

FROM INQUIRY TO INNOVATION

Advanced Acoustic Design at the Intersection of Art, Science, and Technology

Alaa Algargoosh, PhD

Assistant Professor of Architecture | Virginia Tech



Photo Credit: Gretchen Ertl

Architecture education remains predominantly **visual**, often privileging what can be seen and represented over what is experienced. Yet sound is fundamental to how people perceive, communicate, and inhabit space, and acoustic design carries important social and environmental implications. **Socially**, acoustic environments influence comfort, well-being, inclusion, communication, and social interaction; **environmentally**, acoustic solutions raise questions about materials, resources, fabrication, and the adaptation of existing spaces. Teaching architectural acoustics therefore **requires pedagogical innovation** that makes this **invisible dimension of architecture tangible** while preparing students to address these interconnected challenges. I use Advanced Acoustic Design as a framework for integrating art, science, and technology through hands-on exploration, interdisciplinary research, experimentation, and design. Because sound is experienced rather than seen, **this portfolio intentionally emphasizes students listening, experiencing, making, measuring, testing, and inhabiting acoustic environments**, alongside conventional drawings and models. Students learn acoustics not only by representing sound, but by encountering its effects, evaluating them through evidence, and translating that knowledge into design responses to social and environmental challenges.

THE CORE PEDAGOGY

From Guided Inquiry to Independent Innovation

Students learn to move iteratively between research and design: research informs their design decisions, while design generates new questions for investigation. Through this iterative process, students develop curiosity, interdisciplinary fluency, technical confidence, and intellectual independence to become innovators in architectural acoustics and beyond. The framework operates across coursework, design studios, research mentorship, and curricular development, creating multiple pathways from initial inquiry to independent innovation

Innovation requires both the **freedom** to explore and **structure** to advance an idea. I encourage students to pursue ambitious questions, then guide them in identifying the collaborators, methods, tools, and evidence needed to investigate them. **As students gain knowledge and confidence, my role evolves from providing guidance to fostering autonomy**, empowering them to make their own decisions, pursue new questions, and ultimately lead their own innovative work.



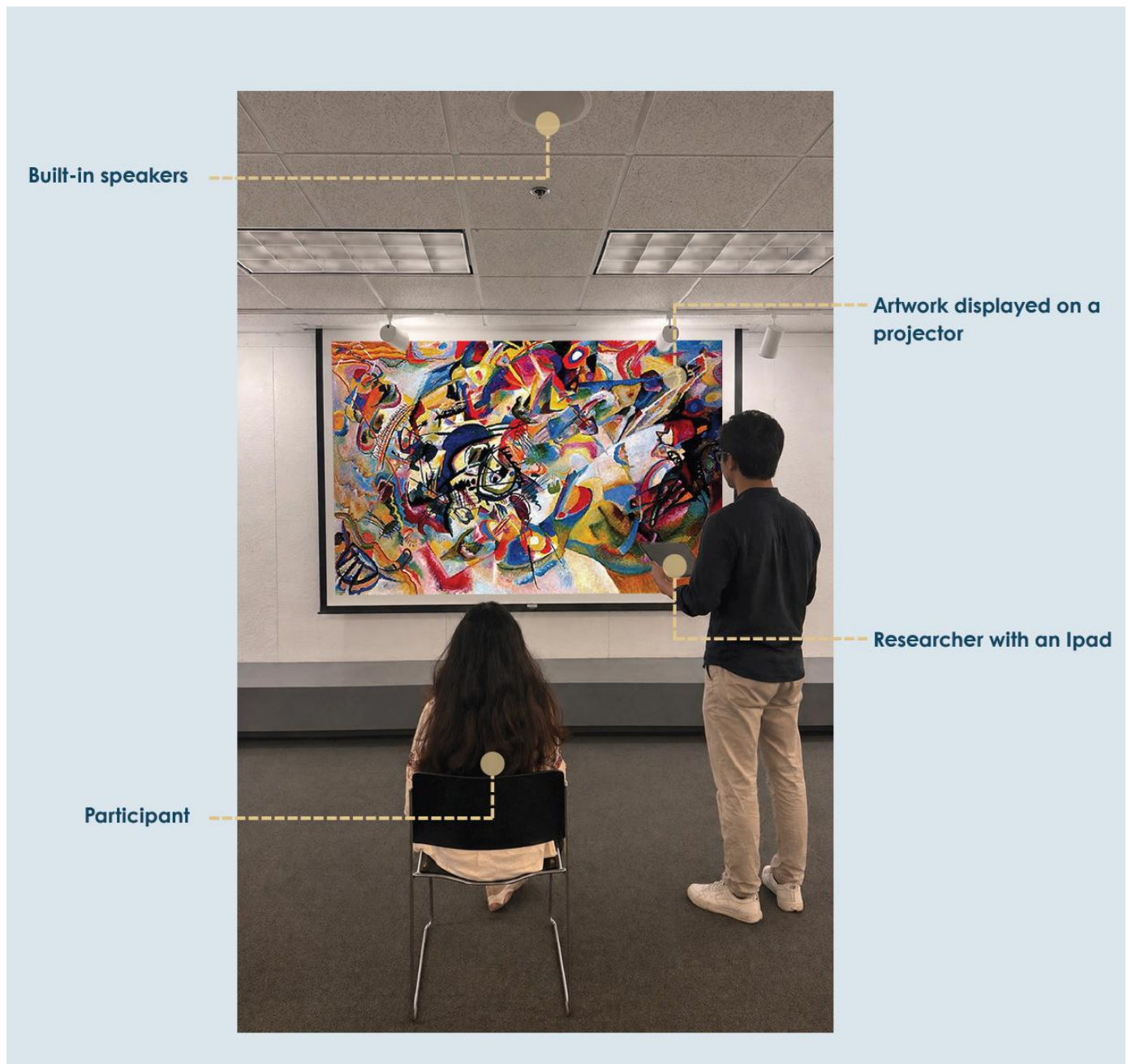
Megan Wysocki testing the EEG device to study the impact of acoustics on cognitive function.

Photo Credit: Evan Musgrave

1.QUESTION: Cultivating Curiosity and Independent Inquiry

32 Graduate Students Advised and Mentored | 13 M.Arch | 10 M.S. | 9 Ph.D. | 6+ Undergraduate

In my Acoustic Experiences course, students begin by asking how sound might influence human experiences such as emotion, cognition, creativity, productivity, and social connection, then **transform their curiosity into questions that can be investigated through research and design**. Student work demonstrates the diversity of questions that can emerge from this approach: How might music influence our perception of visual art? How might sound support connection during virtual collaboration? How can an invisible phenomenon such as sound be made visible through a responsive architectural surface?

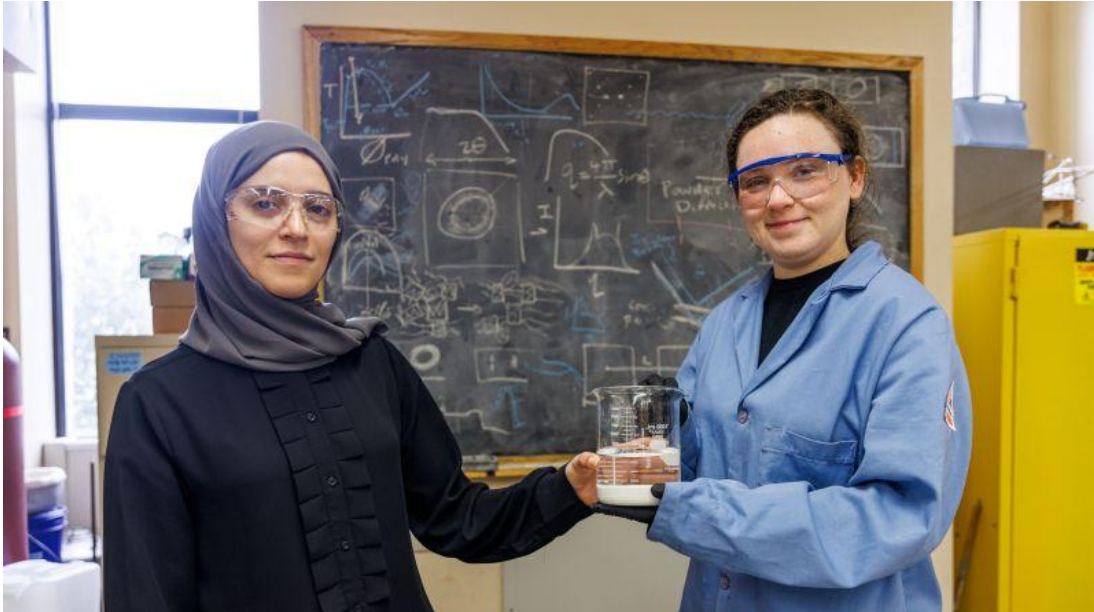


Students learning to design an acoustic experiment to test how ambient sound can impact the perception of visual art. Photo courtesy of the student project team.

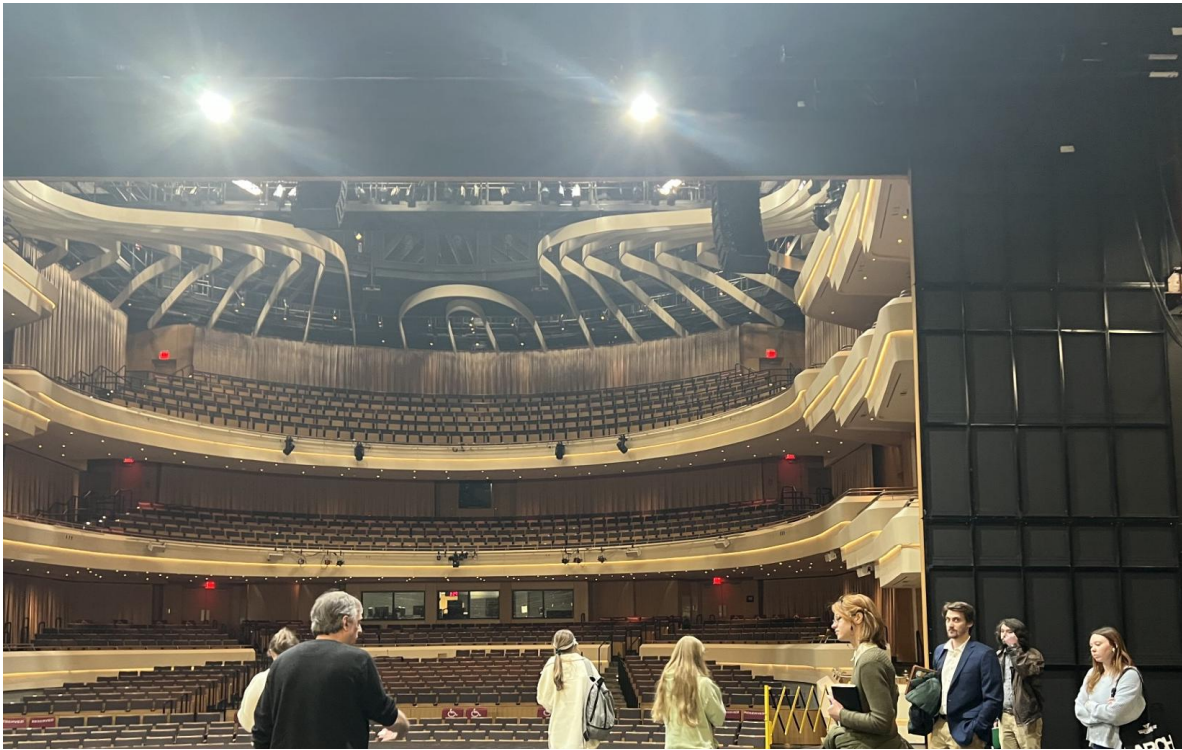
2. EXPLORE: Learning Beyond Disciplinary Boundaries

6+ Disciplines Connected

Architectural acoustics exists at the intersection of architecture, engineering, computation, material science, music, art, technology, and human experience. **My role as a mentor is not to be the sole source of expertise, but to help students build their own networks of knowledge.** I connect students with faculty, researchers, and professionals across disciplines, guiding them to seek and integrate diverse expertise. Over time, students learn to identify and build these connections independently.



Architecture, chemistry, and mechanical engineering students combining disciplinary expertise to develop and test an acoustic material system. Photo Credit: Evan Musgrave

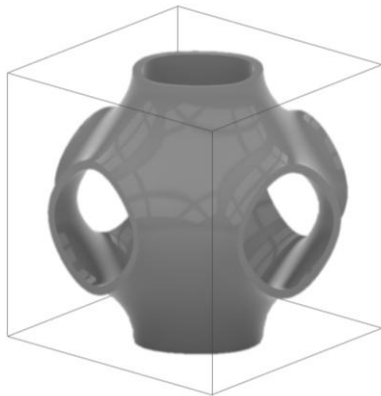


Top: Advanced Design Studio students visiting the Anne and Ellen Fife Theatre, Virginia Tech, to experience and learn about theater acoustics as a case study for their own design projects. Bottom: Acoustic Experiences Course students visiting the Cube, Virginia Tech's immersive audiovisual research environment, to explore spatial sound and auralization through direct experience. Photo Credit: Alaa Algargoosh

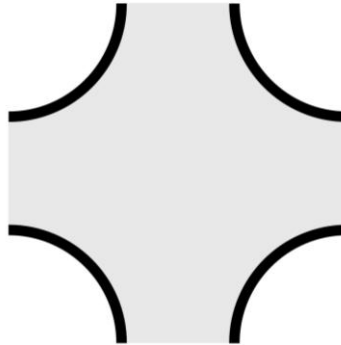
3. DESIGN: Translating Knowledge into Architectural Innovation

10 Design Projects | 7 Research Projects

Students learn to translate scientific and technical knowledge into architectural propositions. Through this process, Jun Hyeok Choi learned to integrate acoustic science, computational design, and fabrication in developing and prototyping an architecturally integrated acoustic system.



< Unit Cell >



< Section Diagram >



Jun Hyeok Choi designing an acoustic solution for building envelopes that enables natural ventilation while reducing noise transmission. The design process involves drawings, 3D printing and prototyping. Photo Credit: Jun

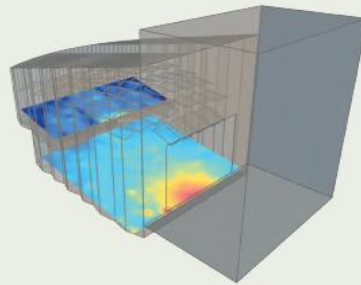
Hyeok Choi



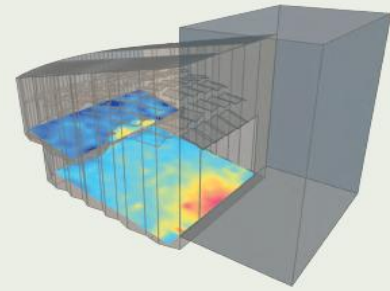
ACOUSTIC PERFORMANCE

Metrics at 1000 Hz			
Metric	Theater	Speech	Target
T30	1.1	.97	0.8 - 1.2 s
C50	2.6	3.2	+3 - +6 dB
SPL	76.3	75.3	65 - 75 dB

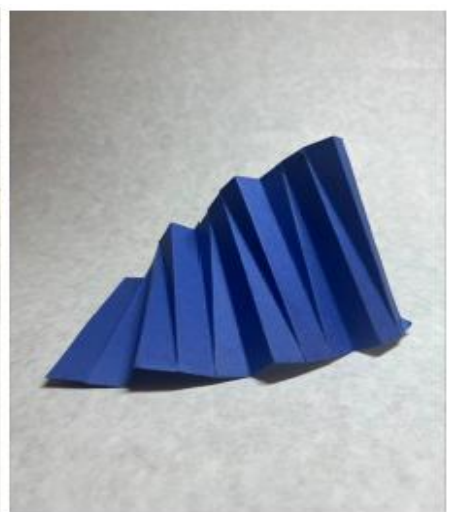
To simulate multiple acoustic metrics, we considered only the back and balcony walls as absorptive for Theater and added more absorption with curtain panels along the side walls for Speech.



SPEECH
More Absorption



THEATER
Less Absorption



Madi Nuckles, Abigail Bogin, and Lizzie Davis translating acoustic principles into architectural forms and performance spaces, integrating acoustics from the beginning of the design process. Photo courtesy of the student project team.



Rachel Robinette & Shala Do translating acoustic principles into architectural forms through physical models of 3D printed objects that they previously designed. Photo courtesy of the student project team.



Yiming Jiao applies interdisciplinary knowledge of sound and responsive technologies to design, prototype, and evaluate an interactive architectural system. Photo courtesy of the project team

4. TEST: Learning Through Experimentation

Simulation | Physical Measurement | Human-Subject Research

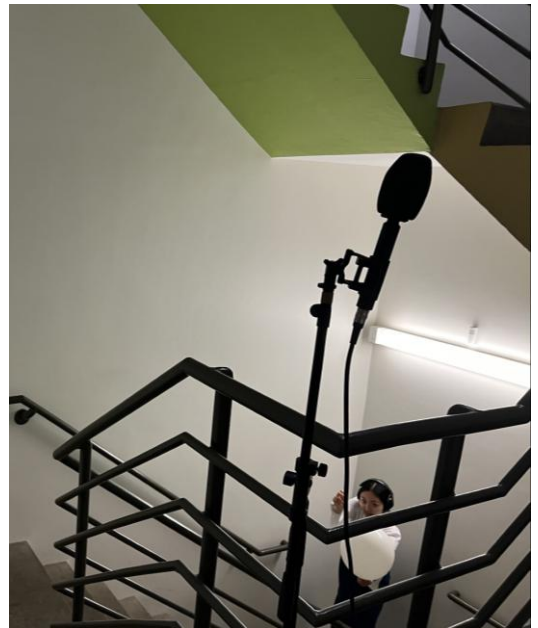
Innovation is not defined by novelty alone. I teach students to **test their ideas against evidence**, using appropriate methods to understand whether a design performs as intended and what can be learned from its limitations. Testing transforms assumptions into knowledge and gives students the evidence needed to make **informed design decisions**.

Exploration ultimately becomes active. Students **model, make, test, evaluate, and revise** rather than accepting an idea simply because it is novel. Through this process, students do more than acquire technical skills. They learn how to learn what they do not yet know.

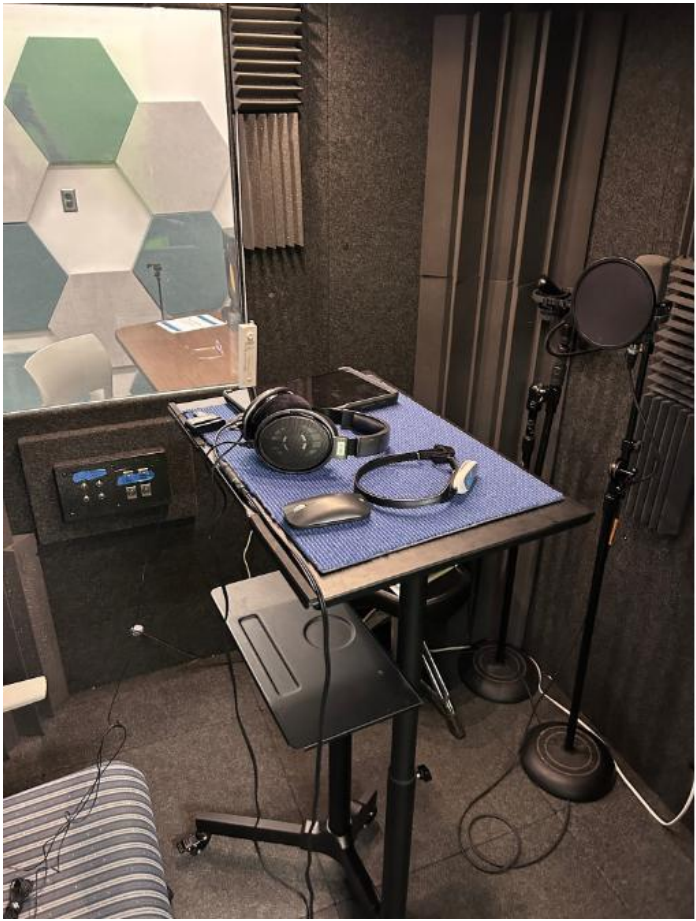
Because acoustic design bridges physical performance and human experience, students learn to work with **different forms of evidence**.



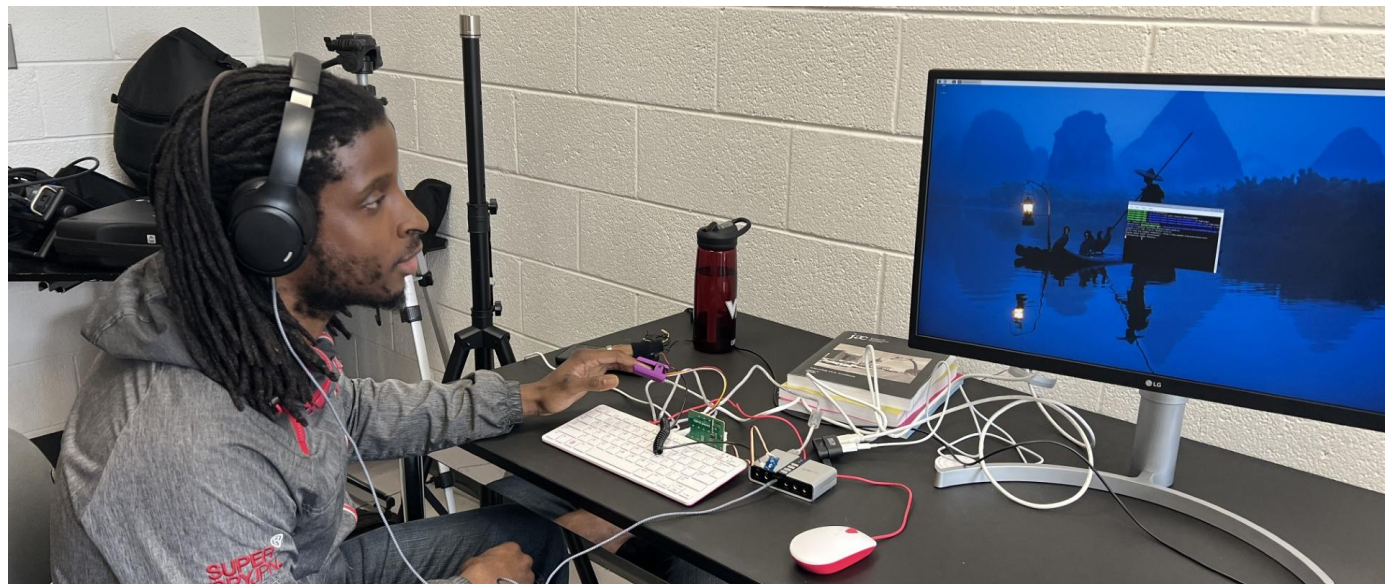
Rachel Ellison-Lee learned to use acoustic evidence as a design tool, developing resonant panels for a music-venue retrofit and validating their performance through physical measurements. Photo Credit: Rachel Ellison-Lee (top), Alaa Algargoosh (bottom)



Top and bottom right: Ally Hong conducting acoustic measurements in spaces that sparked her curiosity because of the distinctive echoes. Bottom left: Megan Wysocki testing the real-time auralization. Photo Credit: library visitor (top), Alaa Algargoosh (bottom).



Megan Wysocki learning to design and conduct human-subject experiments to investigate how acoustic environments influence perception and well-being. Photo Credit: Megan Wysock (left), research participant (right).



Justin Kerobo developing an experimental setup while learning to integrate interactive musical technologies into the study of human interaction with music. Photo Credit: Alaa Algargoosh

5. TRANSFORM:

8+ External Presentations | 3 Competitions | 2 Public Exhibitions

Moving Beyond the Classroom

I extend learning beyond the university so students learn to communicate, evaluate, and advance their work within **professional**, **scholarly**, and **community** contexts.

Connecting Education to the Profession

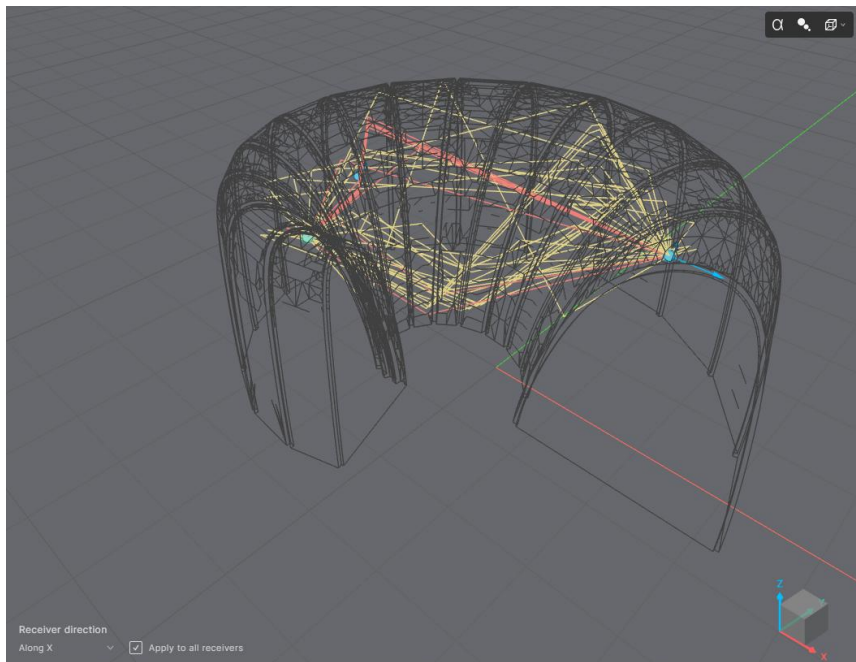
The theater design studio extended learning beyond the classroom through participation in the **Acoustical Society of America Student Design Competition**, where students communicated and evaluated their architectural and acoustic decisions against an external disciplinary benchmark.

Rachel Ellison-Lee transfers knowledge developed through acoustic research into architectural practice, using measurement and **evidence-based design** to inform the retrofit of an existing music venue.

Jun Hyeok Choi progressed from developing and experimentally validating his ideas to **engaging with acoustic consultants**, learning how student research can advance toward professional application and commercialization.

Megan Wysocki progressed from mentored research to securing her own Student-Initiated Research Grant and presenting her work at the International Congress on Acoustics, as an **invited presentation**, developing greater ownership and **professional confidence**.

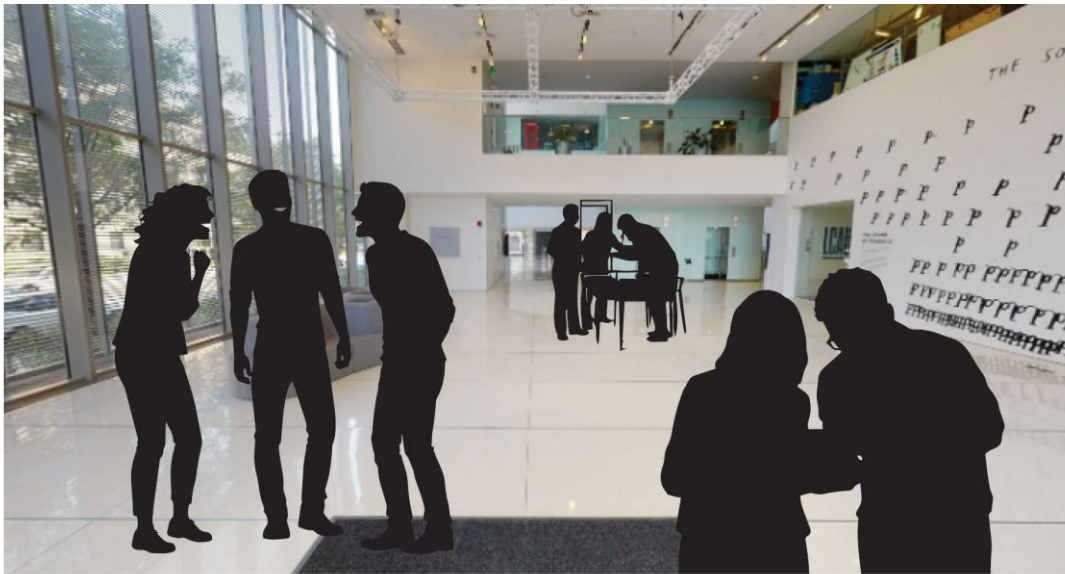
Through Resonant Portals, students learn within an interdisciplinary network connecting an **architectural firm (HKS)** with faculty across **psychology, music, industrial systems engineering, and architecture**.



Students moving from computational simulation to full-scale fabrication, applying research through iterative design and making. Photo Credit: Alaa Algargoosh

Community engagement

The resulting public installation of the Resonant Portals project above extends learning into community engagement, creating an experiential environment through which students, collaborators, and the broader community can encounter and engage with architectural acoustics. Further, Sonic Portal Project engages community members as active participants in documenting, sharing, and experiencing sonic memories, connecting acoustic research with collective experience, memory, and place. Responsive Sound Space Project engages the broader community through a public exhibition of an interactive acoustic environment, inviting people to experience and interact with responsive architecture.



Through Sonic Portal, students learn to engage community members as active participants in documenting, and sharing sonic memories, connecting acoustic inquiry with collective experience. Photo Credit: Lucy Li



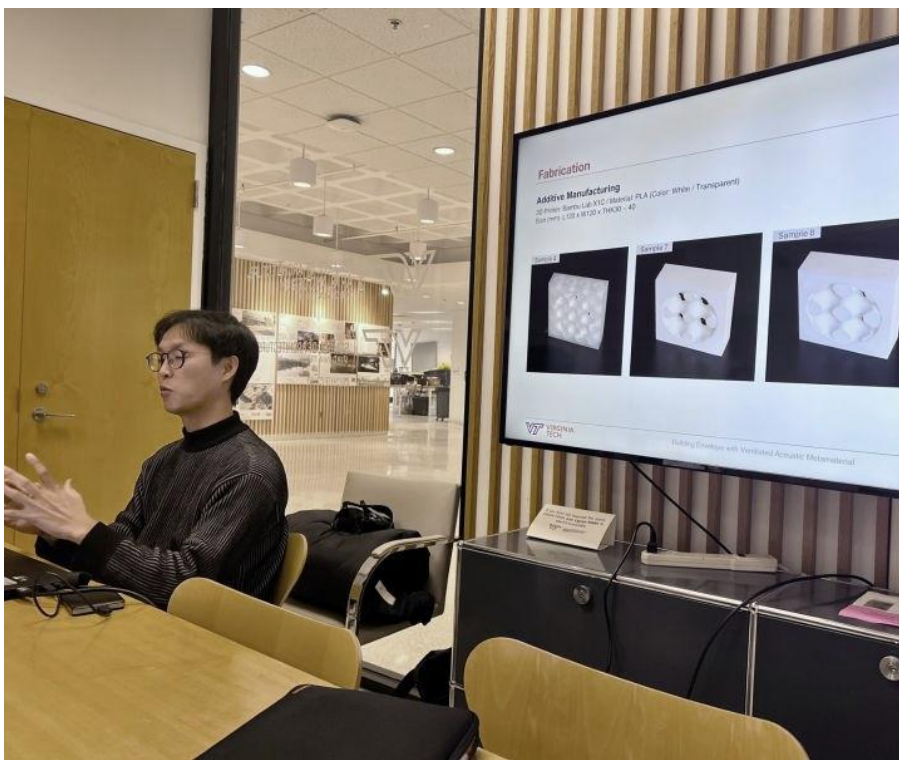
Through the public exhibition of Responsive Sound Space, students learn to communicate interdisciplinary research through an interactive environment and observe how broader audiences experience responsive architecture. Photo Credit: Jun Hyeok Choi

6. LEAD: From Guided Work to Independent Contribution

6 Student Awards | 2 Student-Initiated Grants | 1 Patent Application | 1 Leadership Role

Jun Hyeok Choi's trajectory demonstrates how research mentorship can develop into independent innovation and disciplinary leadership. His work progressed from learning acoustic science, computational design, simulation, digital fabrication, and experimental testing to developing original, architecturally integrated acoustic metamaterial solutions. He applied for and received a Student-Initiated Research Grant to fund a 3D printer for his research, and his work has resulted in research papers currently being prepared for publication, a patent application, and multiple awards mentioned in the teaching impact section. His development now extends beyond his own research through his service as a **Student Council Representative for the Acoustical Society of America**, reflecting his transition from student researcher to an active contributor to the professional acoustics community. **His progression from acquiring knowledge, to creating new knowledge, to contributing to discipline captures the ultimate goal of my mentoring: enabling students to lead their own work and shape what comes next.**

Original Research → Student grant → Publication + Patent → Awards → Leadership Position.



Jun Hyeok Choi presenting his project at Washington Chapter of the Acoustical Society of America where he received the Best Paper Award (right) and at the college (left). Photo Credit: Alaa Algargoosh (left), audience member (right).

Jean Yu and Ally Hong's trajectory demonstrates another path from guided learning to independent initiative. They joined the Sound(e)scape project as summer undergraduate research assistants, where they developed foundational skills in acoustic research, experimentation, and interdisciplinary collaboration. They then independently pursued the opportunity to present their work at InterNoise in

France, where they **were selected for the Flash Talk Challenge for Young Professionals**. Their progression **from first-time undergraduate researchers to presenting their work within an international professional community** demonstrates how students can gain the confidence, ownership, and independence to seek opportunities beyond those initially provided to them.

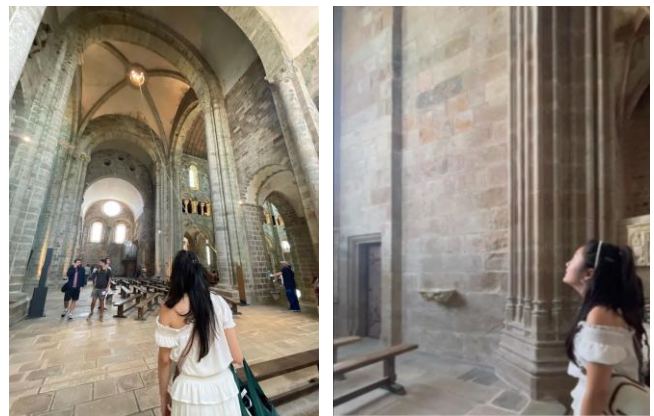


Jean Yu and Ally Hong selected to present Flash Talk Challenge for Young Professionals at InterNoise conference in France. Photo Credit: audience member

TEACHING IMPACT

Students' stories

Students have shared how learning about acoustics extends beyond the classroom, increasing their awareness of sound and encouraging them to explore acoustic phenomena in everyday life. When Ally Hong and Jean Yu traveled to France to present their collaborative research, **they continued exploring acoustics out of personal curiosity**; Ally experimented with singing in a highly reverberant space and listening to how the architecture transformed her voice, an experience that even prompted a nearby tourist to ask her to sing again.



Ally exploring the acoustics of historic buildings when she traveled to France (left) and singing in Mont Sait-Michel Abbey. Photo Credit: Jean Yu

Student Achievements

Student achievements demonstrate progression from guided participation to independent inquiry, external recognition, and professional engagement.

Megan Wysocki secured a Student-Initiated Research Grant and advanced her research to an invited presentation at the International Congress of Acoustics in an ASA–ASHRAE organized session, the Outstanding Master Student, Certificate of Academic Excellence and the Graduate Thesis Award.

Jun Hyeok Choi received a Student-Initiated Research Grant and Outstanding Master of Science Student recognition, with his work progressing to an ASA Chapter Best Paper Award, and a patent application.

At the undergraduate level, Hector Astrom received the MIT Outstanding UROP Award for his work on the Sound(e)scape project, while Jean Yu and Ally Minju were selected for the InterNoise Flash Talk Challenge for Young Professionals in France.

Beyond acoustics-focused research, Serin Siji's SOL+ Campus project won the 2025 U.S. Department of Energy Solar Decathlon Design Challenge, demonstrating the extension of student learning into nationally recognized architectural design and innovation.



Megan Wysocki received the Graduate Thesis Award in 2026 (left) and the Outstanding Graduate Student Award in 2025 (right). Photo Credit: Alaa Algargoosh (left), audience member (right).

Student Evaluation

Below, are course evaluations and student reflections providing additional evidence of the impact of this teaching and mentoring approach. Student feedback demonstrates the effectiveness of my approach across research and design learning. Students highlighted “hands-on learning, group projects,” “highly engaging interactive sessions,” and an “atmosphere that encouraged open discussion.” One student reflected that “experiencing acoustics throughout the room, building and Cube brought tangibility to the invisible aspects of sound,” adding that “hands-on learning experiences like that really fueled my learning in her class.” Others described growth as researchers, noting, “I now have a much better understanding of

research methods and the process of completing a Ph.D.” and [“This research experience has taught me how to apply theories to design parameters.”](#) Together, these reflections demonstrate how experiential, interactive, and research-based teaching supports students in moving from understanding concepts toward applying knowledge and developing independent inquiry.

- Dr. Algargoosh is knowledgeable in the subject matter and I loved how interactive she made the class. The days we had peer reviews were a smart idea, and I appreciated how she allowed us to get feedback on assignments before turning them in for a grade.
- Truly helpful and engaging
- Alaa is a great instructor, she has effectively helped me to develop my ideas for my dissertation research. I now have a much better understanding of research methods and the process of completing a Ph.D.
- Sometimes slides aren't on canvas before the lecture, but that was addressed mid-way through. No real complaints here, Alaa was there for us, very knowledgeable of the course topic, and provided good insight.

- She set the pace of the class so that it was in depth but also very easy to follow.
- Give us examples and practices.
- Research Methods, Proposal Guidelines, Projects, Proposal
- Alaa has great presentations and also gives very helpful feedback on research writing.
- Responding to questions in and out of class. Bringing in more knowledge people to speak on a subject you know less about is also a nice approach.
- The instructor was consistently patient and took the time to explain concepts in multiple ways, which helped students with different learning styles feel included. They were always willing to slow down, revisit material, or provide additional examples when something wasn't clear. They also made themselves available outside of class for questions and support, whether through office hours or email, and were understanding of individual circumstances and needs. This flexible and empathetic approach made it much easier to stay engaged and actually learn the material.

- Hands-on learning, group projects
- Opened the floor for highly engaging interactive sessions.
- Creating an atmosphere that encouraged open discussion
- It was a pretty chill class.
- She provided examples and had guest lecturers. I also really enjoyed the class discussions.
- Class field trips and the interactive and project based learning! Experiencing acoustics throughout the room, building and cube brought tangibility to the invisible aspects of sound!
- Alaa is so knowledgeable on acoustics and her passion for it is contagious! I especially loved when she introduced us to projects and professionals who showed their work related to acoustics and research. I also really enjoyed getting out of the classroom and learning more about acoustics on campus, like when we did the exercise in the stairwell in Burchard and the field trip to the Cube! Hands-on learning experiences like that really fueled my learning in her class.

“Thank you very much for being the best mentor and for the wonderful and unique opportunity to join the Sound(e)scape project. I have had a lot of fun learning and collaborating with the team and especially enjoyed the hands-on demonstrations. Thank you for all your advice and support these past few weeks I admire your great passion for your research and wish you all the best” Jean Yu.

“I am writing to thank you for the past month of the captivating, enlightening and impactful work I was able to be part of. I truly enjoyed the freedom and uncertain environment of research, in large part facilitated by your support and the trust you put in us. Just this past month of research has accelerated my growth as a student and researcher in ways I could've never anticipated and am extremely grateful for.” Hector Astrom.

Teaching & Mentoring Recognition

During my academic career, I received the following teaching & mentoring Recognition: Engaged Pedagogy Fellowship (2018) · Taubman College nominee, Rackham Outstanding Graduate Student Instructor Award (2019) · U-M Graduate Teacher Certificate (2019) · MIT Kaufman Teaching Certificate (2023) · Research Mentoring Certificate (2024) · Virginia Tech student nomination for Advisor of the Month (2025).

BUILDING AN ECOSYSTEM FOR INNOVATION

My teaching extends beyond individual courses. I am building an educational ecosystem in which students can move between coursework, research, interdisciplinary collaboration, professional engagement, and independent inquiry.

At the course level, Acoustic Experiences brings together students from architecture, electrical engineering, and industrial systems engineering to investigate sound through multiple disciplinary perspectives. In the design studio, students apply acoustic research to architectural problems such as theater design and engage with external professional opportunities. Through the Advanced Acoustic Design Lab, students learn through open-ended research, developing skills in experimentation, collaboration, fabrication, and evidence-based design across responsive systems, sustainable materials, and human-centered acoustic environments.



Jun Hyeok Choi (PhD student) mentoring Anika Rachi (a new MS student).

Photo Credit: Alaa Algargoosh

These experiences are reinforced through graduate mentoring, peer-to-peer mentoring, interdisciplinary collaborations, and participation in the development of Virginia Tech's Acoustics Graduate Certificate. Students at different stages share expertise, mentor one another, and collaborate across projects, allowing knowledge to circulate beyond individual courses and faculty-led instruction. Together, these interconnected pathways create multiple entry points for students to progress from initial exploration to independent research, professional engagement, and leadership.

From specialized knowledge to broader design

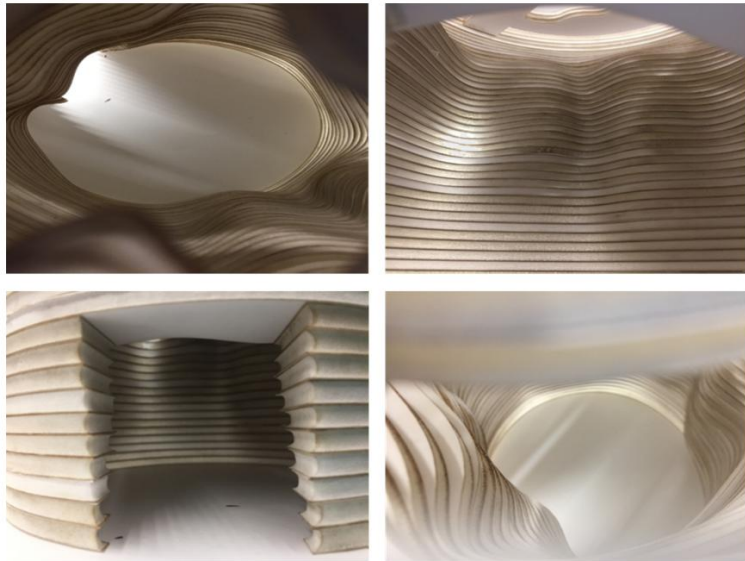
This portfolio focuses on acoustics-related projects to highlight an important yet underrepresented area of architectural education; however, my teaching and mentorship extend beyond acoustics to encompass the broader field of architectural design. Below, I include selected examples of my students' architectural design work.



Course: Environmental Systems

Project: Daylight Design

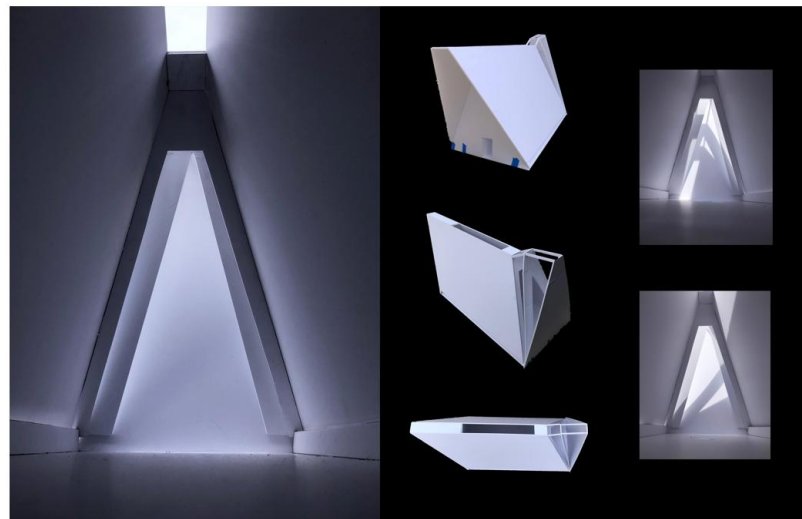
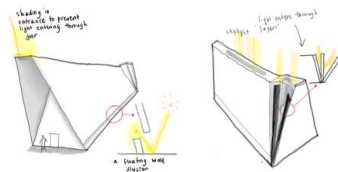
Students: Ingrid Peterson
Johnathan Gilbert



Course: Environmental Systems

Project: Daylight Design

Students: Amanda [Kalbuadi](#)
Grace Hsu
Matt McDonald



Information About Referenced Projects

1. Sound(e)scape: Year Completed: 2024. Role of Nominee: Principal Investigator

Collaborators & Funding Sources/Expenses: Funded by MIT.

Student Compensation: Four undergraduate students participated as paid summer research assistants.

2. Restorative Acoustics: Year Completed: 2026. Role of Nominee: Principal Investigator

Collaborators & Funding Sources/Expenses: Student-Initiated Research Grant

Student Compensation: One graduate student was financially supported as a research assistant for two years.

3. Responsive Sound Space: Year Completed: 2026. Role of Nominee: Co-Principal Investigator

Collaborators & Funding Sources/Expenses: Collaborative project with additional Co-PIs [Sida Dai (PI), Charles Nichols, Meaghan Dee]. Funded by the Virginia Tech College of Architecture, Arts, and Design and the Institute for Creativity, Arts, and Technology (ICAT).

Student Compensation: One graduate student was financially supported as a research assistant for one year.

4. Sonic Portals: Year Completed: 2026. Role of Nominee: Principal Investigator

Collaborators & Funding Sources/Expenses: Collaborative project with additional Co-PIs [Hiroshi Ishii, Xiao Xiao].

Student Compensation: Two graduate students from MIT and the University of Oxford participated in the project. [The MIT student was paid as a graduate assistant during the project one year period and the Oxford student is a research affiliate with MIT]

5. Acoustic Aerogel: Year Completed: 2026. Role of Nominee: Principal Investigator

Collaborators & Funding Sources/Expenses: Collaborative project with additional Co-PIs [Robert Moore, Zhenhua Tian]. Funded by Proof of Concept Grant.

Student Compensation: Four graduate students participated as paid summer research assistants.

6. Resonant Portals: Year Completed: Ongoing; initiated 2026. Role of Nominee: Principal Investigator

Collaborators & Funding Sources/Expenses: Collaborative project with additional Co-PIs [Rosanna Breau, Ramtin Haghnazar, Charles Nichols, Myounghoon Jeon, Tanner Upthegrove], and HKS, Inc. serving as an industry collaborator. Funded by the Institute for Creativity, Arts, and Technology.

Student Compensation: One graduate student is financially supported as a research assistant for the research period, and one student participates for academic course credit (6 credits).