bands
- Pipe cleaners
- Thin cardboard
- Construction paper
- Thin wire
- Thin plastic sheets
- Recycled materials
- Foam

Procedure

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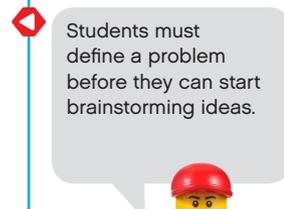
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2. Defining the Problem

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3. Brainstorm

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Now the students will make one of their group's ideas using the LEGO® MINDSTORMS® Education EV3 Core Set, and other materials as needed.

Reinforce that students do not have to come up with the whole solution from the start.

During the making process, remind students to test and analyse their idea as they go, making improvements where necessary. If you want students to submit their documentation at the end of the lesson, ensure that they use sketches and photos of their models to record their design journey during the making stage of the lesson.

6. Review and Revise Your Solution

Students will test and evaluate their designs against the design criteria they recorded before they started making their solutions. They can record notes on their Student Worksheets.

7. Communicate Your Solution

Allow time for each student or student group to present what they have made to the class. A good way to do this is to set out a table large enough to display all of the models. If time is short, pair off the groups and have them present to each other.

8. Assessment

Students will use the Student Worksheet assessment rubric to evaluate their design work according to the learning goals. Each rubric includes four levels: Bronze, Silver, Gold, and Platinum. The intention of the rubric is to help students reflect on what they have done well in relation to the learning goals and what they could have done better. Each rubric can be linked to the Australian Curriculum: Design and Technologies.

9. Tidy Up

Ensure that you leave approximately 10-15 minutes at the end of the lesson to break down the models and sort them back into the LEGO® boxes.

Take turns to share your ideas.



Design criteria example:
The design must..
The design could..
The design should..



How well does it work?
What if..?



Additional Teacher's Notes

Optional Materials

- Cardboard or paper
- Fabric scraps for decoration
- Coloured felt pens or pencils

Prior Learning

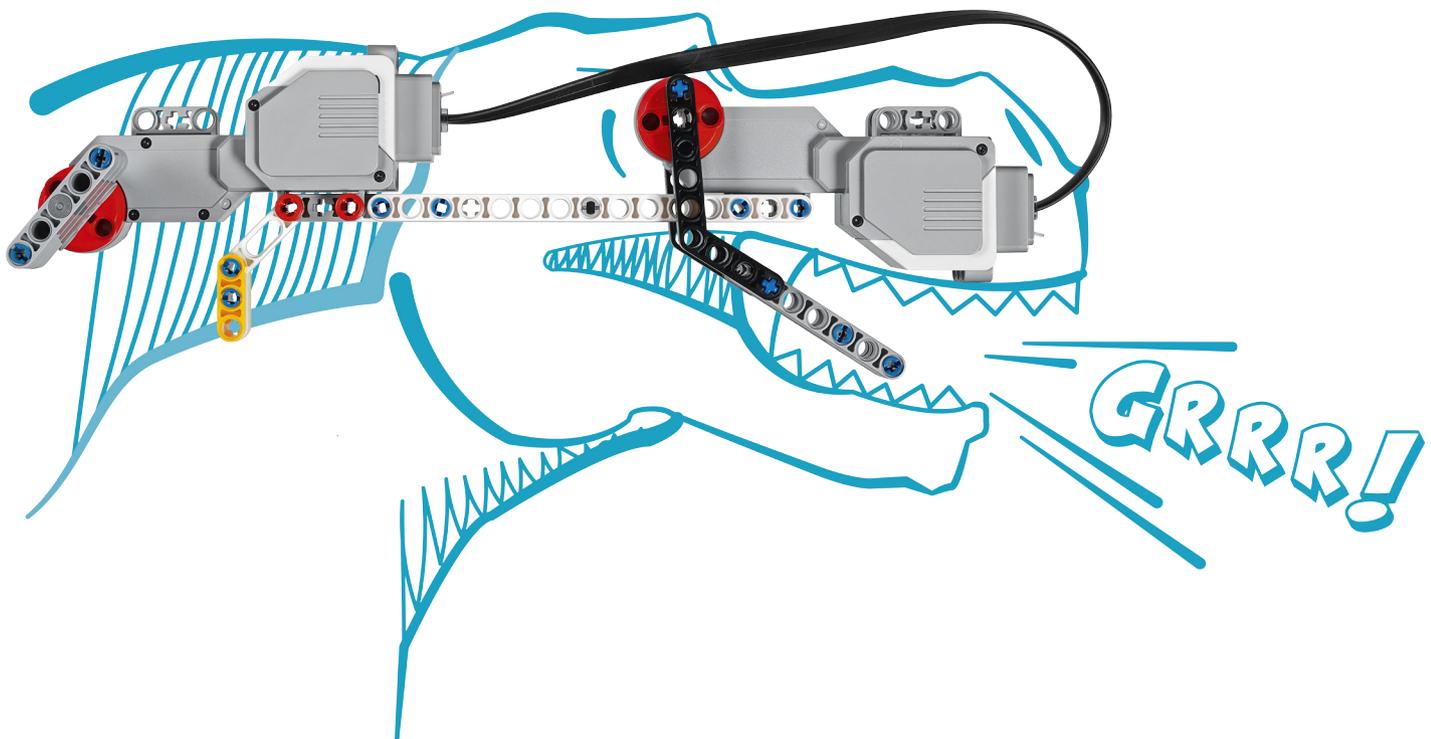
Before beginning this Maker activity, it is recommended that students know how to use the on-brick motor control function, and also how to program a motor to move.

Students can also try connecting two motors together, this is a great way to explore movement.

Tinkering Examples

Some students may need a little inspiration and scaffolding to help them get started. Students can remix an existing model, or invent a new design.

Note: You are advised not to share these images with students.



Puppet

Use this program with the Programmable Brick and Large Motor.





Puppet

Maker Connect

Puppets have been used for generations to tell stories and create characters for TV and film. They can be as simple as a thumb puppet or as complex as a moving animatronic dinosaur used in a movie.

Look at the photos below and answer the questions.

- What do you see?
- Can you see any new design opportunities?
- What problems can you see?
- How could you make use of the LEGO[®] bricks and Programmable Brick?



Student Worksheet - Puppet

Name(s): _____ Date: _____

Defining the Problem

What problems can you see in the pictures? Pick one problem and explain it below.

Brainstorm

Individual work: Now that you have defined a problem, take three minutes to generate ideas for solving it. Be prepared to share your ideas with your group.

Group work: Share and discuss your ideas for solving the problem.

Define the Design Criteria

You should have generated a number of ideas. Now select the best one to make.

Based upon your brainstorming discussion, write out two or three specific design criteria your design must meet:

1. _____
2. _____
3. _____



Documenting your work is very important during the design process. Record as much as you can using sketches, photos, and notes.



Use LEGO® bricks and sketches to explore your ideas.



Sometimes simple ideas are the best ideas.



Design criteria example:
The design must...
The design should...
The design could...



Go Make

It is time to start making. Use the components from the LEGO® set to make your chosen solution. Test and analyse your design as you go and record any improvements that you make.

Review and Revise Your Solution

Have you managed to solve the problem that you defined at the beginning of the lesson? Look back at your three design criteria.

How well does your solution work? Use the space below to suggest three improvements to your design.

- 1. _____
- 2. _____
- 3. _____

Communicate Your Solution

Now that you have finished, make a sketch or take a photo of your model, label the three most important parts, and explain how they work. You are now ready to present your solution to the class.



You can use other materials from around the classroom.



Print off your photos, and attach all of your work onto a piece of paper or cardboard.



5. Additional Maker Briefs

Once you have completed these first three activities, use the same Maker design process to try out one or more of the activities listed below.

1. Table Top Game

Games can help people make new friends, communicate and share new ideas, and just have fun together. Some examples include mini sports games, problem-solving puzzles, and games that can help you remember the things you have learned in class today.

2. Drawing Machine

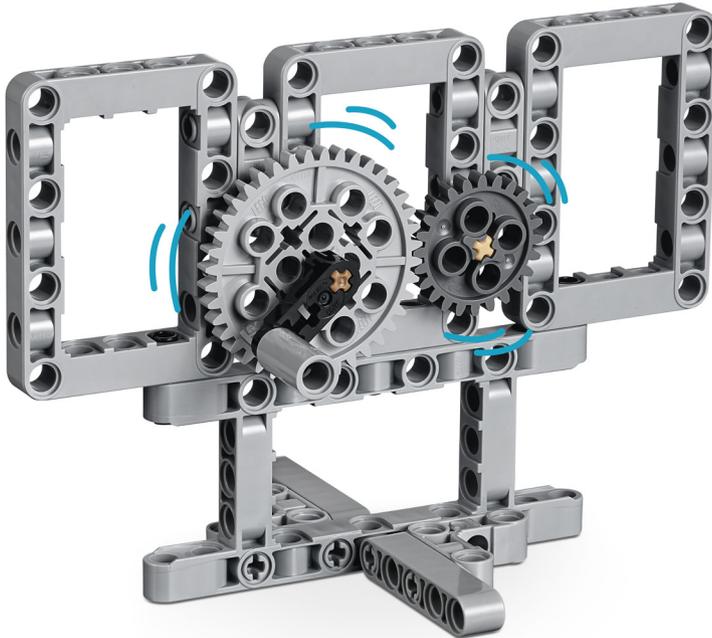
We are surrounded by mechanisms and machines that can draw diagrams or print pictures. These devices are often used for drawing repeated patterns and creating abstract art.

3. Wearable

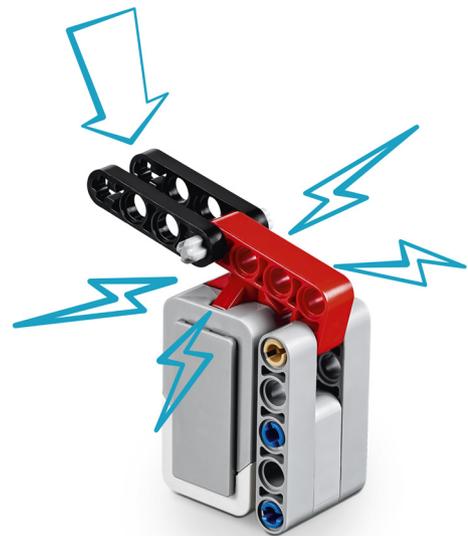
Wearables, or wearable technology, is being used more and more in everyday life. We see wearable technology in the form of health monitors, mind-controlled and gesture-controlled devices, invisibles, VR headsets, and smart watches that can pay for your shopping or even reveal your flight boarding pass! These are just a few of the many products that already exist.

6. Tinkering Ideas

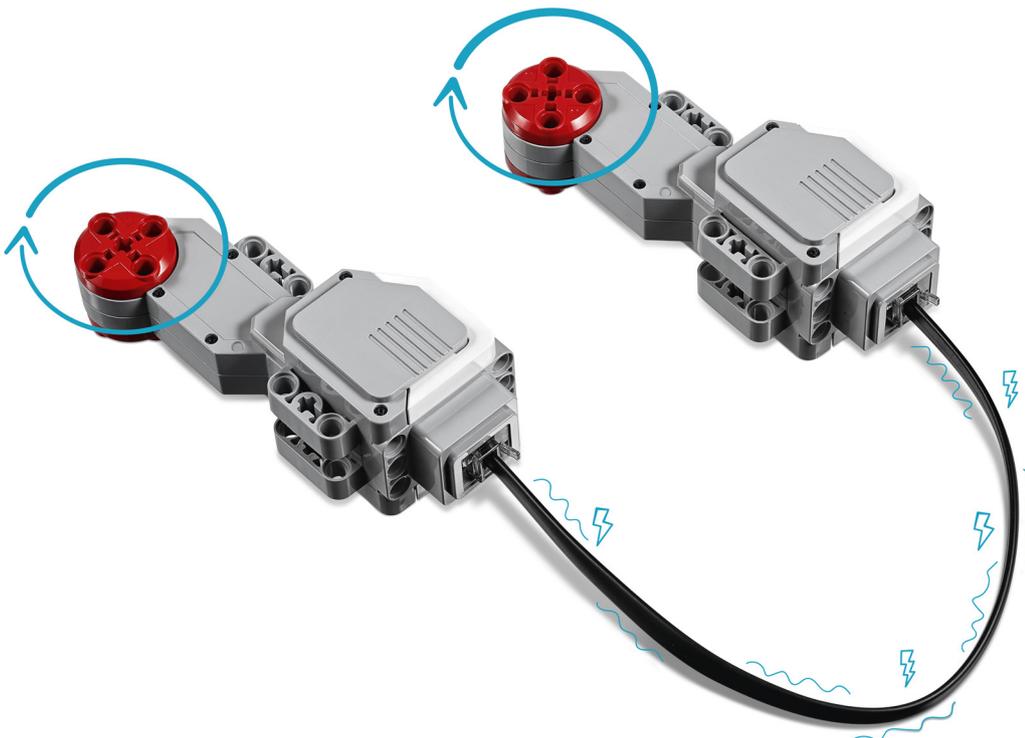
Maker Spaces are often set up with a tinkering wall where students can get hands-on inspiration using examples of principle mechanisms. We have provided the following three ideas to help get you started. See what else you and your class can come up with, and please share your models on social media using the hashtag **#LEGOMaker**.



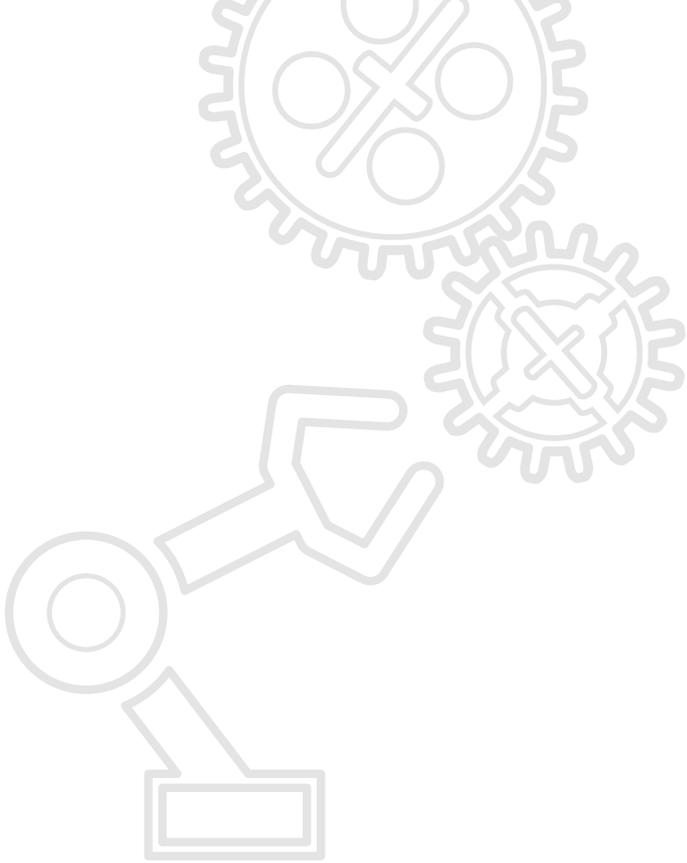
Tinker stand



Switch



Large Motor – to – Large Motor movement



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