

# PRojects



New York Hall of Science • 47-01 111th Street • Queens, NY 11368  
[www.nysci.org](http://www.nysci.org)

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This publication is made possible with generous support from The Walt Disney Company.

RRIP!

The New York Hall of Science (NYSCI) offers a variety of programming, including Make Academy after-school and camp programs, where you can make things by learning how to use tools, manipulate materials, and creatively solve problems.

## PRojects

This booklet will show you activities used in Make Academy programs and some of the innovative objects created by kids. [For even more ideas, check out our Maker Space blog at makerspace.nysci.org.](http://makerspace.nysci.org)

Before starting on your project, familiarize yourself with the tools listed in the [Tools booklet](#). If you are unfamiliar with any of these tools, you should practice using them before you work on your final masterpiece. This will build your confidence with tools and help you learn how to use the tools properly.

It is very important to make sure that all your tools are the appropriate size and weight for the person using them. If there are different-sized people using your space (e.g. young siblings, adults), you should consider getting the same tool in different sizes to accommodate them. This is one way to help prevent injuries.



Make Academy Camper:  
Samantha, Age 11

## Experimental Sound Machine



Samantha started this activity by taking apart musical instruments and exploring what materials they are made of. Through this experience she gained an understanding of what each material does within the instrument to make it work. Then she explored everyday objects to discover what sounds they made.

## Stuff You Will Need



- Paper and Pencil
- Wood (Samantha used a 12 inch by 12 inch MDF board, but you can use any size or type of wood.)
- Machine Screws and Nuts
- Rubber Bands (Various Sizes)
- Tape
- Piezo Element
- ¼-inch Audio Jack
- Markers, Paint, Stickers, Printouts and Magazines for Collage
- Decorative Materials (Markers, Pens, Stickers, Paint, etc.)

## Tools You Will Need *(for reference see Tool Booklet)*

- Clamps *(Tool Booklet, item 7)*
- Drill and Drill Bits *(Tool Booklet, item 17)*
- Sandpaper *(Tool Booklet, item 3)*
- Combination Wrench (It will need to fit the nuts for the machine bolts.) *(Tool Booklet, item 10)*
- Screwdriver *(Tool Booklet, item 9)*
- Soldering Station *(Tool Booklet, item 20)*

## Protective Gear

- Gloves *(Tool Booklet, item 22)*
- Glasses *(Tool Booklet, item 23)*
- Dust Mask *(Tool Booklet, item 25)*

## Step 1

Use your pencil to plot out where you would like your sound pegs to be on your Experimental Sound Machine. This is where you will put the machine screws.

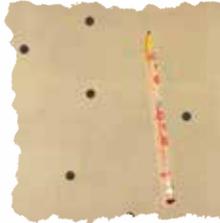
*Good to Know: Spacing your marks out across the piece of wood will provide more distance for the rubber band to stretch. The tighter the rubber band, the louder the sound it will make.*

## Step 2

Decorate your board! You can use markers, pencils, pens, paint, stickers and anything else you want to use.

## Step 3

Drill the holes for your sound pegs. Use two quick-grip clamps or C-clamps to clamp your board between two surfaces. Samantha clamped her board between two tables.



*Good to Know: You can reverse the order of steps 2 and 3 if you like. Why? There is a chance you may damage your artwork with the drill. Samantha didn't mind because she designed the placement of the sound pegs around her artwork.*

#### Step 4

Get some sandpaper and sand the areas around the drill holes to smooth them out.

#### Step 5

Insert the machine screws through the bottom of the board, place a nut on the other end, and tighten with your fingers. Repeat this step until all of the holes have a sound peg.

#### Step 6

Use the combination wrench and screwdriver to tighten the bolts to the board. Place one end of the combination wrench around the nut to hold it in place, then insert the screwdriver into the other side of the screw and tighten.

#### Step 7

Lay your board on the table and stretch various rubber bands over different sound pegs. You can stretch the rubber band around as many of the pegs as you want, but keep in mind that if two rubber bands overlap on top of each other, they will not vibrate as much.

*Good to Know: At any point you can add more pegs or take some out. This is your project and you are in charge!*



#### Step 8

Solder the black and red wires from the piezo element to the two leads of the 1/4-inch audio jack.

*Good to Know: If you don't have access to a soldering gun, you can cover the wire connection with hot glue. Either way, be careful because the connection is very fragile.*

Place the contact mic to the back of your Experimental Sound Machine, using some tape to hold it in place. Then tape the audio jack securely on the back and plug it into an amplifier.

Now you're ready to play! Experiment with the placement of the rubber bands, stretch them out as you pluck them, and see what happens to the sound.

**Make Academy Camper:**  
India, Age 10

## Wooden Acrobat Toy

Kids at NYSCI's Make Academy deconstructed, designed and made all kinds of different wooden toys. A favorite among the campers was the classic acrobat toy — squeeze the lever arms and the acrobat flips.

The acrobat toy seems to be a simple mechanism but as the camp kids found out things aren't always as they seem. If you have one, pick it up, turn it upside down and backwards, and try to figure out exactly how it works.



## Stuff You Will Need

- Paper and Pencil
- Various-Sized Dowel Rods
- 2 Paper Clips
- String (Should be thin but strong.)
- Tape Measure
- Ruler
- Markers, Paint, Stickers, Printouts and Magazines for Collage

## Tools You Will Need *(for reference, see Tool Booklet on page 22)*

- Hammer *(Tool Booklet, item 1)*
- 4 Very Small Nails
- Pull Saw *(Tool Booklet, item 2)*
- Vise Clamp or Quick-Grip Clamps *(Tool Booklet, item 8)*
- Drill *(Tool Booklet, item 17)*
- Needle-Nose Pliers with Wire Cutter *(Tool Booklet, item 11)*
- Sandpaper *(Tool Booklet, item 3)*

## Protective Gear

- Gloves *(Tool Booklet, item 22)*
- Eye Protection *(Tool Booklet, item 23)*

## Step 1

Measure and cut the dowels for the two lever arms, the fulcrum, the acrobat's body, the two arms, and two legs. Get creative with the measurements of all the pieces.

*Here are the measurements used at NYSCI's Make Academy:*

### Acrobat:

*Body: 3 inches*

*Arms: 2  $\frac{3}{4}$  inches*

*Leg: 2 inches*

### Frame:

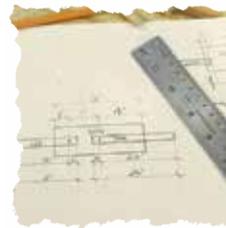
*Lever Arms – 10 inches each*

*Fulcrum – 2 inches*

## Step 2

Drill the holes. There is room for experimenting with where you drill the holes. If you have time, you might want to try a couple different places to see how it affects the movement of the acrobat.

Use a very thin drill bit and a vise clamp to hold your wood pieces so you can drill the holes accurately. If this is the first time you have used a drill, practice on another piece of wood first.



The measurements used at NYSCI's Make Academy are as follows:

- Each arm has three holes: one is  $\frac{1}{4}$  inch from one end and there are two holes on the other end where the hands would be. The first hole should be  $\frac{1}{4}$  inch from the other end and the second  $\frac{1}{4}$  inch from the first one.
- The legs only need one hole  $\frac{1}{4}$  inch from one end; this is where it will attach to the body.
- The body gets two holes, one for the legs and one for the arms. The hole for the legs should be centered  $\frac{1}{2}$  inch from the bottom of the body and the hole for the arms should also be centered and  $1\frac{1}{2}$  inch from the top of the body.
- The lever arms get two holes each, which should mirror the ones on the arms. The first holes should be  $\frac{1}{4}$  inch down from the top and the second,  $\frac{1}{4}$  inch from that.

When you are done drilling, sand all the parts until they are smooth. Then wipe with a damp cloth to get all the dust off.

### Step 3

Now decorate! You can draw a face, paint clothes, add stickers, or any combination of those. Another fun idea is to print out a picture of yourself and glue it onto the head of the acrobat.

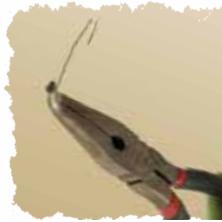
### Step 4

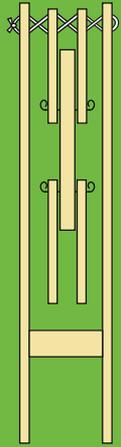
Straighten out both of the paper clips; you will use them to attach the arms and legs to the body. Take needle-nose pliers and pinch them tightly on one end of the straightened paper clip. Slowly roll the paper clip around the end of the pliers, curling it into a small loop. Only do this to one side of the paper clip, for now.

*Repeat this step with the other paper clip.*

### Step 5

Slide the paper clip through the single hole of one of the arms, then through the armhole on the body and the second arm. Use the wire cutter on the pliers to snip the excess paper clip off, leaving about  $\frac{1}{4}$  inch on the other side to curl, just as you did on the other side. Repeat with the legs.





### Step 6

Assemble the lever arms and fulcrum. The fulcrum should be attached one-third of the length of the lever arms from the bottom. For example, with our 10-inch lever arms, the fulcrum would go  $3\frac{1}{3}$  inches from the bottom. Measure and mark where the fulcrum will sit and use a hammer and two small nails to connect each lever arm to the fulcrum.

### Step 7

Place all the pieces on a flat surface with the acrobat in the middle of the two lever arms. Lift both arms up and align them with the holes in the lever arms. Weave the string criss-cross through the holes, the same way you lace your shoes. Once it is through, tie a knot and trim the excess.

Congratulations! You just made your very own acrobat toy. Now squeeze the bottom of the lever sticks and watch your new acrobat flip.



## Light Painting

### Stuff You Will Need

- LEDs
- Coin Cell Battery
- Binder Clip

### Tools You Will Need

- Digital Camera (with shutter control for long exposure)
- Tripod

*Good to Know: If you don't have access to a digital camera, there are many apps for smart phones and tablets that simulate this procedure.*

### Step 1

Set up the camera on a tripod. Light painting requires a long exposure so the camera must remain completely still. Try holding the camera instead of using a tripod to see what happens. Also, you could place the camera on a table or any other stable surface. Set your camera to manual mode and familiarize yourself with your camera's settings, so when you press the shutter button the camera creates long exposure.

### Step 2

Pick your light source; it can be anything from a flashlight to a Fourth of July sparkler. The brighter and smaller the light source is, the more accurate and bright your creation will be. At NYSCI, makers used LEDs, small coin cell batteries and binder clips.

Slide the battery between the legs of several LEDs. Remember that LEDs are unidirectional, so if they don't light up try switching the legs around. Place the binder clip over the legs of the LED, pinching them securely to the battery. You have light!

### Step 3

Light painting will work in a lit room if the light source you are using is bright enough and the exposure is long enough. However, the darker the room the better. One person should be in charge of operating the camera. Of course the camera operator can join in the fun but he/she will also be responsible for opening and closing the shutter.

Once you are in a dark room, open the shutter on your camera by clicking the shutter button. When you hear the click, move the light around until you have completed your masterpiece. Then close the shutter, turn on the lights, and take a look. This process may take a little practice to get it just right, but it is quick and easy to do.

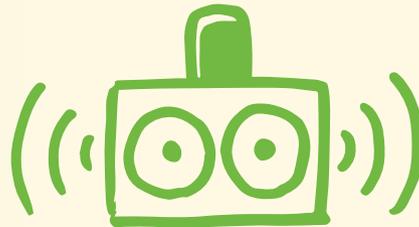




**Make Academy Camper:**  
Dylan, Age 10

## Acoustic Speaker

In NYSCI's Make Academy, Dylan prototyped several acoustic speakers for smartphones and found it worked best to use wood for the frame. Not only does wood provide a perfect stand to hold your smartphone, but also it looks and sounds great! Experiment with different materials and ways to make this project.





### Stuff You Will Need

- 5 pieces of  $\frac{1}{4}$  inch wood or plywood (Can be salvaged or scrap wood and the size depends on how big you want your speaker. Dylan used a piece that was 4 inches by 8 inches).
- Wood Glue
- Markers, Paint, Stickers, Printouts and Magazines for Collage

### Tools You Will Need *(for reference see Tool Booklet on page 22)*

- Pencil and Paper
- Tape Measure or Ruler *(Tool Booklet, item 13)*
- Pull Saw *(Tool Booklet, item 2)*
- Drill with Circle Drill Bits *(Tool Booklet, item 17, 18)*
- Jigsaw (This is used to cut out the canal from the smartphone mount to the speaker holes. If you don't have access to a jigsaw, you can get creative with your design to utilize the tools you do have.) *(Tool Booklet, item 19)*
- Rasp and File *(Tool Booklet, item 4)*
- Vise Clamp and 2 – 4 Quick-Grip Clamps *(Tool Booklet, item 8)*

### Safety Gear

- Gloves *(Tool Booklet, item 22)*
- Protective Glasses or Goggles *(Tool Booklet, item 23)*
- Ear Protectors (The jigsaw can be loud and if you are sensitive to sound you might want to wear ear protection.) *(Tool Booklet, item 24)*

### Step 1

Gather all the supplies and decide how big you want your acoustic speaker to be. If you use the 4 inch by 8 inch model that Dylan used, then you should cut the pieces of wood to the desired size.

*Good to Know: It is good to try to get all five pieces cut exactly the same size, but if they are not perfect it won't affect sound quality.*

### Step 2

Stack your pieces of wood together. The first piece will be your backing; it should remain solid. The second piece is where the mount for the smartphone and path to the speakers will be cut. And the third, fourth and fifth pieces will be the cone extending the audio projection possibilities of your speaker.

Mark each piece according to where it will be in order. This will help you keep track of how the speaker will fit together as you are building it.





### Step 3

Take the second layer, the one that will hold the smartphone as well as provide the canal for the sound to travel through. Decide whether you want to have one or two speaker holes. NYSCI's original design called for one hole, but Dylan decided to go stereo with his project and make two holes for the speaker.



Place your phone about  $\frac{1}{2}$  inch down from the top of piece two and trace the outline of the bottom of the phone. This is where your phone will stand in the speaker.

### Step 4

Play a song on your phone and look to see where the sound is coming from. Smartphones often have a speaker and a microphone near each other. Listen to hear where the sound is coming from and measure the size of the speaker. On the second layer mark a notch in the outline drawing of your phone that is the same size as your speaker.

### Step 5

Decide where the sound will come out on your speaker and mark it with your pencil. Then draw a path from the notches you made to connect to where you want the sound to come out. If you decide to go with high fidelity stereo like Dylan, then you will choose two speakers and two paths from the speaker.



### Step 6

This is where the fun power tool experience begins. First cut the speaker holes in the second layer with the drill and circle drill bit. Clamp the wood to a table with the quick-grip clamps. It is important to use two of them to provide maximum hold. The circle drill bits really bite into the wood so take it slow.



### Step 7

You are ready to cut out the area that will hold your phone as well as the canal leading to your speakers. It is time to use the jigsaw. A jigsaw is a powerful tool and it is very important to practice using it before you attempt this cut. Take a piece of scrap wood and draw a similar path as the one on your speaker. Try cutting it out and see how the jigsaw feels.



Is it hard to use? Keep practicing — it only gets easier! Once you are ready, cut out the cradle for your phone and the canal to your speaker hole. Make sure that the phone fits in and lines up with the canal.

### Step 8

For the time being, you are done with layer two. Stack layer three on top of layer two and mark where the speaker hole is on layer three. Drill a hole with the circle drill bit; repeat for layer four and five.

Dylan used a big circle drill bit on the third layer, a bigger one on the fourth, and an even bigger one on the fifth. He did this to simulate the shape of a cone speaker.

### Step 9

Dylan was very thoughtful with his design and decided to file down layers two through five in order to make the speaker appear like a cone. Stack all your layers together (aside from layer one). Make sure to line up your layers as evenly as possible. Clamp them to the table and start filing. Hold the file at an angle to maximize your efforts and keep the cone even.

### Step 10

All layers are cut and ready to be sanded and glued. Sand the circles of the speaker cone as well as the edges of all the pieces. Dylan figured out a way to use the vise clamp and sand all his pieces together.

### Step 11

Put the first layer on the table and spread some wood glue around the perimeter. Stack layer two on top and do the same. Repeat for each layer and use the quick-grip clamps to hold them all together, nice and tight. Some wood glue may drip out the sides; you can use a damp rag to wipe it clean. You should let it dry for at least four to six hours before removing the clamps.

### Step 12

Now your speaker is assembled! Place your phone in the cradle and see what your favorite song sounds like!

All that is left to do is to decorate it. Get your markers, paint, stickers, collage materials and anything else you want to use to design the perfect look.

