IMMERSIVE SOUND DESIGN FOR EXHIBIT DESIGNERS · MODULE 1 OF 3

Environment-Building With Sound

Turning a space into a place.

Billy Mark, Maro Kariya, and Ethan Marshall Cohen

BEFORE YOU START

What you will need, and where you’re going

What you will need

- Your phone and headphones: to listen, map what you hear, and play the examples
- A pencil
- The two-page field sheet, for the assignment (no printer? copy it onto any paper)

Prefer paper? Print Fig. 1, the listening map (up to three copies).

Everything to print is under **Downloads and links** on the module page.

1.1 Listen first · Hear your space the way a visitor does. 6 min

1.2 Why spatial sound? · Same content, different placement. 6 min

1.3 Imagine the sound environment · Name your sounds, then shape them. 6 min

1.4 Storyboard the visit · Put your sounds on a map. 6 min

1.5 Add the technical overlay · Mark what the system has to do. 4 min

1.6 Learn from built examples · Read real exhibits with your new vocabulary. 2 min

You’ll leave with a storyboard of your own space, with a technical overlay, ready to build in Module 2.

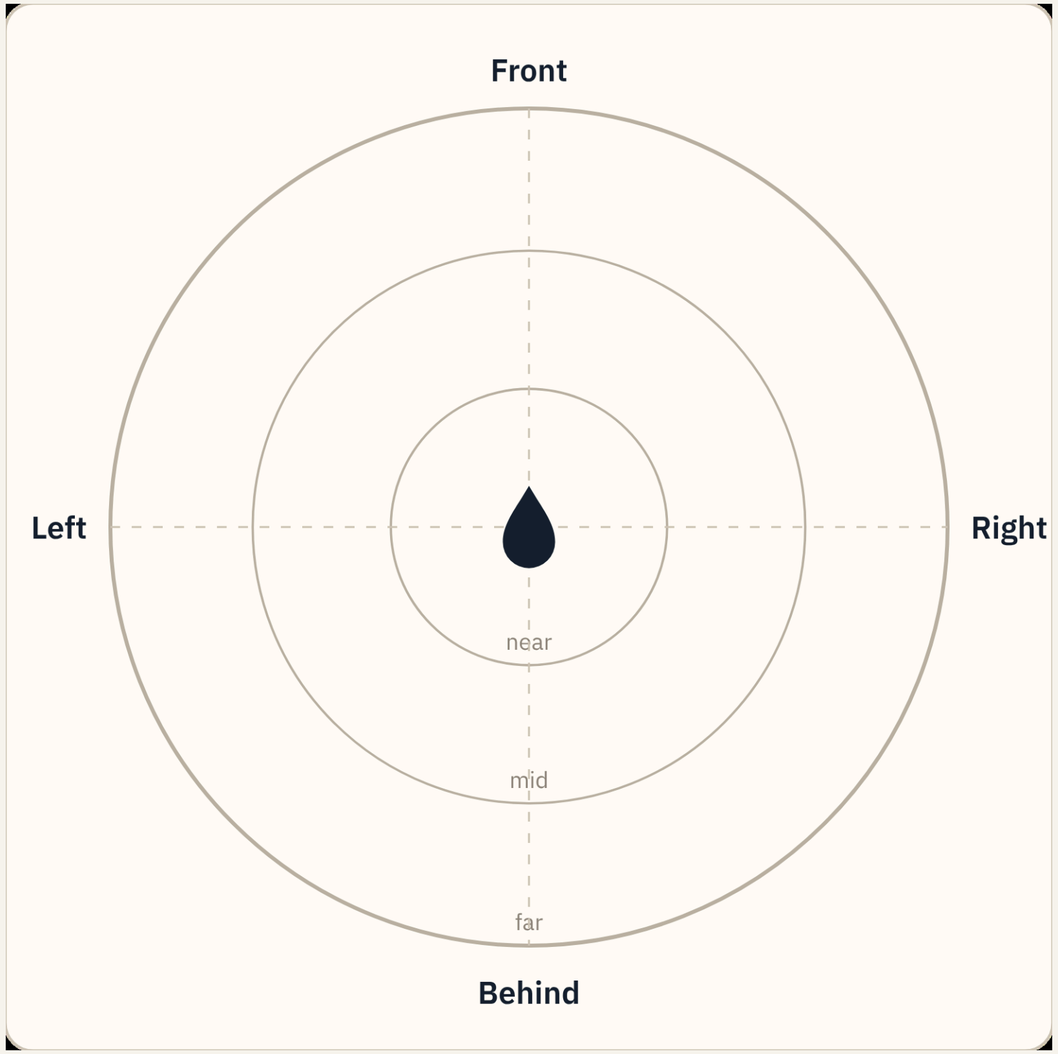


FIG. 1

Your listening map

You are the shape in the middle, facing front. The rings are near, mid and far.

Use the listening map on your phone, or print three copies, or draw three of your own. You'll use one in part 1.1 and two more in the assignment.

PART 1.1 · ABOUT 6 MINUTES

Listen first

Hearing is already spatial.

PART 1.1 · THREE FAMILIES OF SOUND

Every sound belongs to a family

Before you listen, meet the three families you'll use to sort what you hear.

G · Geophony

Sounds of the earth

Wind, thunder, rain, waterfalls, volcanoes

B · Biophony

Sounds of living things

Birdsong, dogs barking, crickets and other animals

A · Anthrophony

Sounds of people and machines

Laughter, shouts, dialogue, traffic, planes, HVAC and appliances

These categories come from the pioneering acoustic ecologist Bernie Krause.



PART 1.1 · YOUR LISTENING MAP

How to map a sound

For each sound you hear, mark Fig. 1:

- **Position** shows where the sound is
- **Dot size** shows how loud it is
- **Letter** shows its family: G, B or A
- Write **above** or **below** for overhead or underfoot

Left: one listener’s map, filled in.

PART 1.1 · YOUR TURN

Now, pause and listen

Find a spot, close your eyes for one minute, and notice the sounds around you:

- What is in front of you or behind, off to a side, above or below?
- What is near or far, quiet or loud?
- Is each sound constant, or does it come and go?
- Does it stay put, or move through the space?

Then map each one: position, dot size and family letter. Use the guided recording and map on your phone, or a paper copy of Fig. 1.

Tip. If you’re somewhere very quiet, try this in a place that interests you and has more going on: a lobby, a park, a café.

PART 1.1

What did you notice?

1

Did sounds come from only one direction?

2

Which sounds give this place its **acoustic signature**? Which only appeared once you listened closely?

3

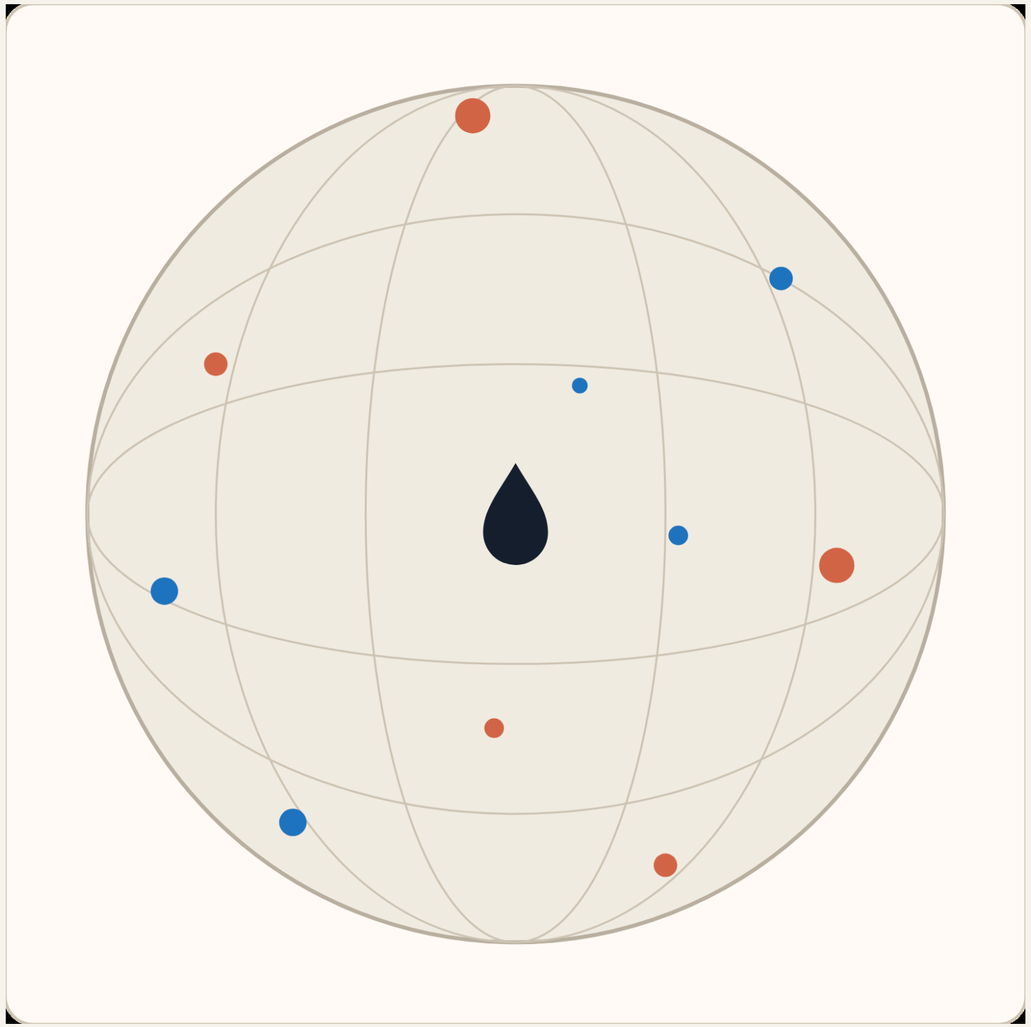
Which sounds would you make louder or quieter, if you could?

Assignment · Repeat this exercise on your own in two other spaces that differ in how much sound they have. Use a fresh copy of Fig. 1 each time.

PART 1.2 · ABOUT 6 MINUTES

Why spatial sound?

Same content, different placement.



PART 1.2

We hear in every direction

Sound reaches us from front and back, left and right, above and below, near and far, all at once.

That multi-directional quality is what makes a space feel like a *place*, and feel real.

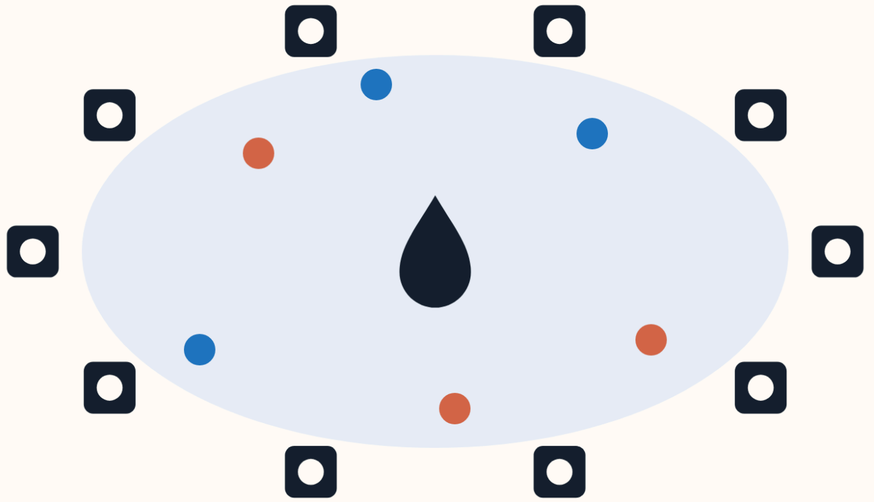
For an immersive exhibit to feel real, its sound has to be designed spatially: as a **sound environment**.

PART 1.2

Stereo vs. a sound environment



Sound sits on the arc between two speakers, in front of you



Sound can come from anywhere around you

Stereo: two channels, usually two speakers.

Spatial: one sound environment made of many speakers.

PART 1.2

Where most venues start

WITHOUT SPATIAL AUDIO

One stereo file plays through two or more speakers.

WITH SPATIAL AUDIO

Each sound gets its own place in the room, with far more precision.

WITHOUT SPATIAL AUDIO

Different sounds play from different speakers.

WITH SPATIAL AUDIO

Those speakers join into one sound environment that visitors walk through or are immersed in, and sounds can travel from one speaker to the next.

Spatial audio can be additive: it often starts from the speakers a venue already has.

Sound shapes how visitors engage

A growing body of research suggests that natural, spatial sound improves experiences. The studies are small, and they point the same way.

Mavridou et al., *Frontiers in VR* (2025)

68 people · VR scenes with and without spatial sound

- More immersion and presence
- A better sense of the place
- Stronger emotional involvement

Rodero & Rodríguez-de-Dios, *Media Psychology* (2024)

50 people · the same audio stories, with and without binaural sound

- Much higher enjoyment
- More vivid mental images
- More attention, slightly better recall

Västfjäll, *CyberPsychology & Behavior* (2003)

45 people · music in mono, stereo or six channels

- Six channels: the most presence
- The most emotional realism
- The strongest emotional response

Langiulli et al., *Frontiers in Neuroscience* (2023)

32 people · film clips in mono, stereo and 5.1

- 5.1: the most immersion
- The most enjoyable and real
- EEG signs of stronger embodiment

Sound Travels (TERC)

Zoo and aquarium educators

- Positive sound experiences raised learning engagement noticeably
- Negative ones had a much weaker effect

Positive sound experiences matter more than negative ones.

In Sound Travels research with zoo and aquarium educators, sound experiences visitors enjoyed raised learning engagement noticeably; unwanted sound had a much weaker effect. So designing the sounds people enjoy does more than only fixing the ones they don’t.

Next, in part 1.3: imagine the environment you want, and name the sounds in it.

PART 1.3 · ABOUT 6 MINUTES

Imagine the sound environment

Start from the experience, then choose the sounds.

What environment are you creating?

- Are you in a control room, a jungle, on a boat?
- It can be realistic or abstract: a literal environment or a collection of experiences.
- What kinds of sounds are in it?
- What feeling do you want to bring about?
- Imagine the environment, then jot down five sounds.

EXAMPLE

Beside a creek in a forest, mid-fall

1. Moving water
2. Birds overhead (which birds?)
3. Leaves rustling
4. A diffuse melody
5. An ambient pad

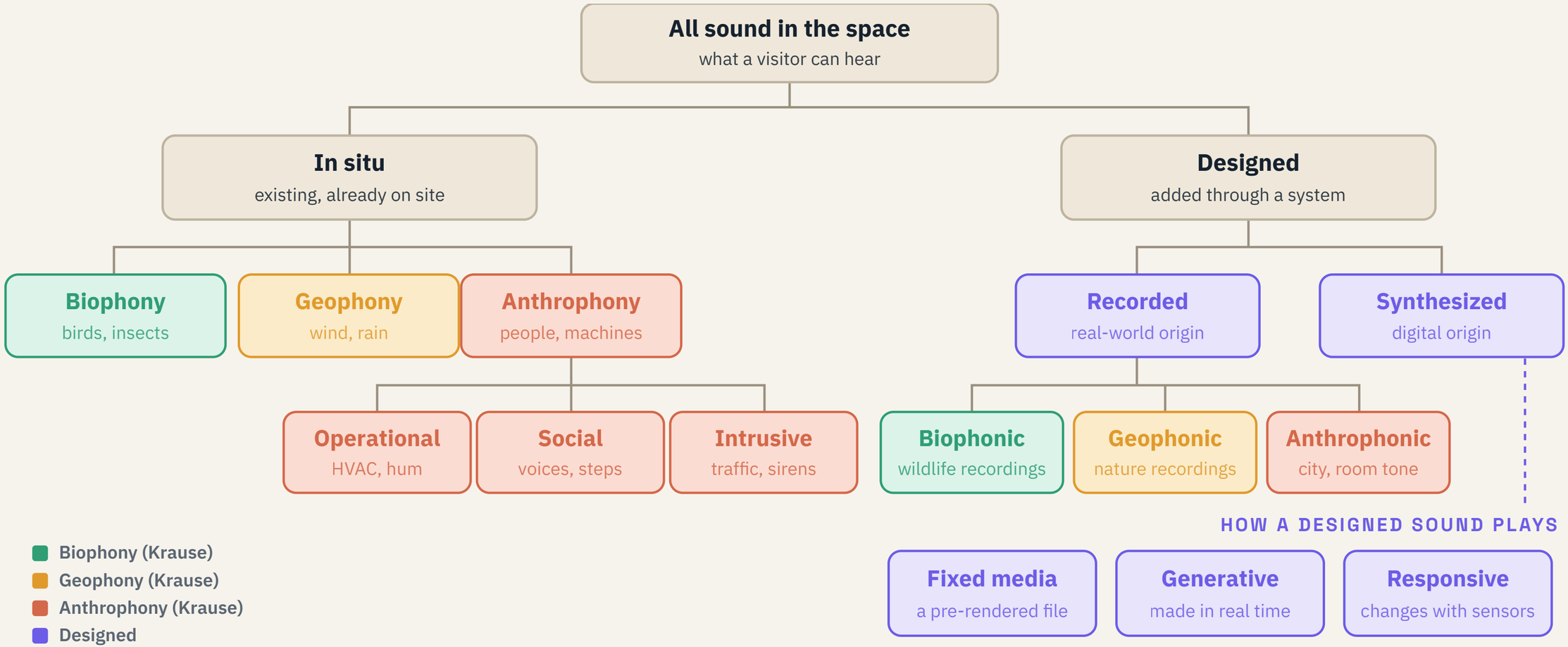
EXAMPLE

A history of recorded sound gallery

1. A wax cylinder crackling
2. A 1920s dance band, far off
3. A typewriter and a phone ringing
4. Voices from old radio
5. A low room tone

PART 1.3 · THE SOUND TREE

How can we categorize sounds?



Two questions before Krause’s three

Is it already here?

In situ (existing, on-site) sounds are already in the space: the HVAC, the visitors, the traffic outside. **Designed** sounds are added through a system you design.

Where does it come from?

A designed sound can be **recorded** or **synthesized**. Either way it still belongs to a family: biophony, geophony or anthrophony.

Which sounds grab you?

Is a sound intrusive, operational or social? Which ones pull your attention, and which do you tune out?

Terms we’ll use from here on · Fixed media: a pre-rendered audio file. **Generative:** audio made in real time by a music system. **Responsive:** audio that changes when visitors interact with sensors.

Location

where the sound sits, and whether it moves

Time

when it plays, and for how long

EQ

its tone: more low end or more high end

Volume

how loud it is next to everything else

PART 1.3 · SPATIAL SOUND MIXING

Four parameters of mixing

Location, time, EQ and volume: the same tools used to mix music, now applied to a room. That is mixing in space.

- Is the sound in the background or the foreground?
- Is it still, or does it move?
- In museums, movement often gets lost. The less things move, the more people notice when something does.

PART 1.3 · SPATIOTEMPORAL CHANGES

Where, when and how loud, over time

Not every sound places equally

We pinpoint high-frequency sounds easily and low-frequency ones hardly at all. You can locate a bird, but not a refrigerator hum.

Give moving sounds a path

Hard-automated: pans the same way every playthrough.
Systematic: follows a rule, like moving 45° left and right every ten seconds.

Shape loudness over time

Which sounds play at once? Which should dip when another arrives? Letting sounds make room for each other is how a scene starts to feel real.

PART 1.3 · EXPERIENCE DESIGN

Sound can move people

Moving sound can tell a story and simulate an environment. It can also guide visitors.

- A sound draws a listener closer to it
- A sound plays every ten seconds
- A sound changes volume as a listener approaches (sensor-driven)
- A sound changes as goals are reached (game-like)

Ask about your exhibit

- Is it linear, or self-directed?
- How will visitors move through it?

Part 1.4 puts the answers on a map.

PART 1.4 · ABOUT 6 MINUTES

Storyboard the visit

You’ve explored new ways to listen to your space and gathered vocabulary to organize your ideas. Now, let’s use them to create a new design. Whether you’re notating the current environment, conceiving a soundscape, or adding new concepts, the goal is a single-page sketch achieved in four steps:

1 · The concept | 2 · Zones | 3 · Sounds | 4 · The walk

STEP 1 · THE CONCEPT

What is this space about, in one line?

One idea that holds the whole environment. Write it so your team could repeat it, and a visitor could too. A clear concept answers the next hundred questions.

THE ARC

What is the beginning, middle, and end?

Where does sound meet the listener, what does it do to them along the way, and what does it leave them with?

OUR EXAMPLE · THE SHORELINE ROOM

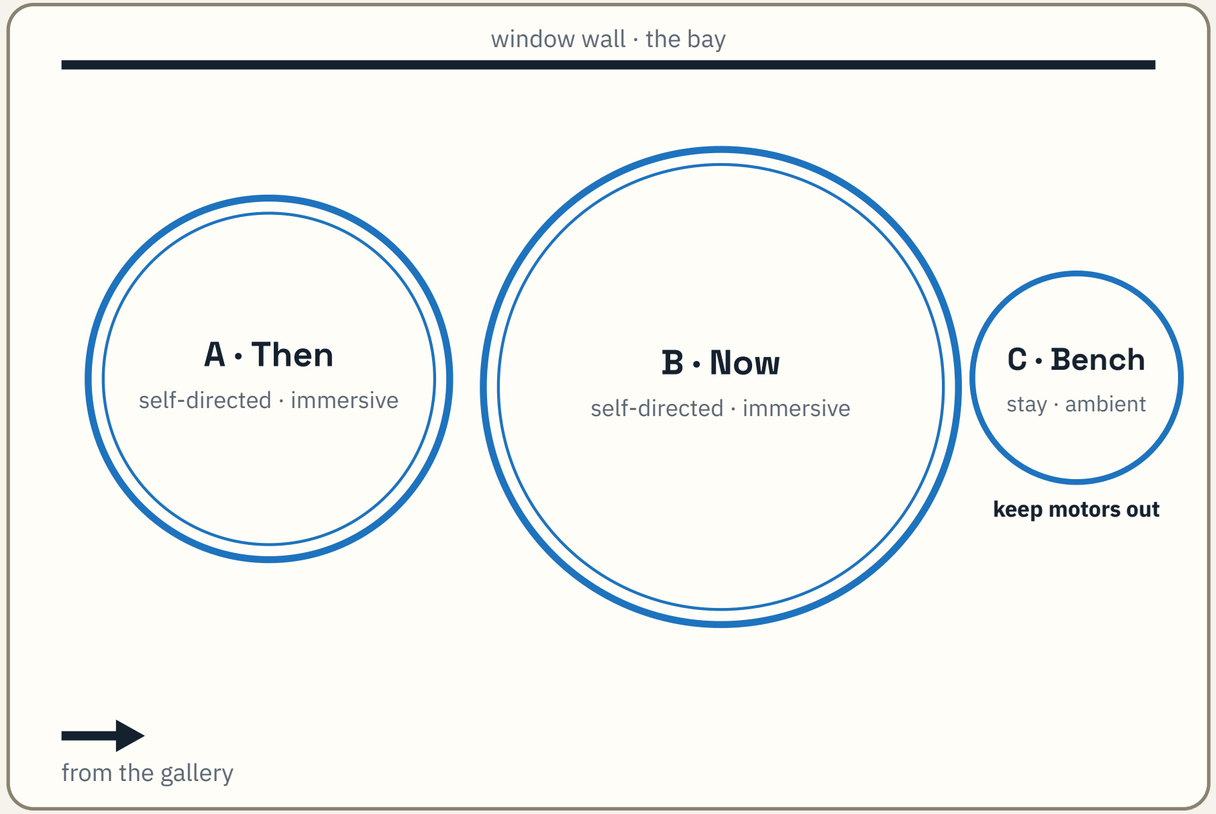
CONCEPT

The same shore, sixty years apart. Listen to what changed.

ARC

Beginning: a wild shore you hear before you see it: surf, wind, gulls, a heron. **Middle:** the same shore today. Motors and voices crowd in, until a visitor turns time back with a slider. **End:** a bench, one voice remembering over a soft melody.

Biophony and geophony give way to anthrophony as you walk.



STEP 2 · ZONES

Draw a circle for each zone

A zone is an area with its own sound. It can be a whole room, and one room can hold several zones. Name each one by how it connects to the concept, and how it should feel.

Level · **Immersive** double line · **Ambient** single line: sound in the background · **Quiet** hatched: sound kept out on purpose

Levels adapted from the AZA 2026 Universal Design slides.

STEP 3 · YOUR MAP KEY

One key for the whole sheet

This is the suggested key for your storyboard.

THE SOUNDS · STORYBOARD



In situ
already in the space



Designed
a sound you add



Dot size
how loud it is



Above / below
overhead or underfoot



Moves
it travels



Key sound
carries the concept



Anticipated visitor path
the route you expect them to take

THE SYSTEM · OVERLAY



Speaker
where a speaker might go



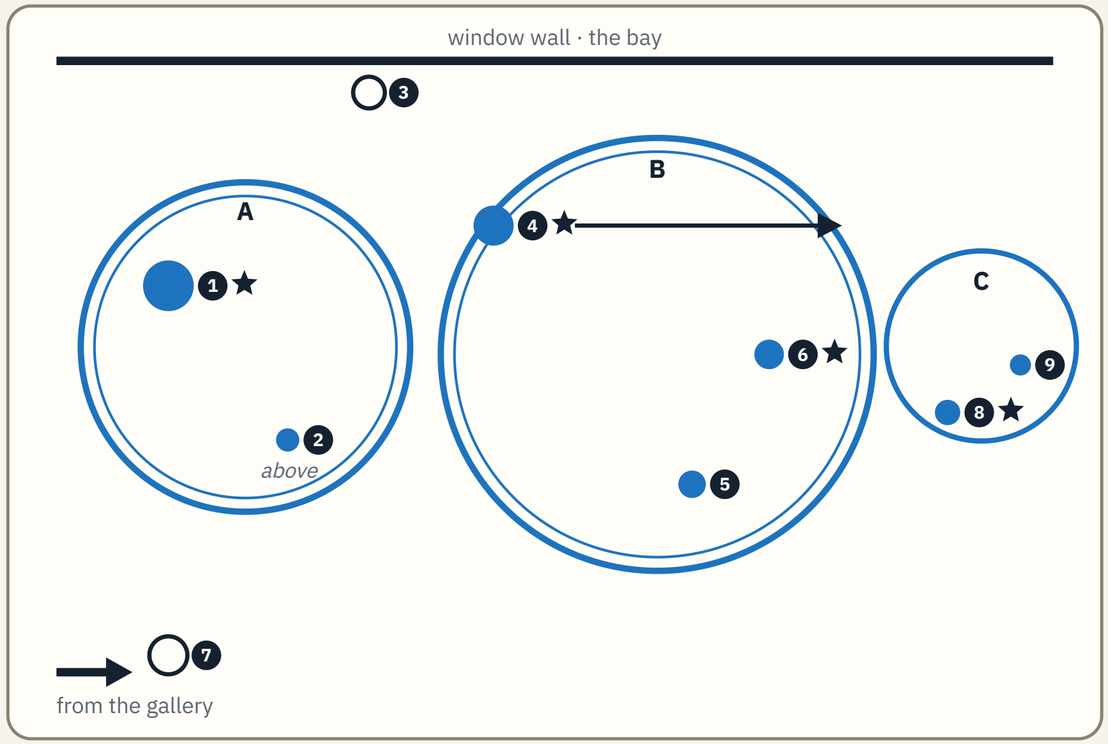
Fixed media
a file that plays the same way each time



Generative
made in real time by a music system



Responsive
changes when visitors trigger sensors



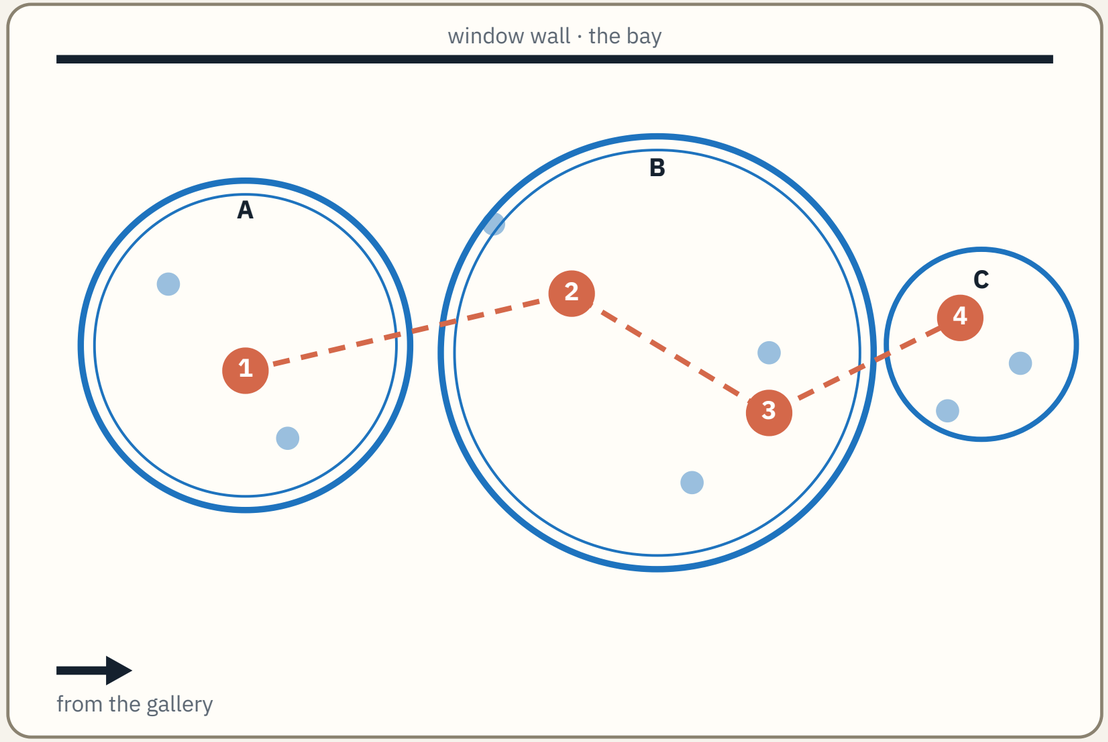
In situ sounds: what will you do about each? Ignore · Mitigate (keep it out) · Mask (cover it with a designed sound) · Acknowledge · Incorporate (make it part of the design)

STEP 3 · SOUNDS

Give every sound an address

Use the key: open for **in situ**, filled for designed, bigger for louder, an arrow if it moves. Star the ones that carry the concept.

1 ★ **Surf on gravel** · designed · always on
2 **Gulls and a heron** · designed · above · now and then
3 **HVAC hum** · in situ · incorporate as a generator
4 ★ **Outboard** · designed · moves · every 2 min
5 **Voices on the dock** · designed · in “now”
6 ★ **Time slider** · designed · plays when moved
7 **School groups in the hall** · in situ · mask
8 ★ **Her voice** · designed · plays when you sit
9 **Soft melody** · designed · generative · at the bench



STEP 4 · THE WALK

What does one visitor hear, stop by stop?

Each stop shapes their attention, alone or with other sounds: **attract** draws them in, **hold** invites them to stay, **release** lets them move on.

Pattern · Linear passing through · **Self-directed** wandering · **Stay** settled, sound moves around them

1 · Attract · 30 s · Then. Surf, wind and gulls. They slow down and look for the water.

2 · Hold · 2 min · Now. An outboard crosses the window wall; voices drift up from the dock.

3 · Hold · 2 min · The rail. They move the slider: motors thin out, gulls come back.

4 · Release · 3 min · The bench. A soft melody, then one voice: “When I was small, you could hear the herons from here.” They sit, and go quiet.

PART 1.5 · ABOUT 4 MINUTES

Add the technical overlay

Now put a system over the storyboard. You don’t need to have all the technical answers – just clarity on how the content is created and where it’s coming from.

PART 1.5

Five questions an integrator will ask

1. What are the limitations: the room, the budget, the noise next door?
2. How many speakers does each zone need?
3. Is each sound fixed media, generative, or responsive?
4. Will interactive elements, like sensors or a tablet, serve the concept?
5. What content design and mixdown will create the effect you want?

Your storyboard already lists the sounds and which ones matter most. The overlay adds what the system has to do to play them.

PART 1.5 · THE KEY

Draw the system on top

The system half of your key

Speaker
where a speaker might go

Fixed media
a file that plays the same way each time

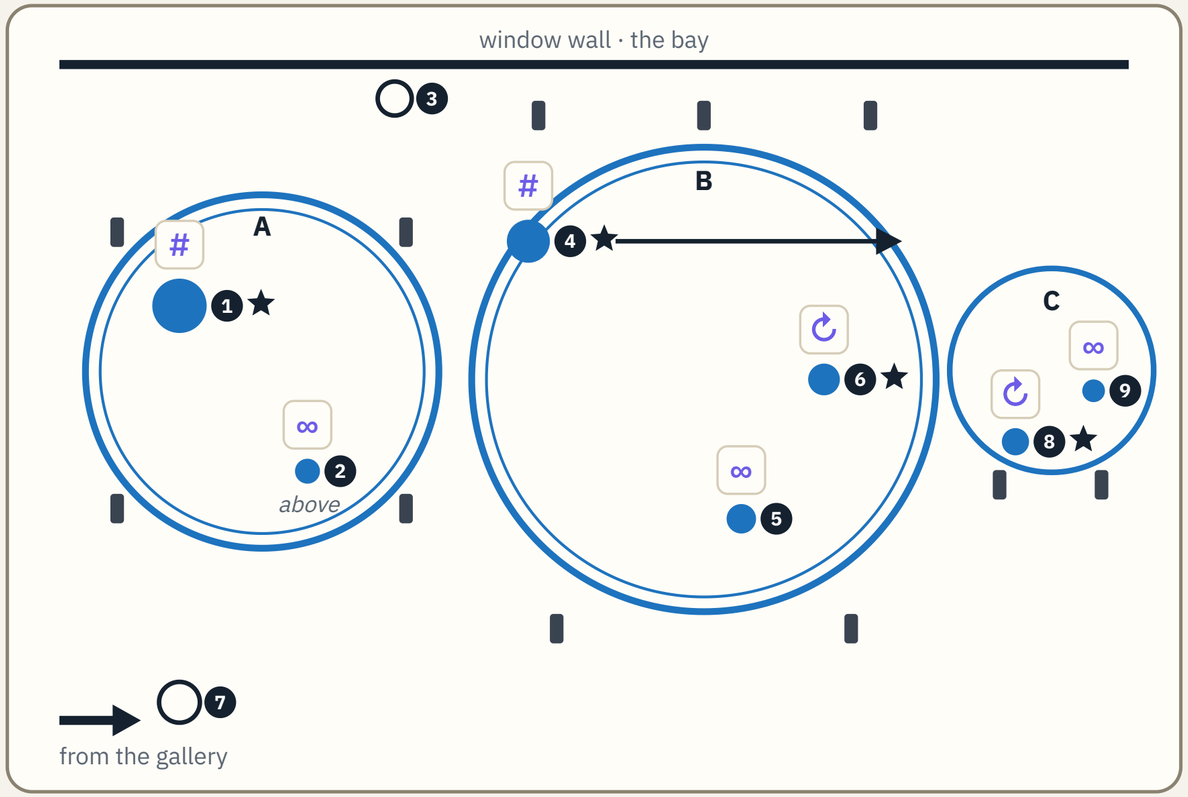
Generative
made in real time by a music system

Responsive
changes when visitors trigger sensors

You met these in part 1.4

Now use them on every zone and every sound: draw where the speakers might go, and mark how each designed sound plays.

Generative sound is made in real time, often by a music system or DAW, so it never plays exactly the same way twice. **Responsive** sound changes when visitors do something a sensor picks up, like moving the time slider or sitting on the bench, where a sensor starts her voice.



PART 1.5 · THE SHORELINE ROOM

The same map, with a system over it

- **A and B:** speakers along the window wall, so the outboard motor sound can travel across the room. The surf is fixed media; the gulls are generative, so they never repeat the same way.
- **The slider:** responsive. It crossfades “then” and “now.”
- **The bench:** two close speakers and a seat sensor. Her voice plays when you sit, with a generative melody in the background.
- **Limitations:** glass reflects sound, school groups pass on weekdays, and speakers can only sit where there is power and a place to mount them.

YOUR ASSIGNMENT · THE NEXT TWO WEEKS

Take the field sheet into your space.

Parts 1.4 and 1.5 come together on one two-page field sheet. Use the Shoreline Room example as a guide.

1 · Get ready
Print the two-page field sheet (single-sided is fine). At the top, write your exhibit, your name, and the day and time of your visit.

2 · On site: listen, then sketch
Spend two minutes just listening. Then, on page 1 of the field sheet, write your concept and arc, and draw a circle for each zone.

3 · Afterward: the sounds and the walk
On page 2, list the sounds in one zone and decide what to do about each in situ sound. Follow one visitor’s walk, stop by stop, and star the key sounds.

4 · Add the system
In a second pen color, draw where speakers ▮ might go on the map. In the sounds table, mark how each plays: # fixed, ∞ generative, ↻ responsive. Note one limitation.

5 · Bring it to Module 2
Keep your field sheet, with one line on what surprised you. In Module 2 you’ll start building your plan.

PART 1.6 · ABOUT 2 MINUTES

Learn from built examples

Our own immersive works, and what they taught us. Read each one with your overlay in mind.

Tendrenetic

Ethan Marshall Cohen and Caitlin C. Harvey · Vander · 2026

Vision: interactive spatial audio installation exploring the analog relationships between gallery visitors and artworks on the one hand, and organisms and ecosystems on the other hand.

Format: 10.1.5 active soundsystem + 10 ‘tendril’ piezo sensors + Max/MSP architecture

Implementation: generative/interactive system using custom-designed Max/MSP patches, foley and field recordings, sample-based and digital synthesis. Each custom-built ‘tendril’ sensor, when tread on, caused a respective aspect of the sonic ecosystem to recoil/hide. The more the system was ‘left alone’ (the sensors left untouched), the more the sonic ecosystem developed and flourished.

See it: weathercitizen.media/work/tendrenetic

Self-responsivity within a resonant body

Ethan Marshall Cohen and Maro Kariya · Norwest Gallery · 2025

Vision / Goal: water-themed soundscape

Format: 4.1.3 · passive speakers + sim-racer 7.1 interface / amplifier

Implementation: Generative sample-based spatial sound exhibit exploring resonance: samples using custom hydrophones, cymbals, and a bath tub full of water. Atmospheric samples from Belle Isle and other natural areas. As the systems progressed, new combinations of samples and atmosphere were generated.

See it: weathercitizen.media/work/norwest

Echosystems

Ethan Marshall Cohen and Maro Kariya · residency at Neighborhood Art School, Detroit, 2025 · Clyfford Still Museum, Denver, August 2026

Vision: immersive spatial sound shows aiming to create science fiction futuristic soundscapes

Interactivity: motion tracking and TouchOSC

Park Echoes

Maro Kariya · August 2025

An immersive audio call and response game built for Sidewalk Festival 2025, where participants were invited to collaborate to reveal a generative soundscape from Eliza Howell Park, evoking connections with other participants through interactive sonic programs.

Format: Fieldspeakers (outdoor 7.1.4 + TouchDesigner + microphone)

See it: marokariya.info/ParkEchoes

Pleinair TV

Ethan Marshall Cohen, Maro Kariya and Kristyn McKinney · 2025

Vision: drawing from the art practice of *plein air* (the French practice of painting outdoors in natural light to capture real-time changes in weather, atmosphere, and scenery), this audiovisual work surrounded a CRT video wall and opposing projection screen with an immersive sound system, all situated within an urban arboretum in Detroit, MI.

Format: 3×3 CRT wall + projection screen + 8.1 active sound system

See it: weathercitizen.media/work/pleinair

Thirsty Machine

Maro Kariya · October 2023

Vision / Goal: Abstract short story about a replicating machine which reproduces incessantly, creating heat, and eventually exhausts a country's water supply. Based on von Neumann's self-replicating machine.

Format: immersive a/v (24-point audio and projector system)

Watch on YouTube: youtube.com/watch?v=Hm5Y4mkM3dI

Mirror Glyph

Maro Kariya · November 2022

Exploration: What is a reflection? How do reflections change the ways we see ourselves? Are androids more than reflections of ourselves? A glyph is a symbol, yet the relation to the meaning is changeable. What happens when symbol meanings are lost from us, when we lose control of information? Each letter within the Roman and katakana alphabets is mirrored at 12 angles (intervals of 30 degrees) to create novel characters, illustrating how familiar symbols can quickly become foreign through the process of reflection.

Watch on YouTube: youtube.com/watch?v=ZIFhg6Zny3k

Crickets of Semantra

3.1.3 · Spatial Sound Festival · September 2026

Details coming soon.

END OF MODULE 1

You listened, named and placed your sounds, and gave them a system.

Bring your field sheet to **Module 2: Hearing and Making Spatial Sound**. Your starred sounds go into Inviso, so you can hear your plan on headphones.