

# Sonic Arcade

Shaping Space with Sound



# what's inside

---

## 03 introduction

---

## 04 how does a museum work?

---

## 06 helpful hints for your visit

---

## 08 activities

### 09 SOUND ART: WHEN DOES SOUND BECOME ART?

- 11 Talking about sound art DISCUSSION RESOURCE
- 12 Composing a soundscape COLLABORATIVE MAKING
- 14 Wearing sounds 2D/3D ART-MAKING

### 16 NOTICING SOUND

- 17 Class listening challenge CAREFUL LISTENING
- 18 Soundwalk CAREFUL LISTENING
- 19 Sound diaries COLLECTING SOUNDS
- 20 How does sound shape our understanding of place? CREATIVE WRITING
- 21 Experiencing immersive sound CREATIVE WRITING
- 22 Describing sounds VOCABULARY RESOURCE

### 23 VISUALIZING SOUND

- 24 Drawing sound 2D ART-MAKING
- 25 Sound 3D 3D ART-MAKING
- 26 Emily Counts: Sounds and shapes CREATIVE WRITING/DRAWING
- 27 Optical sound experience for iPhone or iPad ART & TECHNOLOGY

### 29 STEM CONNECTIONS

- 30 Feel your voice EXPERIMENT
- 31 Water Glass Orchestra EXPERIMENT
- 32 Tonoscopes: Picturing sound waves EXPERIMENT
- 33 Stereo hanger EXPERIMENT
- 34 Thumb piano EXPERIMENT

---

## 35 webography

---

## 36 credits

# introduction

Dear Educator,

The Museum of Arts and Design (MAD) is pleased to present *Sonic Arcade: Shaping Space with Sound*. This exhibition explores sound as substance—a material in its own right, which is crafted through objects that project and transmit sound waves, such as resonant bodies, electronic circuits, and radio waves. *Sonic Arcade* features contemporary artists, designers, and performers who explore the auditory and emotional resonances of sound and respond to its potential to influence how people experience their environment and senses.

This Teacher’s Resource Packet is intended to assist you in introducing students to sound-based art and design through:

- Exposure to artists and artworks in the exhibition
- Inquiry-based questions and prompts for leading group discussions and introducing important concepts and themes
- Activities that promote sensitive listening
- Creative activities in a variety of media, including writing, sound-making, visual art, and technology
- A curated selection of web-based resources for more activities and information

Themes include:

- Sound Art: Defining sound art, exploring the differences and similarities between sound artists and musicians, and learning about the materials and methods sound artists use
- Noticing Sound: Becoming a sensitive listener and learning to describe sound in detail
- Visualizing Sound: Responding to sound through visual art
- STEM Connections: Unpacking the scientific phenomena related to sound

For educators planning to bring their students to the exhibition, these resources can be used for pre- and post-visit experiences at your discretion. For those who cannot attend the exhibition, these resources can nonetheless be used to teach your students about sound art through thoughtful discussions and engaging activities.

At MAD we believe that educators are excellent at determining the content and activities best suited to their students. We encourage you to decide for yourself which materials are developmentally appropriate for the young people you work with. We invite you to exercise your creativity and skill in adapting these materials to best serve the unique needs of your group.

Above all, we hope this resource will encourage students to become more attentive to their sonic environments and inspire them to find creative voice through sound, art, and play!

Sincerely,

MAD Education Department

# how does a museum work?

The Museum of Arts and Design has been functioning as an international resource center for craft, arts, and design since 1956. Through its collections, exhibitions, programs, and publications, the Museum serves as a forum for critical debate concerning the nature of craftsmanship and the engagement with process that links materials, techniques, forms, patterns, and concepts in all creative work.

## ADMINISTRATION

The team led by the Director of the Museum determines the programs, plans, and philosophy of the Museum. It also raises funds to realize the Museum's goals and works directly with the Board of Trustees, which guides the Museum's functions.

## CURATORIAL

Led by the Chief Curator, this is the team that works together to decide which exhibits will be shown, how they will look, what artwork is to be included, and how the exhibits are to be interpreted. This team makes galleries look inviting to visitors and determines how to best showcase the objects.

## REGISTRATION

Led by the Registrar, this team arranges for the safe handling of art to be placed in an exhibition and maintains the permanent collections acquired by the Museum.

## EDUCATION

This team provides the interactive interpretation of the objects on view through the educational programs designed for children, adults, and families who visit the Museum.

## DOCENTS

This team gives tours of the exhibitions to engage and educate visitors.

# how does a museum work?

## FACILITIES

This is the team that allows the day-to-day operations of the Museum to continue: from the lights being turned on to the safety of all who enter the building.

## SECURITY

This is the team most often seen in a museum. Its main task is to protect the artwork from harm so that in the future, people will be able to see the same objects as seen in the Museum today.

Museums are places where we can learn about the past, present, and future of the world around us. The diversity of knowledge is endless when the habit of museum exploration is formed at an early age. We look forward to welcoming your group into our galleries.

# helpful hints for your visit

While visiting the exhibition, try to use all your senses. Notice the way the pieces are displayed. Can you distinguish any specific groupings of pieces? If you enjoy looking at one piece more than others, can you explain why?

Here are some questions and suggestions to think about as you move around the exhibition:

## WHAT CAN BE OBJECTIVELY OBSERVED?

- What is the physical description? Measurement, weight, materials used, articulation of materials...
- What iconography, if any, is used? Designs, words, diagrams...
- What are the object's formal design characteristics? Lines, shapes, forms, color, texture...

## WHAT WOULD IT BE LIKE TO INTERACT WITH THIS PIECE OF ART? HOW WOULD YOU HANDLE, LIFT, DISPLAY IT?

- How might the piece of art feel if you touched it?
- What might the object do? Does the piece have a function? Consider and explain.
- If the artwork could talk, what might it say?

## WHAT MIGHT BE IN THE MIND OF THE ARTIST?

- What is your emotional response to this artwork? Fear, joy, indifference, curiosity, revulsion, excitement...

# helpful hints for your visit

**WHAT IS IN THE MIND OF THE ARTIST? WHAT ARE THE VIEWERS THINKING AND FEELING? USE CREATIVE IMAGINING AND FREE ASSOCIATION.**

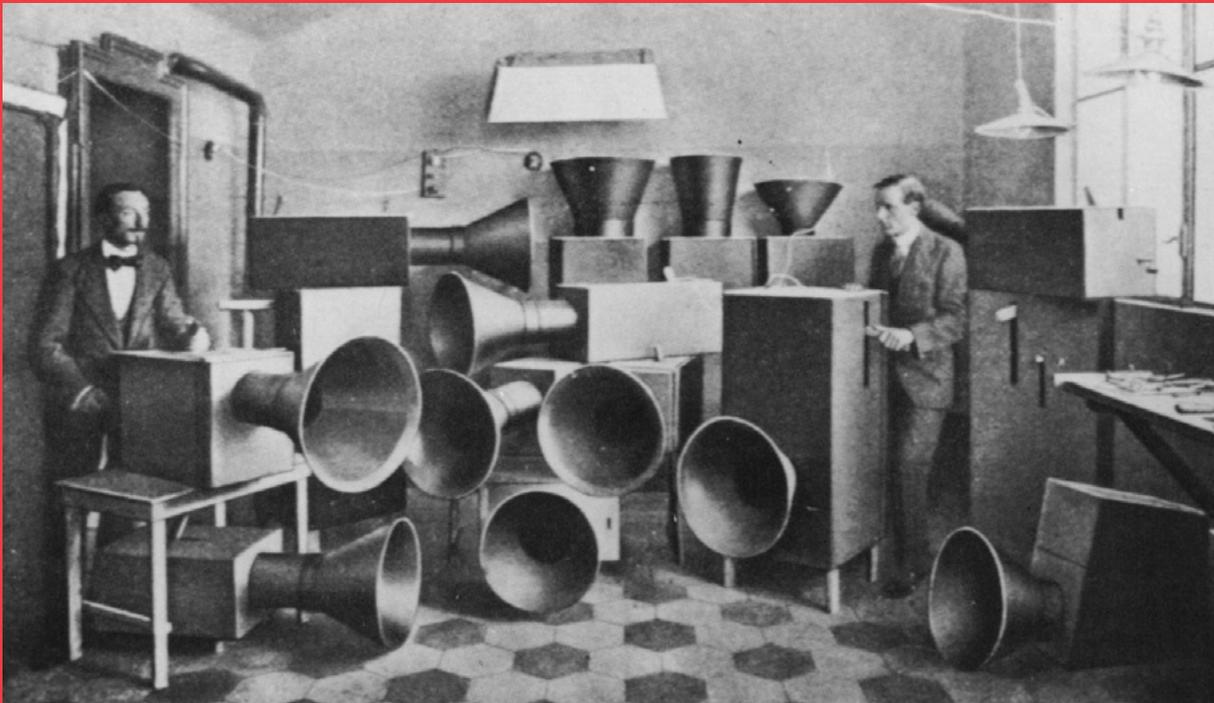
- Review all of the above information and consider what was going on in the world when the work was produced to develop possible interpretations of the piece. (Theories and hypotheses)
- Does the artwork tell a story? Does the piece have underlying political or social meaning? (Understanding and visual thinking)
- What more would you like to know? How can you find out? Develop a strategy to investigate your questions through looking or further research.

# activities

# sound art: when does sound become art?

*Sonic Arcade: Shaping Space with Sound* features artists, designers, and makers who explore the possibilities of sound: how it can be crafted and shaped, and the unique ways that it affects our bodies, emotions, and perceptions of the world. This type of art is called sound art or sonic art. Instead of using traditional materials such as paint, canvas, wood, or metal to create artworks, sound artists use all types of sounds and noises as their material.

The first sound art developed in the early 20th century, when people such as the Italian artist and composer Luigi Russolo began to experiment with creating music from “machine noises,” rather than traditional instruments. Today, contemporary sound artists use a huge variety of techniques to create sound art: from live performances to recorded sounds, from experimental instruments to immersive interactive installations.



Luigi Russolo with one of his noise-generating machines, 1913.

# sound art: when does sound become art?



Sound art has some similarities to music, but in other ways is very different. For example, several of the works in *Sonic Arcade*, such as Studio PSK's *Polyphonic Playground*, are designed to be played like instruments, and emit sounds when people interact with them. But the sounds they produce are very different to traditional instruments. Sound art invites us to ask the question: When do sounds stop being “noises” and become art? What are the similarities and differences between music and sound art? How do artists use sound creatively?

Studio PSK, *Polyphonic Playground*, 2014; 2016. Wood, steel, acrylic, printed circuit board, electronics, audio. Courtesy Fashion Space Gallery.

# talking about sound art

Introduce these ideas to your class by playing one or more clips from the sound artists below, and use the discussion prompts to begin a conversation.

**Bill Fontana, Harmonic Bridge, 2006**

**MSHR, Resonant Hyper Scape Modulator—Scape I, 2015**

**Warning: video contains flashing imagery**

**Janet Cardiff and George Bures Miller, The Infinity Machine, 2015**

- Which sound piece in *Sonic Arcade*, or from the clips above, made the strongest impression on you? What about it do you like, or dislike? Why?
- In what ways are music and sound the same thing? In what ways are they different?
- Why do you think an artist would choose to use sound in their artworks?
- In what ways are sound artists using sound differently from musicians and composers?
- Do you think the artworks you saw/heard could also be considered sculptures? Why/Why not? How else might you categorize these artworks?

## composing a soundscape

Sound artists often create immersive soundscapes. Soundscapes are compositions made up of combinations of different sounds that evoke a particular feeling or environment. They can be created from field recordings, digital sounds, or percussive and non-traditional instruments. You can create a soundscape with your class using everyday objects, voices, and movement.

### Materials—

- Newspaper pages
- Classroom objects (optional)
- Percussion instruments (optional)

- 1 Give each student a newspaper or wad of newspaper pages.
- 2 Break students into small groups and have each group invent as many different sound effects as they can using their newspaper (e.g., rustling or ripping the pages; rolling it to use as a percussion stick or even a megaphone). If you like, you can invite them to use objects from around the classroom as well (e.g., fanning the pages of a textbook), or percussion instruments that you have available.
- 3 Next, groups prepare their soundscape compositions. Encourage them to think about how they will coordinate the sounds to create their soundscape. When will they introduce new sounds? How loud/quiet will it be? What rhythms will they use? Will they use repetition?
- 4 Each group shares their soundscape composition with the class.

Need inspiration? Use the following websites to get students to think about what kind of sounds they would like to evoke. **Noisli** allows you to build up layers of different sound effects (such as leaves rustling, storm clouds breaking, or coffee shop chatter). **Cities and Memory** is a collection of field recordings submitted by people from all over the world.

# composing a soundscape

## Variation: Neighborhood Soundscape

If your school has technology that students can use to make recordings, they can record sounds from around the school or their neighborhood, and collaborate to create an edited sound art piece. For this project, you can also go on-line to access free downloads of audio recorders for phones and tablets, as well as free editing software, like **Audacity**.

- 1 Ask students to make a short recording every day for a week, at different locations and at different times of day. Students can record a single sound, or make recordings up to 30 seconds in length.
- 2 Optional: Have students interview people, asking them what sounds they associate with the neighborhood. The spoken words can be incorporated into the project.
- 3 Students work in small groups to edit their sounds into a short sound piece using music editing software.
- 4 Students share their soundscapes and discuss the process and finished pieces. Do they consider them artworks, music, or both? What do the pieces say about the neighborhood? In what ways does hearing familiar sounds in the context of sound art affect the way we hear them?

## Alternative activity: Sound Art Radio

Radius, featured in *Sonic Arcade: Shaping Space with Sound*, is an experimental broadcast platform founded by sound artist Jeff Kolar that distributes work by artists who use radio as a primary element in their practice. If recording technology is available, you can have students create their own artist radio broadcast.

- 1 Students collect field recordings and interviews and create collaborative soundscapes as in the above activities.
- 2 They collate these soundscapes to create a podcast that can be uploaded to the school's website. Students' sonic portraits of the neighborhood can thus be shared with the whole school community.

## wearing sounds

Noordeman & Wright are a design team that created *Audiowear*, a series of musical jewelry. Their ceramic jewelry pieces incorporate a performative element and produce sounds that can be used to create music. Recordings of the sounds generated from *Audiowear* were sent to various musicians, DJs, and hip-hop artists, who used them to create original tracks.

In this activity, students will create a design for their own piece of musical jewelry that can be worn and played like an instrument.



### Materials—

- Paper
- Drawing materials such as pencils, markers, or crayons

- 1 Ask students to think about the question: “What kind of sound would you want to wear?”
- 2 Students draw a design for their musical/sound-generating jewelry. They should consider what materials the jewelry would be made of; the type of sound it would produce; and the shape and color.

Left:  
Arjen Noordeman  
and Christie Wright,  
*Trumpet Bracelet*,  
2015. Porcelain.

Right:  
Arjen Noordeman  
and Christie Wright,  
*Xylophone Bangles*,  
2015. Porcelain.

# wearing sounds

## Variation: Crafting Jewelry

### Materials—

- Paper and cardboard in a variety of colors and thicknesses
- Adhesives such as glue, tape, staples, and paper fasteners
- A variety of craft materials such as cellophane, craft sticks/wooden dowels, cardboard tubes, string, ribbons, fabric, and buttons

After drawing designs for their pieces, students use available materials to construct physical prototypes. It may not be possible for these pieces to make the sounds imagined by the students; however, students should be encouraged to explore the kinds of sounds the materials are capable of making.

# noticing sound

To get to know many of the artworks in *Sonic Arcade*, or any sound art pieces, we need to listen carefully to the sounds they make. To prepare students to listen carefully, begin by discussing the difference between hearing and listening. We hear without choosing to, while listening requires an effort to give real attention to what you are hearing. The activities below encourage students to carefully attend to the sounds around them and to share their observations and questions about their everyday sonic environments. To help students find language to describe the sounds they hear, you can use the Describing Sound Word List at the end of this section.

# class listening challenge

Sometimes, if you want to focus on one of your senses (like hearing), it helps to block out a different sense (in this case, vision, by closing your eyes).

- 1** Have students sit comfortably and close their eyes, and ask them to refrain from talking during the exercise. Set a timer for 30–60 seconds and ask students to focus on what they hear. Encourage them to remember as many sounds as possible.
- 2** Break students into small groups and have each make a list of all the sounds they recall.
- 3** Each group reads their list, and the words are written on the board. Any sounds listed on two or more groups' lists are crossed off. The group with the most sounds wins.
- 4** Discuss the list of sounds on the board. How could these sounds be described? After reflecting on the ambient sounds, invite students to share how they'd like to change their sonic environment.

# soundwalk

- 1 Take a walk on a predetermined route through your school and/or neighborhood. Try to find a path with a variety of soundscapes, quiet and loud, inside and outside, etc. Have students agree not to speak and to focus on the sounds they hear.
- 2 Discuss the experience. What sounds did you hear? Which sounds caught your attention first, and which did you notice later? How would you describe the soundscapes you walked through? What would you change about them? Why? Do you think this soundwalk would be different at different times of the day, or even a different time of the year?

## Variation: Walking Soundtracks

- 1 Each student determines a walking route within the school or neighborhood. These can consist of written directions and/or maps.
- 2 Students then develop a playlist or soundtrack to respond to the surroundings and enhance the walk by altering the traveler's experience along the route.

# sound diaries

- 1 Provide every student with a notebook, or sheets of paper.
- 2 For one week, each student will take 2-3 minutes a day to visit a destination of their choice and write down all the sounds they can hear in their sound diary. They might choose a playground, a neighborhood space, or a room in their home. Tip: Encourage students to think about the “hidden” sounds in their environment (e.g., the sound of their own breathing, very quiet noises in the distance) as well as the obvious ones (e.g., people having a conversation nearby, loud equipment).
- 3 At the end of the week, students share some of the sounds they wrote about. Ask the students: Did you hear anything unusual or unexpected? Did you become aware of new sounds? Did it make you more aware of your surroundings, or change what you know about your environment?

## **Variation: Audio Samples**

In the event that appropriate technology is available, students can enhance their sound diaries with audio recordings.

# how does sound shape our understanding of place?

Often, when we think of a place, we think first of what it looks like. This activity is a way to encourage students to consider the role that sound has in shaping our environment.

## DISCUSSION PROMPTS

- Are there particular sounds you associate with certain places?
- How can sounds affect our mood?
- What sounds do you find soothing and what sounds are irritating?
- What sounds make you happy or sad?
- What sounds help you focus and what sounds are distracting?

## CREATIVE WRITING EXERCISE

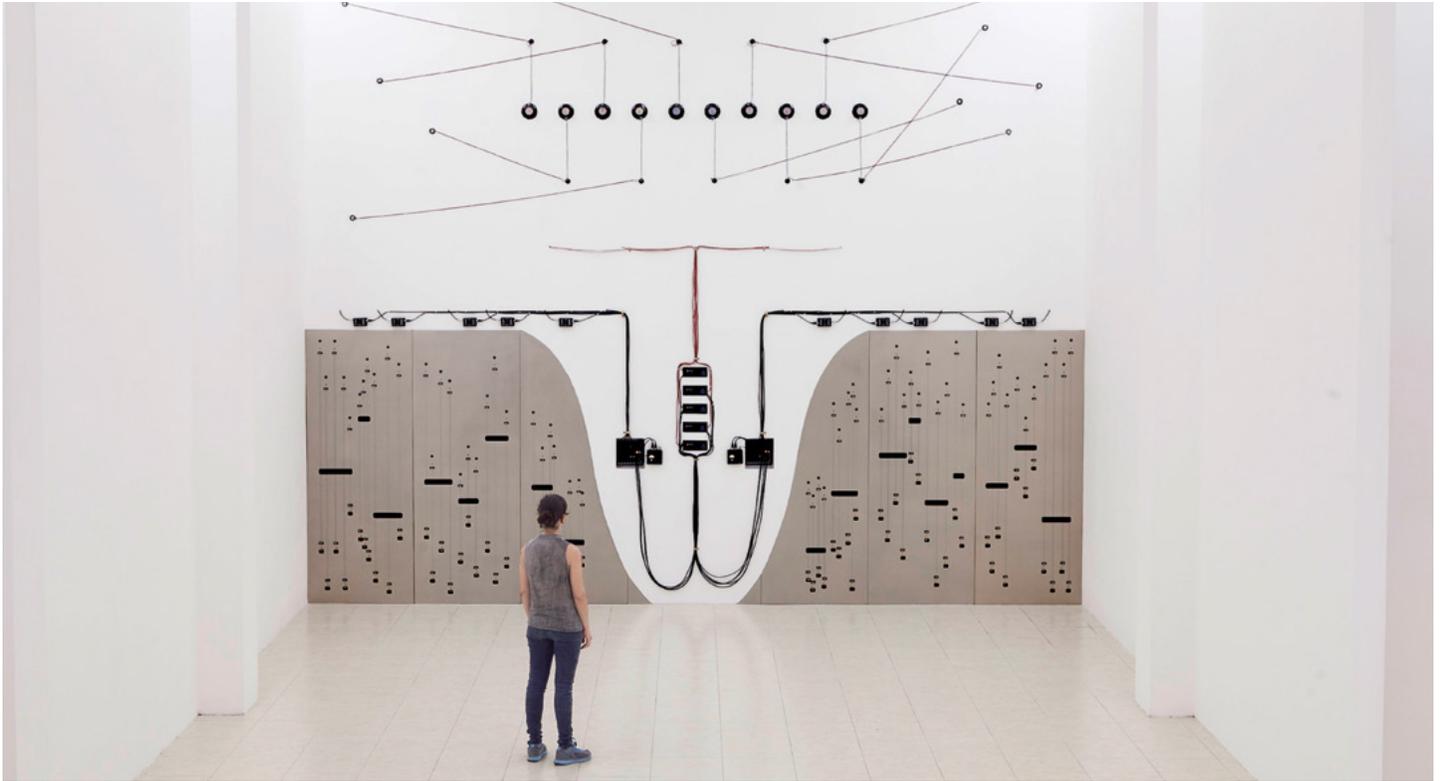
Sometimes, if you want to focus on one of your senses (like hearing), it helps to block out a different sense (in this case, vision, by closing your eyes).

- 1 Ask the students to close their eyes and pick an environment or place they know well.
- 2 Each student writes a detailed description of this place, by describing only what it sounds like. Start by asking some questions: What sounds would they hear? If there are people there, can we hear them talking—what are they saying? Can we hear what they are doing—are they working, playing, or passing through? Is there music playing? If so, what kind? If it's outside, can we hear industrial sounds, sounds of nature, or perhaps a mix?
- 3 Ask some students to share their writing, and other students to guess what place they are describing.

## Variation: Imagined Spaces

Students follow the creative writing exercise above, but rather than describing a real place, they imagine how a place they have never been to might sound (e.g., a rainforest, a street market in another country, the jungle, a spaceship).

## experiencing immersive sound



Sometimes, if you want to focus on one of your senses (like hearing), it helps to block out a different sense (in this case, vision, by closing your eyes).

- 1 Before visiting the Museum, show students an image of Naama Tsabar's artwork, *Propagation (Opus 3)*. Explain that this artwork is an instrument that visitors can play through touch, so that its sound fills the room.
- 2 Ask students to describe the kind of sounds they imagine this piece might make.
- 3 Visit the piece at the Museum and have students write about their experience of it. In what ways was the piece different or similar to what they imagined it would be?
- 4 Ask students, which was your favorite artwork in *Sonic Arcade*? What did it sound like? What made this artwork stand out in your mind?

Above:  
Naama Tsabar,  
*Propagation (Opus 3)*,  
2015; 2017. Wood,  
speakers, amplifiers,  
mixers, wires, cables,  
piano strings, bone,  
cable holders, contact  
microphones, brass,  
medium-density fiber  
board. Courtesy the  
artist.

# describing sound

These are some words you can use to describe sounds:

Babble	Clatter	Glug	Pop	Slam	Trill
Bang	Click	Gnash	Pound	Smack	Twang
Beep	Clink	Grate	Pow	Snap	Wail
Bellow	Cluck	Grind	Pulse	Splash	Whack
Blare	Crack	Groan	Purr	Splutter	Wheeze
Boom	Crackle	Grumble	Rap	Squeal	Whine
Buzz	Crash	Gurgle	Rattle	Swish	Whir
Cackle	Creak	Hum	Ring	Tap	Whisper
Chatter	Croak	Jingle	Rip	Tear	Whistle
Chime	Crunch	Knock	Rumble	Thud	Whoosh
Clack	Ding	Moan	Rustle	Thunder	Yap
Clamor	Drip	Murmur	Scratch	Thwack	Yelp
Clang	Drum	Patter	Scream	Tick	Zap
Clank	Echo	Peep	Shriek	Tinkle	Zing
Clap	Fizz	Ping	Sizzle	Toot	Zip

**Onomatopoeia** is a word that imitates the sound it describes, like “splash,” “buzz,” or “clang.” How many onomatopoeias can you find in this list?

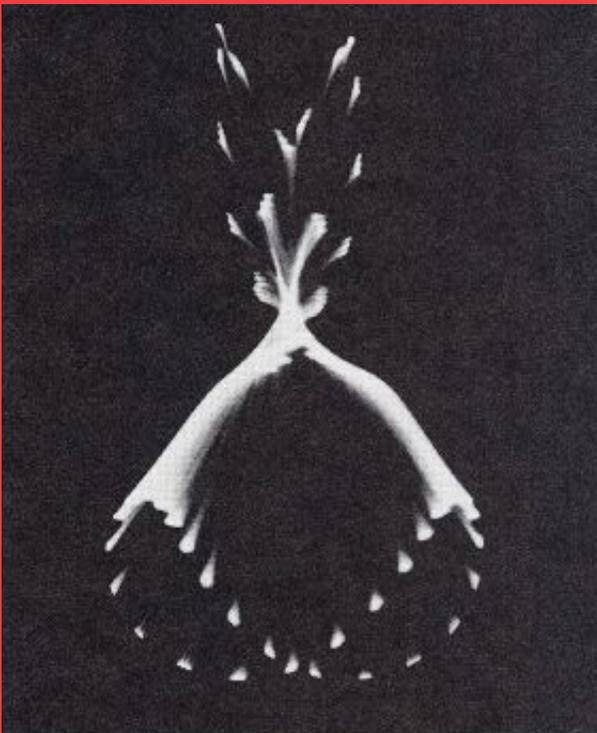
Bark	Chirp	Grunt	Mew	Roar	Snuffle
Bleat	Cluck	Hiss	Moo	Screech	Squawk
Bray	Croak	Hoot	Neigh	Snarl	Tweet
Cheep	Growl	Howl	Quack	Snort	

Words to describe the qualities of sounds:

Calm	Harmonious	Low-pitched	Noisy	Soft
Dull	High-pitched	Melodic	Piercing	Squeaky
Faint	Hoarse	Muffled	Quiet	Strong
Gentle	Husky	Musical	Shrill	Thunderous
Grating	Loud	Muted	Silent	Tuneful

# visualizing sound

*Sonic Arcade: Shaping Space with Sound* features works that explore how sound can be made material, sound as a visual composition, a playground, or a piece of jewelry. How can we use other senses to experience and represent sound? How does sound translate into color, shape, line, and texture? The following activities encourage students to make visual interpretations of sound and music. It is important to stress that there is no right or wrong way to interpret sound. Some may want to make literal representations of sound sources, while others may focus on abstract representations. Following the activities, students have the opportunity to discuss the choices they made as they interpreted sound in visual terms.



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Ben F. Laposky  
*Oscillon #3 (Electronic  
Abstraction)*, 1953  
Photograph  
Courtesy Sanford  
Museum and  
Planetarium.

# drawing sound

In this exercise, students will listen and visualize what sound represents and record their ideas through drawing.

## Materials—

- Colored papers
- Drawing materials (such as pencils, markers, chalk or oil pastels, ink & brushes, or charcoal)

- 1 Select at least two examples of music or ambient sound and play each for several minutes as students work. Have students listen to each piece of music for at least 30 seconds before they begin choosing materials and drawing.
- 2 Encourage students to envision what the music represents to them and record their ideas through drawing. There is no wrong way to interpret the music: Some students may interpret the sounds abstractly as shapes, colors, or patterns. Others may choose to represent what they hear in representational forms such as landscapes or figures.
- 3 When the music ends, encourage students to share what they made and tell each other about their creative decisions. Reflect on the process of working to music as well as the different ways that students represented what they heard in visual terms.

## Variation: Collaborative Drawing

After 1-3 minutes, prompt students to pass their papers to the right or left, round-robin style. Students continue drawing on the paper they have received, now responding both to the music and to their neighbor's marks. Repeat this variation multiple times.

## sound 3D

In this exercise students visualize sound as abstract 3D forms, which they will create using colored papers.

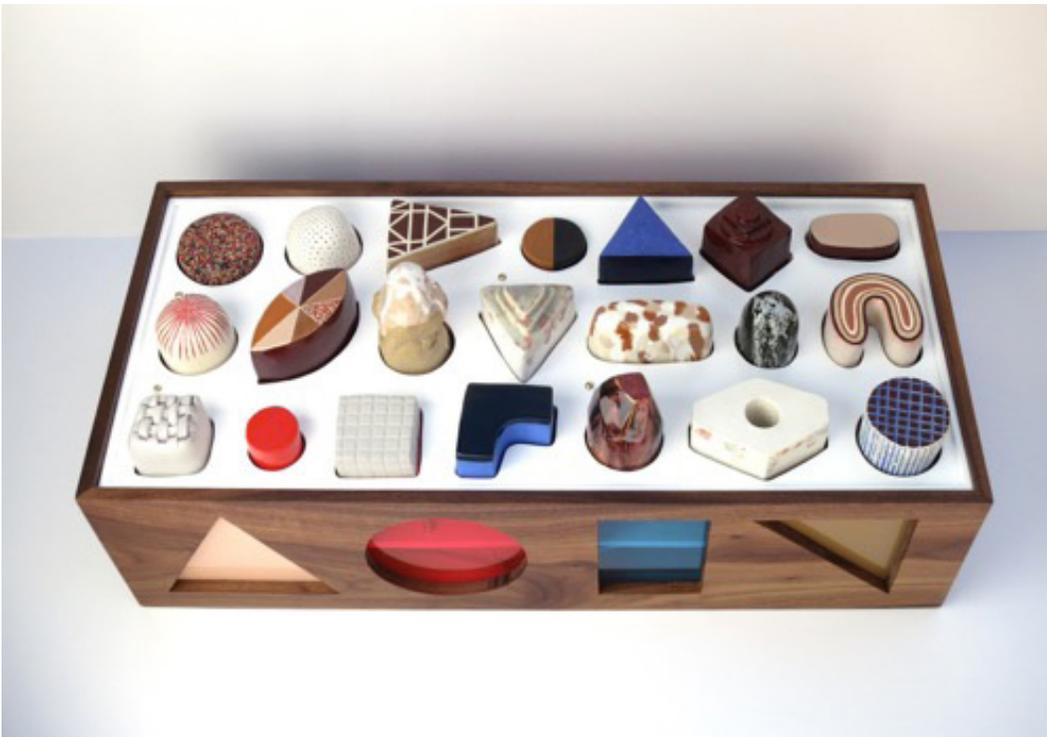
### Materials—

- A variety of papers, of different colors, sizes, and weights (e.g., tissue paper and cardstock)
- Adhesives such as tape, staples, and paper fasteners

- 1 Demonstrate different ways to transform paper into 3D forms, by cutting, folding, tearing, bending, twisting, and crumpling.
- 2 Have students experiment with the available materials for a few minutes. This allows them to gain some experience working with the materials and feel more confident going into the exercise itself.
- 3 Play two or more examples of music or ambient sound for students to respond to. Have students listen to each piece of music for at least 30 seconds before they begin sculpting. Encourage them to create sculptures that convey the sense of energy and rhythm they hear in the music.
- 4 When the music ends, encourage students to share what they made and tell each other about their creative decisions. Reflect on the process of working to music as well as the different ways that students represented the sound in visual terms.

## emily counts: sounds and shapes

A number of unconventional instruments are included in *Sonic Arcade: Shaping Space with Sound. Super Mode*, by Emily Counts, is a synthesizer of sorts. Each shape on the top surface is a button that emits a sound when activated.



- 1 With your students, view and discuss the image of Emily Counts' piece. What do they notice? What do they think this might be? How can they tell? Ask your students to brainstorm words to describe the work, and write the words they use on the board.
- 2 Ask students to draw three of the shapes from the piece and write descriptive words for sounds that they imagine might come from each "button."
- 3 Have the students share their drawings with sound descriptions and discuss. Do the students associate geometric shapes and organic shapes with different types of sound? Why or why not?

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Emily Counts,  
*Super Mode*, 2017.  
Stoneware, porcelain,  
walnut, plywood,  
acrylic sheets, single-  
board computer,  
circuitry, lighting,  
hardware, bronze,  
audio. Sound samples:  
Robert Aiki Aubrey  
Lowe. Computer  
programming and  
circuitry: Andy Myers.  
Courtesy the artist.

## optical sound experience for iphone or ipad

Louise Foo and Martha Skou's collaborative practice spans the worlds of music, visual art, and design. For *Sonic Arcade: Shaping Space with Sound*, the artists created an installation in MAD's stairwells, covering the walls in bold geometric patterns made from conductive paint and curtains. Visitors can touch the patterns, which will, when activated, produce sounds. The installation builds upon the artists' app, *Format No. 3*, which transforms your phone or tablet into an optical sound device. The app uses the device's camera to scan visual data and transform it into sound.



Foo/Skou, *Format No. 3: Alphabet*, 2017. iPhone application and lithographic print. Photo by Jenna Bascom. Courtesy of the Museum of Arts and Design.

# optical sound experience for iphone or ipad

## Materials—

- iPhone or iPad
- Paper, pencils, and black markers

- 1 Download the free PDF of the *Format No. 3* visual print and the free iPhone app.
- 2 Demonstrate and explain what the app does, then provide students with a copy of the *Format No. 3* print. Allow students to play with the sound-generating app, taking turns or working in small groups.
- 3 Have students design their own “visual scores” which can be read or “played” by the app. They should sketch them out on paper first, and then, when they are happy with the design, go over them in bold black marker. *Note:* The app responds with sound whenever it “sees” something black, so the designs should be drawn in black on white paper (more black equates to more sound).
- 4 Once the designs are complete, students can use the app to scan their drawings and discover how they sound. Ask them to share what they notice: Some patterns are loud when they are scanned, while others are more quiet; can anyone explain why? Would you describe these sounds as “music” or “art” or something else?

# STEM connections

Sound art is an excellent jumping-off point for exploring STEM topics such as the physics of sound, sound waves, and how the ear works. In *Sonic Arcade: Shaping Space with Sound*, Julianne Swartz's *Sine Body* explore the concept of recording and capturing sound waves. An electronic feedback process reads the air mass inside each vessel, generating the harmonics that come from that particular form. Each object emits its own pure tone, which is unique to its particular design.

We have collected a few simple experiments that you can use in the classroom to demonstrate scientific concepts related to sound. These activities have been selected because they are popular and easy to reproduce in almost any classroom. In some cases we link to external resources to help guide you in constructing simple objects needed for these experiments.



Julianne Swartz,  
*Sine Body*, 2017.  
Hand-blown  
glass, porcelain,  
electronics, audio.  
Photo by Jenna  
Bascom, courtesy of  
the Museum of Arts  
and Design.

## feel your voice

When you make a noise with your voice, this causes your vocal cords to vibrate. These vibrations cause the air around them to vibrate too. These vibrations move through the air and are called sound waves, which is how sound is carried.

- 1 Invite students to be very quiet. Have them carefully place their fingers on their throat.
- 2 Ask them to make a low, long sound (such as “ooooohhhh”). What do they feel with their fingers?
- 3 Now, get them to make another long sound, louder this time (such as “aaaaahhhh”). As their voices change sounds, ask them to move their fingers to follow the vibrations made by their vocal cords.
- 4 What differences did they notice? Did their fingers tingle more or less than before?

## water glass orchestra

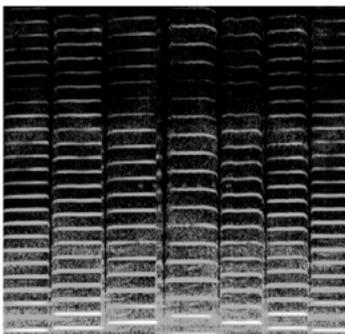
Sound occurs when vibrations in an object cause the air around that object to vibrate, which creates a particle-to-particle disturbance, traveling through the air as sound waves. Sound also travels through other mediums, such as water. The speed and frequency (how often particles vibrate) at which it travels differ depending on the medium. Here is a simple and fun experiment you can do with your class to demonstrate this:

- 1** Line up several glasses of the same size. Each should contain a different amount of water, ranging from very little to almost full (for best results use real glass).
- 2** Using a pencil, teaspoon, or other similar object, gently tap the rim of each glass. The glasses with less water will have a higher pitch than those with more water. This is because sound travels slowest (causing lower-frequency vibrations) in the glasses with the most water, and travels faster (causing higher-frequency vibrations) in the glasses with the least amount of water.

For more ideas and information, including the classic “singing glasses” experiment, click [here](#).

## tonoscopes: picturing sound waves

When we speak or sing, our voices cause vibrations, creating sound waves. Particular frequencies have beautiful natural patterns. A tonoscope is a simple acoustic device that, when you sing into it, enables you to see the patterns created by the sound of your voice. These symmetrical images are known as *Chladni Patterns*, named after Ernst Chladni, who is credited with discovering this phenomenon. The artwork below, a detail from a digital print by Foo/Skou, is inspired by these patterns. There are numerous ways to create a tonoscope and explore the patterns your students' voices make. Download a how-to guide created by the **Aeolus Outreach Programme**, or search online, for “how to make a tonoscope.”



Foo/Skou, *Format 3: Alphabet*, 2017. Digital print. Courtesy the artist.

## stereo hanger

In this experiment, students will observe how sound waves travel differently through different mediums.

- 1** Students tie a length of string (approx. 12 inches) to each corner of a metal coat hanger, and loop the strings around their index fingers.
- 2** Another student taps the metal coat hanger (e.g., with a pencil or teaspoon) to produce a sound.
- 3** The student holding the hanger brings their index fingers, with the strings attached, to their ears.
- 4** The other student taps the metal coat hanger again. This time, it will sound very different.

What students are witnessing here is the difference between sound waves traveling through the air versus through a solid material (the string). Students can experiment with different objects, such as metal spoons or forks, and different types of string.

## **kalimba or mbira (thumb piano)**

*Thumb piano* is a term used to describe a type of sub-Saharan African instrument, such as the mbira, which is played by plucking metal keys of different lengths. When the keys are plucked, they cause vibrations, which travel through the air as sound waves. The pitch of the keys depends on how long they are: longer keys cause slower vibrations, which result in lower sounds; shorter keys cause faster vibrations which, result in higher sounds. You can create a simple version of a thumb piano in your classroom using wooden blocks, basic screws, and popsicle sticks. Download a how-to guide created by the **National Science Digital Library**, or search online for “how to make a thumb piano.”

**web-  
ography**

# featured artist links

## TONOSCOPES

Learn more about acoustic tonoscopes from the Aeolus Outreach Programme [here](#)

## CHLADNI PLATES

Learn more about Chladni plates [here](#)

## SINGING GLASSES EXPERIMENT

Find further ideas for in-depth singing glasses experiments [here](#)

## MAKING A SOUND MACHINE

Access a lesson plan for making a sound machine for older grades (connections to physics, force and motion, and sound and waves) [here](#)

## SYNTHESIZERS

Access a beginner's guide to modular synthesizers, including a list of useful terms, [here](#)

## THEREMINS

Learn about the synthesizer's precursor, the theremin—a device that allows you to play music without even touching the instrument

Leon Theremin, Playing His Own Instrument [here](#)

The Physics of the Weird and Wonderful Theremin [here](#)

## CIRCUITRY

Use these lesson plans to teach students how simple electronic circuits work (some prior knowledge of basic electronic concepts is required):

[Series and parallel circuits](#)

[Building a basic series circuit](#)

## MUSIC COGNITION

What is music? **This** article explores the relationship between repetition, music, and our brains.

# credits

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