

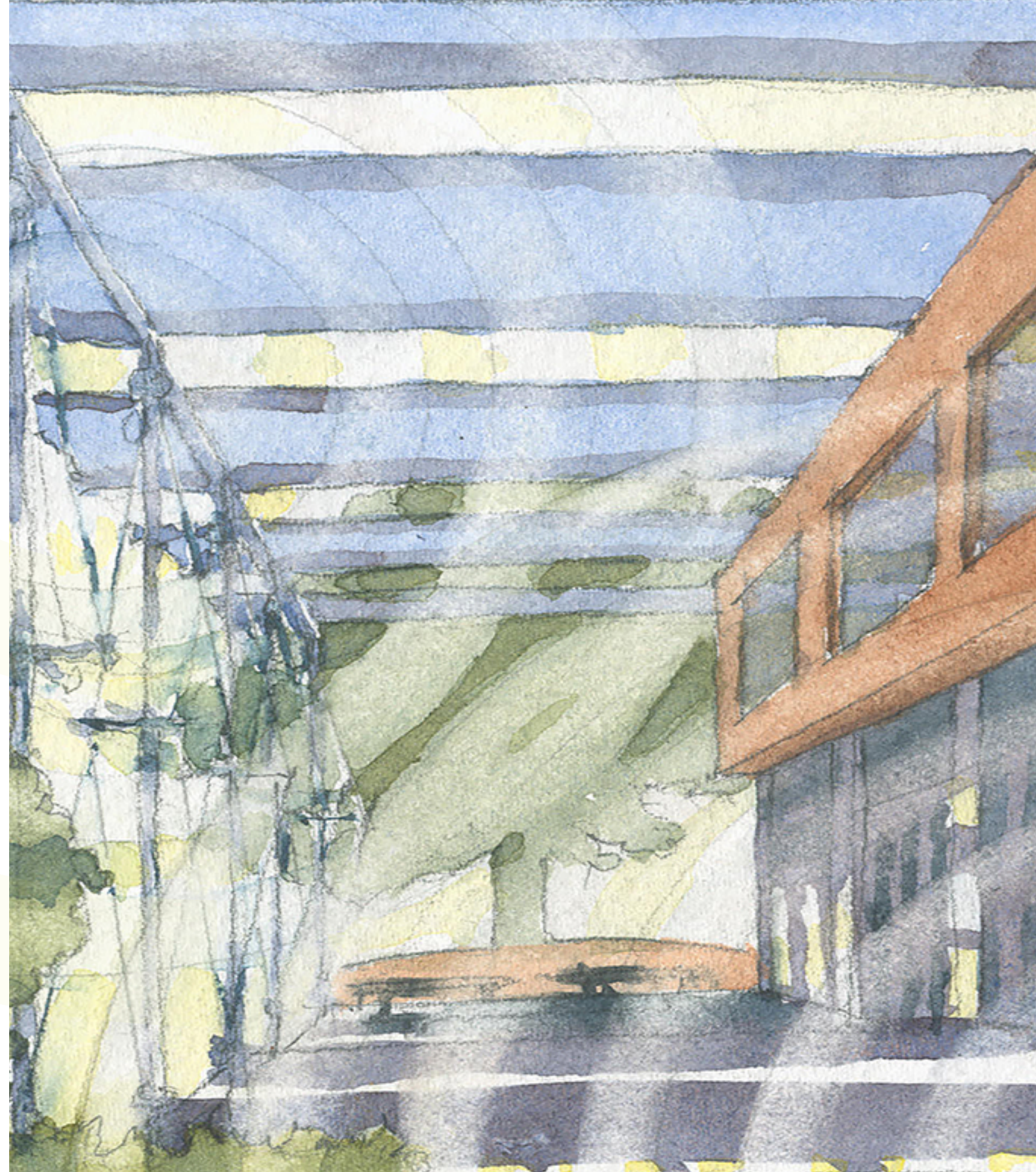
Perkins&Will

Measuring Aural Architecture as an Equity Performance Standard

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*Kendeda Building for Innovative Sustainable Design
Georgia Institute of Technology, Atlanta*
Watercolor courtesy of Barbara Worth Ratner



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Contents

A watercolor illustration of a landscape. In the foreground, there is a fence made of wooden posts and wire. Behind the fence, there are several trees with green leaves. The background consists of horizontal bands of color, including shades of blue, yellow, and white, suggesting a sky or a field. The overall style is soft and painterly.

Section 01.

The Gap: Aural Architecture and Equity

There continues to be a gap between our ability to engineer acoustics and the need to design for our perception of sound. Equity falls through that gap.

The Gap: Aural Architecture and Equity

Sound as Design Opportunity

“Dear Architects” runs the headline of critic Michael Kimmelman’s 2015 appeal to the profession: “[Sound Matters](#).” In his multimedia editorial, Kimmelman quotes Ricardo Scofidio as saying that, excepting theatrical typologies, architects don’t give much attention to how spaces *produce* specific sounds, “partly because the process of making models and drawings doesn’t allow for it.”¹ We need better tools.

We want to design for the human experience, but the known gap between the physical properties of “acoustic architecture” and the experiential domain of “aural architecture” continues to limit the potential of architectural design to provide accessible, socially cohesive, culturally responsive experiences.² That is, the persistence of the gap between what we do and don’t have the tools to measure (i.e., acoustics vs. perception) constrains our ability to integrate soundscape design into any holistic approach to space and place. We continue to outsource “noise” mitigation to acoustic engineers because that is what we can do, but in so doing we persist in leaving a range of design challenges and opportunities unaddressed. Among these is the power of sound to address equity in urban and architectural environments.

¹ Michael Kimmelman, “Sound Matters.” *New York Times*. 29 Dec. 2015.

² For the gap between the physics of sound and the perception of sound, see Barry Blesser and Linda-Ruth Salter, *Spaces Speak, Are You Listening?*; MIT Press, 2012; and Seth Horowitz, *The Universal Sense*; Bloomsbury, 2012. In disciplinary terms, the gap might translate as the difference between the physics and mechanics of sound and the neuroscience and psychology of attention.

“To evaluate aural architecture, we must ascertain how acoustic attributes are perceived: by whom, under what conditions, for what purposes, and with what meanings.”—Barry Blesser

Measuring Perception of Sound

This Innovation Incubator advances the ongoing efforts to build better tools for considering the subjective, culturally determined experience of sound, or what digital-audio pioneer Barry Blesser calls “auditory spatial awareness.”³

Arup’s spectacular [SoundLab](#), launched in 1998, today develops “auralisations” of environments still in the design phase. By engaging their auditory spatial awareness, these simulated soundscapes include clients in design decisions that affect a project’s soundscape. Auralisations are a luxury, however, even though soundscapes are an essential consideration in every architectural

design, not merely in concert halls and transportation infrastructure.

Sharing Arup’s ambition nonetheless to shift the industry’s sound mindset from mechanics to perception, this Incubator explores two more accessible methods of assessing the perception of sound in architectural spaces: the soundwalk and the questionnaire. Further, it explores the value of soundscape assessments in designing for equitable access and diverse experiences.

The soundwalk and the questionnaire are two of the four methods indicated by [ISO Technical Specification 12913](#), “Acoustics—Soundscape.” In 2014, the International Standards Organization published Part 1

³ More complex than the mere detection of sounds, auditory spatial awareness is “a multiplicity of related but independent abilities” and “includes the emotional and behavioral experiences of space” (8, 11).



Sound across Standards and Disciplines

Soundscape and Equity in Performance Standards

Existing certifications do not give adequate consideration for auditory spatial awareness or the role of soundscapes in equitable outcomes.

01.

Living Building Challenge 4.0

Equity is one of seven performance categories, or “petals,” in LBC certification, which exacts holistic rigor based on actual rather than anticipated outcomes. Of the Equity petal’s two imperatives, Universal Access and Inclusion, only the former takes sound into consideration. More important, it reduces the relevance of the soundscape to “noise audible to the public.”

02.

WELL Building Standard v2

The performance-based certification focuses on holistic health in interior environments. Sound is one of ten performance categories, but the requirements are entirely dedicated to controlling “disturbance” and promoting “comfort,” which may encode implicit biases. The Community requirements address equity, but sound gets only nominal consideration.

03.

Social Equity Assessment Method

The SEAM Standard is a new sustainability certification for commercial real estate projects. Though it has not yet formally launched, it promotes action toward social sustainability “beyond health and wellness to encompass matters like justice and equity.” Three rating systems cover ranging project types. The sample scorecards suggest that sound will be a nominal consideration.

of this Technical Specification, establishing its definition of *soundscape* as a “perceived” acoustic environment. Part 2, published in 2018, indicates four methods of collecting soundscape data, emphasizing that soundscape study “relies primarily on human perception and only then turns to physical measurement.”

Notably, all four assessment methods lend themselves to environments that are *already built*. However, designers need easily adopted and implemented tools that can, like Arup’s auralisations, anticipate soundscapes (aural architecture) while projects are still in the design phase.

Equity Through Soundscape Design

This Incubator uses a built project, the Kendeda Building for Innovative Sustainable Design at the Georgia Institute of Technology, in Atlanta, to conduct the soundwalk and craft the questionnaire. Certified Living Building Challenge in 2021, the Kendeda Building has also met the Equity imperatives of the profession’s most rigorous performance standard. The soundwalk and questionnaire are therefore treated as heuristics for considering how to leverage data about the perception of sound in order to design beyond noise mitigation and in response to the social, emotional, and cultural parameters of equity.

The questionnaire in particular is intended as a draft prototype for engaging users during conceptual or schematic design. Conceived as though the Kendeda Building were not yet built, the survey targets a small cohort of blind or low-vision users on the universal-design principle that they are attentive to the qualities of their acoustic environment. A framework for equitable design recommendations emerges around noise, attention, and culture.

Soundscape study crosses disciplines to hear beyond “noise” in designing contextually.

The bias toward physical measurement of sound flattens “aural architecture” into a palette of noise, silence, signal, and ambience. Just as the ISO TS 12913 standardizes a concept of soundscape in recognition of the wide-ranging, sometimes competing definitions of the word, it standardizes the concept of noise (among a number of other field-specific terms). Excepting a few widely accepted uses, such as “broad-band noise” and “environmental noise,” the ISO expands the general definition to include “unpleasant,” “unexpected,” and “harmful” sound. This broader definition accounts for subjective preference and needs, variance across time, and culturally determined expectations. In short, it empowers a more equitable collection of data, leading to more dynamic design interventions and more equitable outcomes.



Heard from the roof garden of the Kendeda Building for Innovative Sustainable Design, the Marcus Nanotechnology Building is the loudest building on Georgia Tech's campus.

Engineering and Technology

MODELING SOUNDSCAPES

1. The Perkins&Will Design Process Lab has the tools to measure the physical performance of sound in modeled environments. For example, the lab performed an acoustic analysis of a classroom for the [“Road Map for K-12 Education,”](#) published in 2021. Lab co-leader Dr. Marcelo Bernal welcomes the addition of qualitative assessments to guide physical metrics.
2. Arup stages its [“auralisations”](#) in “specially designed rooms, with neutral acoustics and state of the art spatial audio systems.”
3. MIT’s Computer Science and Artificial Intelligence Lab ([CSAIL](#)) now investigates machine learning to model acoustic environments and soundscapes.

Life Sciences

NEUROSCIENCE, BIOLOGY, AND BIOPHILIA

1. Writing about hearing in [The Universal Sense](#) (2012), neuroscientist Seth Horowitz defines *perception* as “the integration of sensations into a coherent model of the changes in energy around us.” He explains how the brain perceives sound so fast that sound “drives some of our most important subconscious and conscious processes,” including attention and emotion (16-7, 102).
2. Neuroscientist [Yonatan Fishman](#) studies how our brains [learn to hear noise as music](#) over time.
3. Consulting firm Terrapin Bright Green uses E.O. Wilson’s “biophilia hypothesis” to make [the business case for water sounds](#) as a noise-masking treatment in open-plan offices.

Architecture and Design

AURAL “ILLUMINATION” AND CONTROL

1. Digital-audio innovator Barry Blesser distinguishes between “soundscape” and “aural architecture” to distinguish between the perception of sounds and a space as “illuminated” by the perception of sound (16).
2. Past Perkins&Will Innovation Incubator projects have studied the [efficacy of sound masking](#) and the correlation between [sound and performance](#) in the workplace as well as the [attenuation of noise pollution](#) in urban parks.
3. BAUX, a Swedish acoustic-materials firm, self-published [The Book of Acoustics](#) in 2020. The accessible guide defines key terms and outlines the “ABCDs of sound control”: absorb, block, cover, diffuse (28–9).

Social Sciences

CROSSMODAL PERCEPTION, ATTENTION, AND LINGUISTICS

1. Experimental psychology labs like the [Crossmodal Perception Group](#) at Oxford University investigate the “integration of information” gathered across the senses.
2. The perception of “noise” may be better addressed by the interaction of acoustics with other sensory parameters. And instead of controlling distractions, a design might orchestrate attention, or selective hearing, as a dynamic, multisensory response to architecture.
3. Late technical communication scholar Halcyon Lawrence invited us to consider accent, not mere intelligibility, in designing speech environments. Her research on [accent bias in voice-interaction technology](#) reminds us that voice characteristics are an aural indicator of equity.

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Sound in the Arts and Humanities

“At the heart of our collaboration is a bold aspiration to hear sound used as a primary means of knowledge production.”—Soundbox, on [PROVOKE!](#)

Fine Art and Film

Most artistic explorations of sound, music, and acoustic theater are in conversation with avant-garde composer [John Cage](#), who was concerned with perceptions of sound in social spaces. In [Playing the Building](#) (2005), pop musician David Byrne makes architecture into an instrument, while Bernhard Leitner’s [Le Cylindre Sonore](#) (1987) is an architectural soundscape. The 2022 documentary [32 Sounds](#) features “deep listening” champion Pauline Oliveros, “river archivist” Annea Lockwood, and ASL interpreter Christine Sun Kim, among 28 other soundscape provocations.

Cultural Studies and Media History

The emphasis on equity in Halcyon Lawrence’s investigation of voice technologies corresponds with the rise of media studies among humanists. [Mary Caton Lingold](#) is at the forefront of using digital technology to recover historical soundscapes. Her [Sonic Dictionary](#) hosts two digital collections by students in my courses on sound and equity in the Kendeda Building. In [The Sonic Color Line](#), literary scholar Jennifer Lynn Stoeber traces a history of racialized sound in the U.S. She is also the founding editor of [Sounding Out!](#), the foremost critical forum on sound and identity.



Photo CC-BY-NC-ND: *Kester House & Garden, Interior, Genkan*, by Kimie Kester.



Section 02.

**Case Study:
Living Building
Soundwalk**

Case Study: Living Building Soundwalk

What does equity sound like?

At the 54th meeting of the Environmental Design Research Association (EDRA) in Mexico City, I presented “**Architectures of Sound**,” the course I taught in the spring and summer of 2018, before the Kendeda Building had even started construction.¹ Centered on the question “What does equity sound like?,” the course followed a series of assignments, including **a participatory design game**, field recording sounds in programmatically similar spaces on the Georgia Tech campus, and blogging about equity. These assignments scaffolded a final group project, the creation of interactive tours of the prospective Living Building (click to left). The students’ tours imagine the soundscape in the building and anticipate aural obstacles and opportunities for equity based on the building plan provided by the architect of record.

Now that the Kendeda Building is occupied and, as of 2021, fully certified in the Living Building Challenge, it offers an excellent test case for considering the postoccupancy soundscape as part of the university’s ongoing assessment of the building’s equity performance. The Center for Serve-Learn-Sustain transitioned the Equity Petal Working Group into a **Vertically Integrated Project**, for which students make recommendations on how the building works toward UN Sustainable Development Goals (SDG). Soundscape assessment should play a role in the curriculum.

¹ The course was supported by a course-development grant from the university’s Center for Serve-Learn-Sustain.

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What Does Equity Sound Like?

— KENDEDA BUILDING SOUNDWALK

Click right to hear: In October 2023, I recorded a soundwalk of the Kendeda Building at Georgia Tech, from Ferst Drive to the roof terrace, where the Nanotech Building earns its reputation as the loudest building on campus.

A watercolor illustration of a park scene. On the left, there are several trees with green and yellow leaves. A path leads from the foreground towards the background. In the background, there are rolling hills and a building. A wooden bench is visible in the foreground on the right. The overall style is soft and artistic.

Section 03.

**Prototype:
Soundscape
Questionnaire**

“I want to propose...that the blind be taken as the prototypical city dwellers when imagining wonderful cities.”

— Chris Downey, AIA, “[Design with the Blind in Mind](#),” TEDCity2.0, 2013

What if we asked blind users about the soundscape?

In a chapter on “time, attention, and emotion,” Seth Horowitz concedes that as much as neuroscientists relish their miraculous measuring devices, “when we want to determine what our subjects feel, we sometimes have to fall back on a good old-fashioned technique: asking them.”¹ The ISO Technical Standard includes a postoccupancy questionnaire to assess psychoacoustic indicators such as loudness, sharpness, roughness, tonality, and fluctuation in strength.

I drafted a soundscape survey as though the Kendeda Building were *still in design*, imagining a small cohort of blind and low-vision users. While they do not necessarily hear better than sighted people, this cohort may be more aware of how sound affects their experience.² As a heuristic, the survey projects a framework for anticipating the rhythm of attention, from navigation and signal alternatives to voice to the affective profiles of noise and silence.

¹ Horowitz, *Universal Sense*, 125.

² An actual questionnaire would need to be rendered accessibly with a screen reader or similar.



Community members from the Lighthouse for the Blind and Visually Impaired explore a tactile model of Enchanted Hills Camp, a summer camp for blind and low-vision children.

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Prototype Soundscape Questionnaire

Introduction

The Kendeda Building for Innovative Sustainable Design is pursuing full certification in the Living Building Challenge, which includes performance standards for Equity in access and inclusion. This survey asks questions about how you perceive and respond to sounds in your environment for a range of purposes, from navigation to being in community. In this survey, “noise” is not limited to unwanted or harmful sound and includes unexpected sound or the general character of the soundscape. “Silence” is not limited to the absence of sound and includes environmental noise that recedes so far into the background that it is no longer perceived.



Navigation

ACCURACY AND SAFETY

1. Rate these sound sources on their value for navigating accurately (1 = essential, 3 = insignificant, 5 = inhibitory):
 - Single voice
 - Vocal chatter
 - Footsteps
 - Water feature
 - Other (specify and rank)
2. Rate these sound sources on their value for navigating safely (1 = essential, 3 = insignificant, 5 = inhibitory):
 - Single voice
 - Vocal chatter
 - Footsteps
 - Water feature
 - Other (specify and rank)

Attention

ORIENTATION AND PROGRAM

1. Rate these sound sources on their value for orienting yourself: (1 = essential, 3 = insignificant, 5 = inhibitory):
 - Single voice
 - Vocal chatter
 - Doorways/Passageways
 - Water feature
 - Other (specify and rank)
2. Which sound sources will define your purpose in the building? (Choose three.)
 - Single speaker's voice
 - Transactional exchange (e.g., meeting, assistance)
 - Social conversation, including laughter
 - Music (live, broadcast, headphones)
 - Nature (e.g., animals, weather, water)
 - Other (specify)

Noise/Silence

ENVIRONMENT AND BIOPHILIA

1. Which feeling most closely describes your immediate association with “noise”?
 - Alarming
 - Irritating
 - Distracting
 - Comforting
 - Fun
 - Other (specify)
2. Which feeling most closely describes your immediate association with “silence”?
 - Oppressive
 - Unnerving
 - Distracting
 - Comforting
 - Peaceful
 - Other (specify)
3. Rate these sound sources from the local ecosystem from least to most appealing (1 = least, 3 = most):
 - River
 - Wind
 - Rain
 - Thunder/lightning
 - Crickets/Cicadas
 - Birds
 - Bees

Culture

LANGUAGE AND COMMUNITY

1. Name up to three languages you will use to communicate in this building.
2. Is music a meaningful part of your community connection to this building? (Yes/No)
 - If yes, what kind of music?
 - If yes, is it live music? (Yes/No)
 - If yes, what are the most important instruments? (Name two)



Section 04.

Conclusion: An Emerging Framework

Toward Design Recommendations

Noise has a purpose. Attention has a rhythm. Culture has a voice.

Equity Indicators

If soundscape assessment will be used to anticipate perceptions of sound and design for equitable outcomes, we need to build on the psychoacoustic indicators of the ISO assessment specification. We need indicators that control for cultural bias in perceptions of comfort and register the cultural domains of equity in addition to accessibility.

Such indicators might register polylingualism, silence, navigation, community identity, somatic sensation, and the biophilic musicality of the materials palette.

Further Study

To develop soundscape assessment:

- The ISO assessment specifications need to be purchased and consulted.
- Blind and low-vision users should be consulted on an accessible survey.
- A POE should be conducted on the Enchanted Hills Camp, scheduled to open in late 2024.
- The survey could be adapted for other and more diverse cohorts of users.
- A workshop should be staged with the firm's acoustic engineering partners.
- Soundscape assessment should be added to the Kendeda Building VIP curriculum.

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