Immersive Psycho-Acoustic Design and Evaluation Workflow (i-PADEW)

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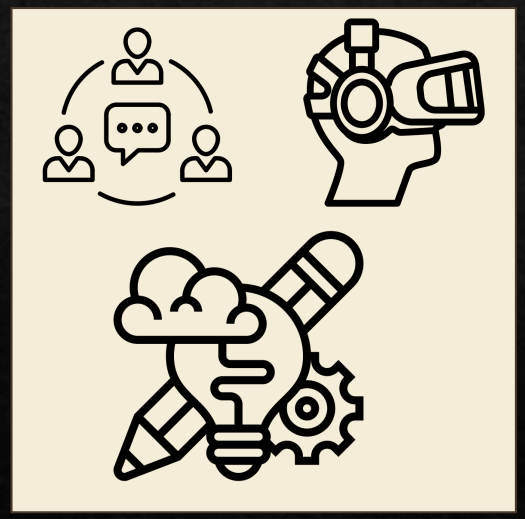
Research Purpose

Current Acoustic Design & Research:

- Building acoustic performance has a great impact on occupants well-being.
- Current architecture acoustic design methods emphasis on numeric report which is difficult to communicate between multiple parties and lack of the integration with user feedback in the early design stage.

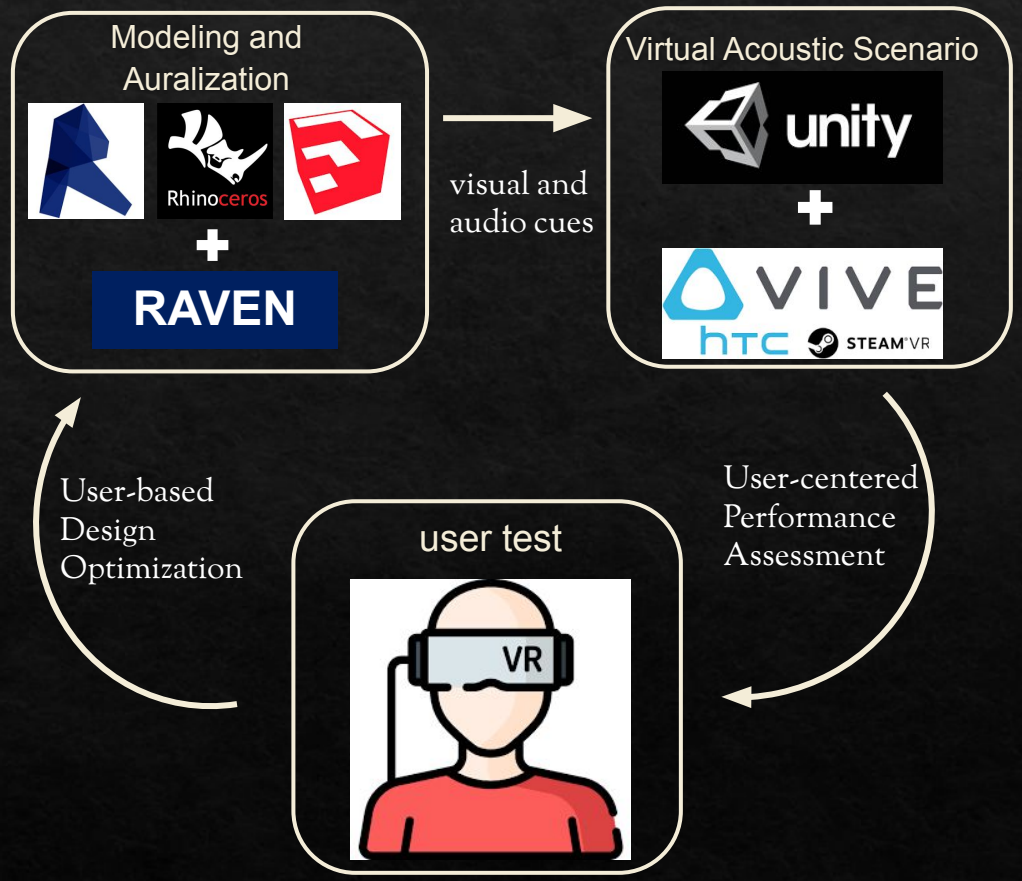


We propose Immersive Psycho-acoustic Design and Evaluation Workflow (i-PADEW) that allows architects, engineers, and clients to:

- test various acoustic design parameters, including:
  - building materials with acoustic properties
  - room sizes
  - room shapes
  - environmental context, such as social or work context
- obtain the instant user feedback
- improve design scheme efficiently and collaboratively

Methodology

- We proposed an Immersive Psycho-acoustic Design and Evaluation Workflow (i-PADEW)
- We conducted a validation test by using classic acoustic simulation method.



Psycho-Acoustic Design and Evaluation Workflow

SABINE EQUATION
EYRING EQUATION

where:

V - Volume (m^3);
A - Total Absorption (m^2);
A_{air} - Air Absorption (m^2);

$$RT = 0.16\ V / A$$

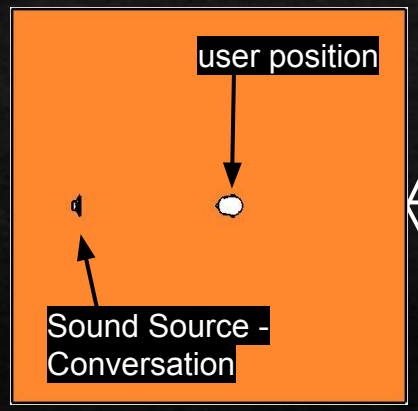
$$RT = 0.16\ V / [A_{air} - S_T \log_n (1 - \alpha_{avg})]$$

RT - Expected Reverberation Time (s);
α_{avg} - Absorption Coefficient (avg. all surfaces);
S_T - Surfaces Total Area (m^2).

Classic Acoustic Simulation Method
Reverberation Time (RT)

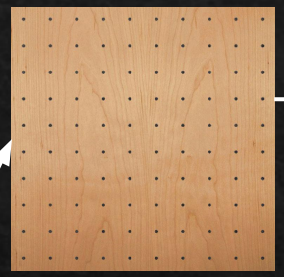
Experiment Design

Auralization

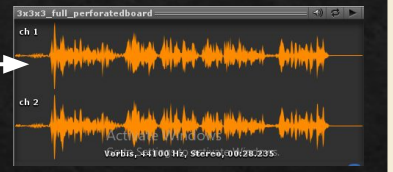


3m x 3m x 3m Single Office

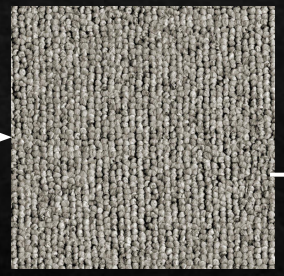
Case 1
Perforated Board



Auralization_Case 1



Case 2 Carpet



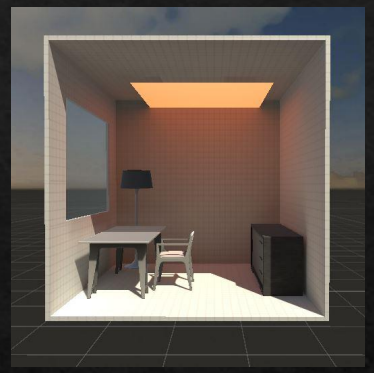
Auralization_Case 2

Case 3 Concrete

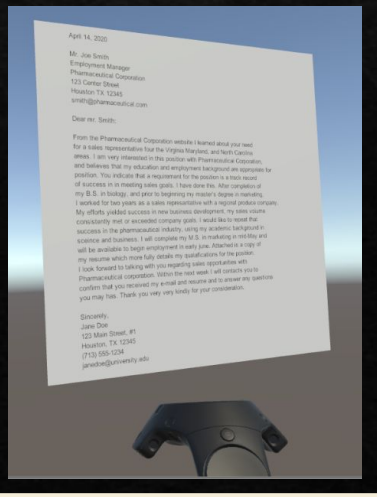
Auralization_Case 3

VR Modeling

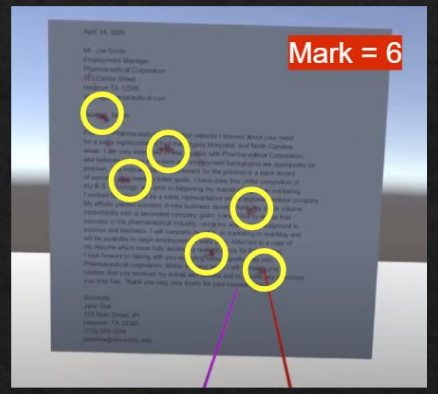
3m x 3m x 3m Single Office

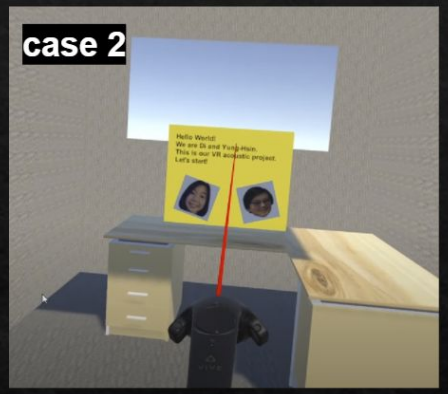


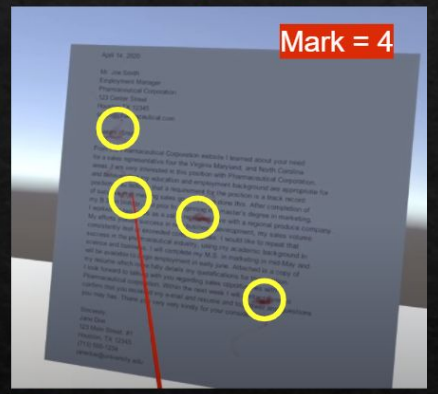
Interactive Scene: Proofreading Task

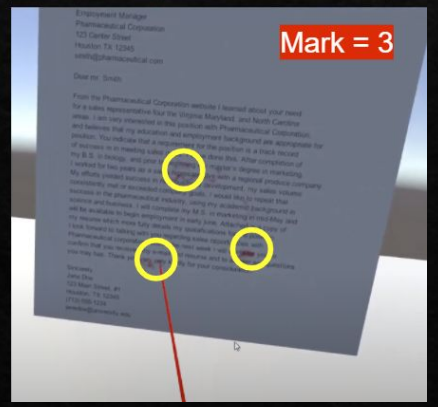


User Test









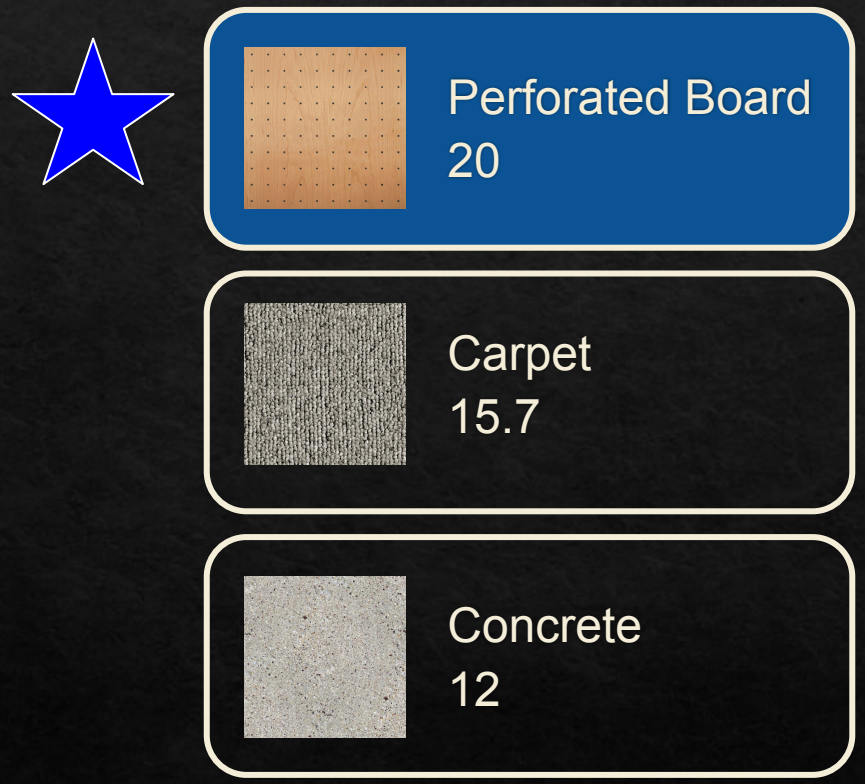
Task accuracy + User survey

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

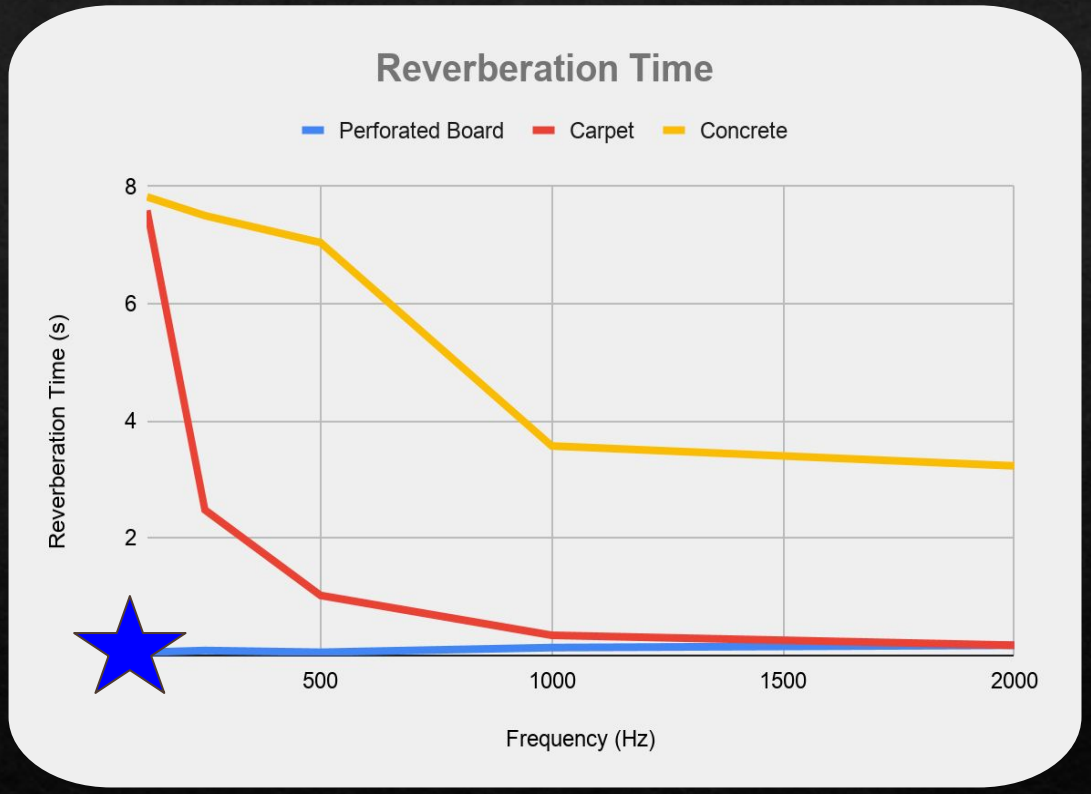
- The virtual space felt realistic.
- The controller was easy to use
- I could focus when performing the task.
- The virtual acoustic environment was comfortable.

Results and Conclusion

i-PADEW is validated by the classical method. The best material is Perforated Board in both methods.



i-PADEW



Classical method

Contribution to Knowledge

- i-PADEW can be implemented in every stage through the whole building life-cycle.
- Encourage human-centered, adaptive, and intelligent design.

Future Works

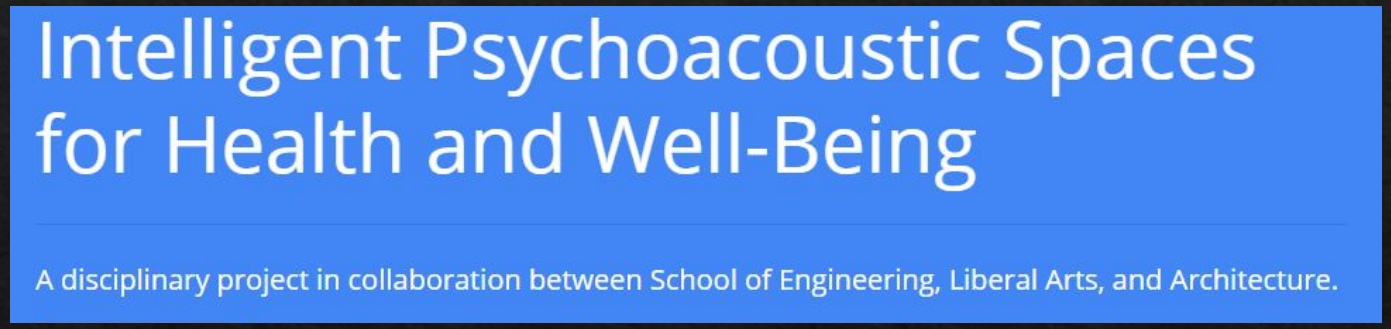
- Human factors:
  - attention, stress, perception
  - Physiological factors
- Other acoustic design parameters:
  - room size, room shape, room layout
  - environment context: social-place, workplace, education, etc..
- User population:
  - Large population size
  - Multiple user groups based on profession: designers, engineers, clients, etc..
- The relation between visual cues and audio cues.

"Enhance the humanity in the age of digital simulation within AEC industry."

Appreciation

TAMU Innovation [X] Project

https://innovation-x-tamu.netlify.app/#ourteam



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Reference

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1.
2.