

# PROJECT OVERVIEW

## SOUND MACHINES



Create sounds and rhythms with a set of handcrafted programmable noise makers using Scratch code. LEGO WeDo is an easy-to-use set of motors and sensors that can interact with the Scratch programming environment; with it, you can control motorized mechanical sound makers made from everyday materials, and create your own sounds by combining materials in the physical world and coding their behavior in the digital realm.



**Disclaimer:** This is not a “how to” activity guide. It is a summary of the experiments and findings of an extended period of research and development around tinkering in the digital world, with a focus on investigating programmable sound machines. By sharing this, we hope to inspire discussions and provide ideas for projects and tinkering activities in this area.

Sound Machines is a collaboration between the Tinkering Studio, MIT’s Lifelong Kindergarten group, LEGO Foundation, and Reggio Children Foundation.

the  
tinkering  
studio

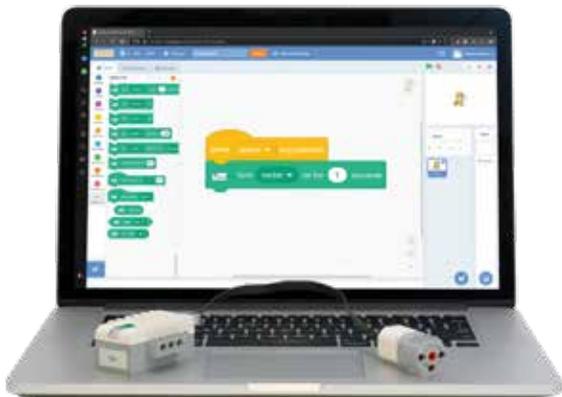
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# MATERIALS

## Computer hardware



Apple Laptop



LEGO motor

LEGO WeDo SmartHub



iPad

We used LEGO WeDo SmartHubs and motors to program and activate our Sound Machines. These can be controlled via Scratch 3.0 through a laptop, or using LEGO's own iOS app with an iPad. There are also WeDo sensors available (tilt and distance), which can optionally be used to complexify the exploration.

Both platforms have their unique advantages, and self directed learning is best supported by allowing learners to transition between the two coding environments.

## LEGO parts



The simple mechanisms involved in LEGO sound machines can easily be constructed with LEGO technic parts. Here are the essential parts needed to build programmable sound machines.

A custom made LEGO pegboard to build on can be helpful too. Instructions on how to make sound machines with pegboard can be found here: <https://www.instructables.com/id/LEGO-Tinkering-Pegboard/>

## Materials for making sounds

We also supply general craft supplies for participants to create noise makers they would like to attach to their soundmachine.

They include:

- marbles
- metal balls
- golf balls
- thin metal sheet
- thin plastic sheet material
- straws
- glass bottles
- pie trays



## Materials and tools for support structures

The sound machine support structures can be made out of cheap everyday materials combined with the LEGO parts listed above.

Essential materials include:

- pieces of 4" wood various length
- Wooden dowels
- Skewer sticks
- Clothespins
- Paper towel cores
- Corrugated cardboard
- Tape
- Scissors (for participants)
- Box cutter (for educators constructing sound machines)
- Hot glue gun and sticks (for educators constructing sound machines)



# GETTING STARTED

This activity requires to build a small set of motorized sound makers that learners explore, program, and manipulate during the workshop. Educators should reserve a day for building and testing sound machines. Once constructed, the set of materials and contraptions can be re-used during workshops.

## Set-up laptops, iPads and LEGO WeDO

### For laptops:

Go to <https://scratch.mit.edu/wedo> and follow the steps to set up a LEGO WeDO controller and connect it to Scratch on laptops.

### For iPads:

To set up a WeDo controller with an iPad, go to <https://itunes.apple.com/us/app/wedo-2-0-lego-education/>, download the app and follow the steps.

## Create a set of sound machines

The possibilities for sound making with sound machines are broad, from percussive sounds with recycled materials to instruments made with guitar string and resonant bodies. In the Tinkering Studio we use pre-made sound machines and invite learners to activate them with code. A set of 6 to 8 sound machines is ideal to engage a group of 6 learners in the exploration. We also recommend to have materials readily available to customize the existing sound machines or create new ones from scratch. Some successful and versatile starting points we have used are described in the examples section below.





This activity can be intimidating to jump into without some prior experience with Scratch programming. It's important for the facilitators to become familiar with simple starting blocks of code before they start working with visitors in order to make suggestions that can best support learners' own ideas and goals. Encouraging learners to try out many different sound machines is a great way to guide them to combining different sound machines, which in turn can lead to new goals in the realm of programming.

When challenges inevitably arise, the facilitator can act as a brainstorming partner to talk through what is not working with the code. Sometimes the facilitator knows what can be changed, and other times they are also trying to figure out what's happening. We found that being co-learners is a great way to collaboratively work through a challenging problem.

### Soundmachine examples

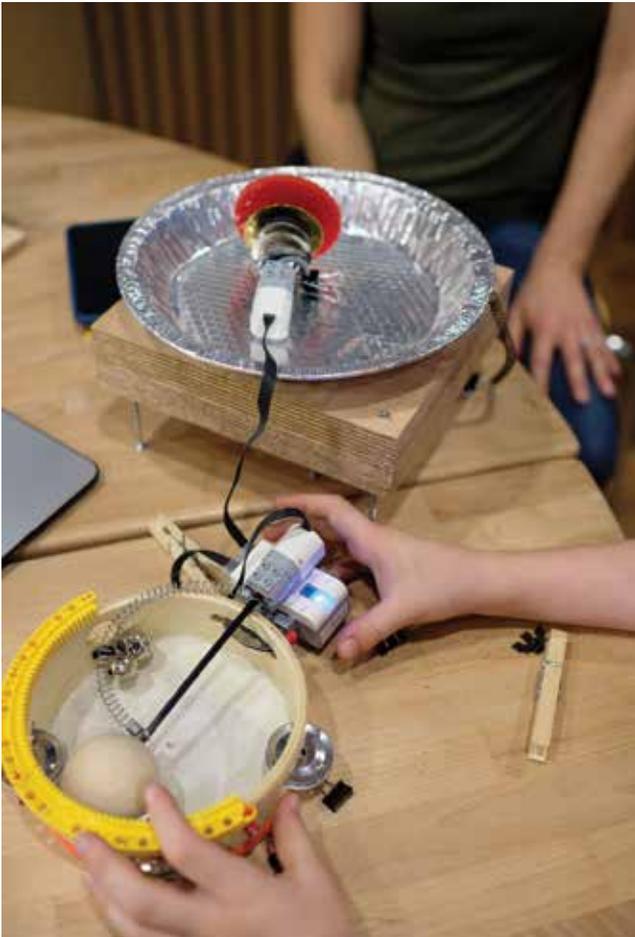


Based on our workshop sessions with visitors in the Tinkering Studio, we curated a set of sound machines that are rewarding to program and provide different levels of complexity to engage a range of learners. Some of the machines are ready to be programmed right away, others require some adjustments or the addition of a choice of sound maker to work.



This video shows a few of our starting examples being programmed and modified.

## Alternative entry point - motorized strikers with free arrangement of sound makers



As an alternative to the pre-built sound machines above—which require considerable time to make before a workshop session can take place—we experimented with simple rotating strikers mounted on WeDo motors. The strikers can be used by visitors to tap or hit found objects and instruments they arrange on the table in order to create soundscapes. Initial tests of this material set with visitors showed potential for open play combined with programming.



# EDUCATOR ADDENDUM - ACTIVITY, ENVIRONMENT & FACILITATION

## A note about our philosophy

The Tinkering Studio is based on a constructivist theory of learning, which asserts that knowledge is not simply transmitted from teacher to learner, but actively constructed by the mind of the learner. Constructionism suggests that learners are more likely to make new ideas while actively engaged in making an external artifact. The Tinkering Studio supports the construction of knowledge within the context of building personally meaningful artifacts. We design opportunities for people to “think with their hands” in order to construct meaning and understanding.

## Prototyping the activity

Over a time period of one year, together with our collaborators of the MIT LLK group and the LEGO Idea Studio, we explored a variety of ways to tinker with programmable sound makers. We prototyped versions of the activity focused on building mechanisms for musical instruments, activating sound makers through sensors (**circular sound sequencer: <https://vimeo.com/327104093>**), and plugging sound machines into a pre-designed sound sequencer code on Scratch (**System of sound: <https://vimeo.com/327103687>**)



During our R&D sessions with visitors, we found that controlling an existing sound machine using code and hacking it by making changes to the mechanism or adding materials is a particularly rich exploration in the context of a Tinkering Studio drop-in workshop. Learners made themselves familiar with different sound makers with simple code and then proceeded to more complex programming, often controlling two sound machines from one laptop using Scratch. We saw a wide variety of projects created with this framework, and different levels of collaboration emerged when groups explored together.

## Environment

As a visitor to the Tinkering Studio, it may be difficult to discern the nature of the activity when what one immediately sees are laptop computers placed around an empty table. This is why it's crucial that we place pre-made sound machines on the table. Familiar and friendly materials used in an unfamiliar way spark questions and provide entry points during the initial engagement phase.

We set up a large communal work table with 8 visually interesting programmable sound machines placed around the table. While laptops and iPads are also placed on the table, our set up and facilitation puts the emphasis on choosing a sound machine to play with rather than picking a laptop to work on. We found that this primes learners for an open exploration of physical materials as opposed to a coding exercise which to many can be overwhelming and too abstract as a starting point.

Observing other learners and their machines across the table can—when supported by facilitators—lead to shared explorations and collaborations, and inspire ideas for combining sound machines to experiment with composition and to create new sound makers.



*Communal work table*



## Sound making materials

A small set of materials that can be added to a number of the machines on the work table is laid out on a smaller table to the side. We find that separating these materials from the main workstation keeps the table from being over crowded.

## Additional environmental elements (optional)

- We like to set up two motor-powered sound machines (with LEGO power functions motors) with a simple on/off switch but without the option to code as a way to immerse learners in the topic.
- A hot glue gun station can be useful for this activity if building your own machine is part of the workshop.



## iPads to start the activity, laptops to take it further

Providing easy entry points for this activity is particularly important. While Scratch code is easy to learn, starting the exploration with a focus on a computer screen and unknown software can be a turn off for participants.

iPads with WeDo software are a great way to start coding without the need of much introduction, since the touch screens are easier to interact with for younger participants than a mouse or trackpad. On top of this, the portable iPads paired with WeDo hubs invite learners to move around the table, plug into different sound machines and investigate how the same code creates varying outcomes.

We found that, after exploring with everyday materials and simple mechanisms for a while, learners naturally transition to laptops when they are ready for richer interactions. To allow a seamless transition to this more complex platform, we also have laptops with WeDo hubs paired and ready to go on the work table.

# FACILITATION

## Spark exploration

Since pairing WeDOs can take time, we like to have this ready for participants. We color code each iPad and laptop and the corresponding WeDo hub. Learners work with one iPad and hub throughout the session and connect different sound machines to it. This makes for a natural workflow and also makes explicit the computational idea of applying an abstracted set of commands to different mechanisms.



When introducing the activity, it's helpful to have an example already set up. In the Tinkering Studio, this looks like an iPad running a simple program with a WeDo paired to it and two sound machines ready to plug in. We ask participants to interact with an example to get a feel for how the different mechanisms play with the code on the iPad.

## Sustain engagement

We strive to design problem spaces that encourage learners to define their own challenges and project ideas. One way we do this is through material selection and prompts. For WeDo explorations, we suggest different pathways after the first phase of free exploration. For example, further inquiry can focus on the digital realm by programming a rhythmic sequence for a sound maker, by coding it to respond to movement using WeDo sensors, or by controlling two sound machines with Scratch on a laptop so they play a sequence together. The exploration can also be taken in the direction of timing and rhythm in the physical world: different materials are added in a circle around a revolving striker and sound sequences quickly emerge.



In each case, the role of the facilitator is to help learners find a project idea they like, drawing on personal interests and discoveries they made experimenting with existing sound machines.

## Deepen understanding

When learners grapple with finding the right tools and approaches to solve their problems, the facilitator can “act as a brainstorming partner to talk through what is not working with the mechanisms or the code that is controlling them. Sometimes the facilitator knows what can be changed, and other times they are also trying to figure out what’s happening. Being co-learners is a way to collaboratively work through a challenging problem. This process may also bring about further understanding from the participant in how to structure a Scratch program and what the blocks mean.

# REFLECTIONS

## Projects that span the physical and digital world

We have explored activities connecting physical and digital worlds in the past, most recently with Digital Light Play. The task of tinkering in both worlds can be simultaneously stimulating and challenging. We saw participants tackle this task in a variety of ways: focusing on one realm exclusively, starting with one and bouncing back-and-forth, or exploring one part entirely before moving onto its companion.

We found tinkering at this intersection to be incredibly rich and compelling. The physical materials and construction of the sound machine contraptions lend themselves to being directly observed, researched, and tested in ways that are often more familiar and comforting to novice programmers. This can be a way to rely on prior experience, step back into more familiar territory, and gain confidence in their own abilities at the same time as they venture forward into the less familiar and sometimes daunting realm of coding, which can be much less accessible and understandable via direct means.

## Programming and making

We found that making and working with compelling materials that give immediate feedback often took center stage over writing code, and that there needs to be a strong and obvious motivation implicit in the project if our goal is to promote software as a tool. One way to show the utility of software is to present learners with machines that are pre-built, and illustrate the utility of code to create complex sound patterns. It is notable that engagement with digital tools can be supported by providing ready-to-code materials in the real world as a way to inspire concrete ideas that show the potential for programming to deepen the experience.

## Sound as an entry point to animation and narrative



Sound machine explorations often evoke images and stories connected to the sounds learners create. Combined with the rich animation environment of Scratch 3.0, a new theme for tinkering with sound presents itself: an invitation to create “Sound Stories.” Learners imagine a visual or story that connects to a sound they create with everyday materials and engage in producing an animation on the virtual Scratch stage that includes recorded sounds.

Here (<https://vimeo.com/294045136>) is a video of the making of such a sound story. We see opportunities for further activity R&D work with a software tool or Scratch microworld catering specifically to the creation of animations or collages with sounds and visuals from learners surroundings.



# ACKNOWLEDGEMENTS



**SCIENCE** Simons Foundation This work was supported by a grant from Science Sandbox, an initiative of the Simons Foundation  
**SANDBOX**

The **LEGO** Foundation  This project was made possible through the generous support from the LEGO Foundation