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An Interactive Soundscape Simulator for Professionals of the Built Environment

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This paper presents an ongoing project aiming to bridge the academia-professional gap between soundscape researchers and Professionals of the Built Environment (PBEs) by providing urban soundscape design training, as well as new immersive tools to help them realize their goals.

Through an extensive literature review and further requirements gathering with PBEs through workshops, conclusions were drawn that an immersive soundscape tool with integrated active learning modules would be an appropriate step towards arming PBEs with both the knowledge and tools to not only help prevent noise pollution and other problems, but to actually make cities sound better.

INTRODUCTION

Noise pollution is a major concern in urban spaces, as it can reduce inhabitants' overall well-being, quality of life, and causes detrimental negative health effects, including "Hearing impairment, hypertension and ischemic heart disease, annoyance, sleep disturbances, and decreased school performance" [1]. These negative results stem, among other factors, from poor sound planning. Sound is usually considered late in the planning processes, often resulting in sound becoming an unwanted presence, e.g., opening a daycare next to a highway. Such situations cause people to act reactively to the negative aspects of sound. However, if sound is proactively planned for, sounds can be used as a resource to help make a city experience more pleasant for people. Through utilizing sound as a resource, professionals can e.g., help promote public space utilization [2], foster social interactions [2], and promote stress recovery by providing a calm environment [3].

Professionals of the Built Environment (PBEs) (e.g., urban planners, designers) tend to think only in terms of sound levels (i.e. decibels), discounting the enormous potential of sound design and planning [4]. Two major contributing factors to this neglect include: 1) a curriculum where sound is barely mentioned. Furthermore, when sound is mentioned, it is only in terms of noise pollution and sound levels; 2) A regulatory framework that also only relies on sound levels. Given this deep-seated and narrow view of sound by both school curriculum and governmental regulatory bodies, it is no surprise that PBEs only think in terms of sound levels, discounting the enormous potential of sound design and planning [4].

Research indicates that PBEs may lack the resources that would allow them to intentionally utilize sound as a resource in the early stages of their designs, rather than just as a nuisance to be mitigated

after the fact [4]. While ample evidence is available in academic literature, e.g. on the complexity of the auditory experience, PBEs perceive academic work as not clearly applicable for their everyday work, despite the high trust they have in academic institutions [4, 5]. The challenge is thus to facilitate knowledge transfer and mobilization between these groups. Additionally, we have undertaken the task of designing of a tool that attempts to help bridge this gap for PBEs.

This paper outlines an ongoing project which aims to better understand the needs of PBEs through a user-centered design process, which will culminate with the completion of a soundscape tool that acts as both a medium for knowledge transfer, as well as a prototype tool to help PBEs experience the acoustic consequences of their design choices. This is done by 1) identifying and justifying the need for an immersive soundscape tool for PBEs, and the challenges of creating such a tool through discussing the concept of ecological validity to ensure reliability; 2) The knowledge gap between academics and professionals is discussed, along with steps to facilitate knowledge transfer between the two parties; 3) Preliminary requirements for a prototype immersive tool are discussed, as gathered through literature review and follow-up workshop; 4) Remaining factors of ecological validity, tool quality, and tool adoption plans are discussed through the conceptual models of A) presence, and B) user engagement.

A NEED FOR IMMERSIVE TOOLS: MOVING BEYOND THE DECIBEL

A soundscape refers to "an acoustic environment as it is perceived or experienced and/or understood by people, in context" [6]. While a soundscape approach is predominantly concerned with how people experience and respond to sounds (see figure 1 for more details), this interpretation of sounds is further affected by other senses, including vision. For example, it has been demonstrated that soundscapes with weaker noise barriers (e.g., smaller in size, which let more sound through) can be perceived as more pleasant than soundscapes with stronger noise barriers, when the noise barrier is more visually appealing (e.g., covered in flowers and foliage vs. a plain wall) [7]. Thus, despite louder sounds being blocked from the stronger barrier, a stronger visual component from a weaker noise barrier can provide an overall better sensory experience for people. As such, a method of capturing a wider sensory experience from people before physical designs are built is crucial during the early design phase. By utilizing this method, a wider range of poor design choices can be identified and rectified early on and help to avoid costly solutions after a poor design has already been implemented.

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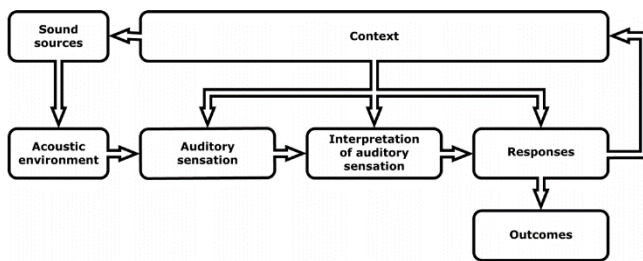


Figure 1: Conceptual framework for soundscapes [6].

This idea of moving away from purely decibel measurements to the inclusion of decibel *and* an integration of the sensory experience is not new [8]. For example, putting a fountain in a park increases the sound level, but typically results in a better sensory experience. However, the question remains as to how realistic a reproduced soundscape needs to be in order to elicit a comparable sensory experience from a person (as a real city soundscape would).

To determine how realistic a simulator must be to elicit comparable sensory experiences to real soundscapes, the concept of ecological validity can be applied [9]. When applied to reproduced soundscapes, this means that in order to trust in any reported sensory experiences that people have with the simulator, it must meet several conditions: 1) the participants must be familiar with the types of urban environments being simulated; 2) the simulator must be able to produce a virtual environment, capable of eliciting sensory experiences based on cognitive representations elaborated over years of experience in urban spaces; and 3) the task that participants are asked to perform in the simulator must be representative of something they may actually perform in such a city space. When these requirements are met, studying a person's sensory experience in a simulator can be used to make inference about their experience in a similar real-world soundscape. If the requirements are not all met, the transferability of the findings may be called into question.

A considerable challenge of creating a 'perfect' soundscape simulator are the technological limitations for requirement 2. As such, we are tasked with finding a 'good enough' solution with the available technological resources we have, to ensure a high level of ecological validity. These must also be cost effective, plausible solutions if they are to be utilized by PBEs.

ATTEMPTS AT CREATING ECOLOGICALLY VALID REPRODUCTIONS

In an early study, it was found that audio reproductions of soundscapes must reproduce spatial features of the environmental to elicit experiences similar to everyday-life situations [10]. As such, a high bar for audio reproduction has been already set vs. simpler alternatives, such as stereo. Yet the demand for a wider sensory experience further complicates matters, as the task of integrating visuals now follows the audio reproductions. To better integrate spatial audio and visuals in an immersive setting, Virtual Reality (VR) has been the focus of many studies, given its ability to give users 'on-demand experiences' in a virtual space [11]. Thus, further studies on using VR for soundscapes have been underway.

Current academic research into using VR for soundscapes has been largely exploratory to date, as a large focus has been placed on answering the question of ecological validity. That is, will a reproduced VR soundscape be representative of an everyday-life soundscape scenario? If it is not, then any conclusions drawn from the VR soundscape experiences will not be transferable to everyday-life soundscapes, and thus, will not be of use. With this question in

mind, different methods have been utilized to compare reproduced and everyday-life soundscapes to validate VR as an appropriate tool for soundscape research in a laboratory setting. Several studies are discussed below to give an indication of the current stage of research, as well as an indication of the challenges being worked on.

A common method of research into ecological validity has been to give participants identical tasks in both VR simulations vs. in-situ (everyday-life), and to compare the results. If the results are not significantly different between the two conditions, the VR simulation can be determined to be ecologically valid for the given task (assuming that a representative population is also used). To give several examples, A) It has been shown that a VR simulation is capable of producing similar negative side effects of a noisy soundscape, such as decreased cognitive functions [12]; B) A VR reproduction of an existing soundscape can produce the same pleasantness ratings as an everyday-life soundscape [13]; C) A VR production can also receive congruent responses when measuring global environmental quality, acoustic and visual coherence, and familiarity with the environments [14].

While the aforementioned studies focus on *can* user responses between the two be valid, other studies narrow in on choosing appropriate hardware for the task. For example, D) when tasked with giving general appraisals of a soundscape, as recorded by a 360° video, it was determined that there was no significant difference when viewing from a high-end Head-Mounted Devices (HMD), low-fidelity smartphone-based HMDs, or even 2D monitors [15]; E) When exploring possibilities of using Augmented Reality (AR), hear-through headphones users reported that the virtual sound sources sounded natural to its users; F) In an attempt to mobilize some of this knowledge, a review of good spatial audio practices has been written, along with further studies on audio device selection (not limited to VR usages). i.e., A comparison was performed between in-situ vs VR First Order Ambisonics (FOA) (Static Binaural) vs. VR FOA-head-tracked binaural vs. VR FOA 2D octagonal array of speakers. The results indicated that there was no difference in sound-source dominance or affective soundscape qualities, although a difference in perceived spatial qualities was found. FOA with head-tracked binaural is indicated to be sufficient for evaluation of VR soundscapes, however, the speaker array was indicated to be more immersive than headphone methods [16].

Finally, G) presents a study that examines how people can overcome technological limitations. Generic Head-Related Transfer Functions (HRTF) are inherently limited when producing binaural audio, as they will not match the user, resulting in imperfect spatialization. However, it has been demonstrated that sound source localization can be improved through multisensory exposure training, which was not found when training via audio alone. Thus, exposure training can help overcome imperfect technologies when paired with other sensory cues.

To summarize, each study provides valuable knowledge on producing and evaluating ecological validity of reproduced soundscapes in VR and other immersive technologies. However, while further studies are still required to fully understand the capabilities and limitations of reproduced soundscapes in VR, it must be understood that these tools have still been created by researchers, for research-oriented questions. These studies help determine how VR may (or may not) be utilized but have not yet been extended to meet the needs of PBEs. Rather, this field of research is still predominantly in the exploratory side and has yet to gain full steam in the applied side of helping make our cities sound better.

A LACK OF URBAN SOUND DESIGN TRAINING FOR PBEs

While further issues regarding ecological validity for multisensory tools must still be addressed, the second issue regarding training PBEs can be addressed in parallel. As identified, there currently exists a limited sound curriculum which does not go beyond noise pollution and sound levels [4]. Thus, simply creating a multisensory tool is insufficient to rectify this problem, as PBEs are currently untrained in the fundamental design techniques for soundscapes in general. As such, a knowledge transfer outreach program to PBEs must bring them into the conversation of creating better sounding cities so that both parties may contribute to the development of appropriate tools that can be utilized in accomplishing this arduous task of making our cities sound better.

A NEED FOR NON-TRADITIONAL KNOWLEDGE TRANSFER

PBEs tend to trust academic literature. Unfortunately, academic literature is not typically written with professionals as an intended audience. PBEs value short and solid recommendations (in part due to their busy workloads) [4], yet academics tend to be very reserved in making solid recommendations based off their findings. As such, it is understandable that a different manner of knowledge transfer is required. PBEs desire direct interaction with experts [4], as it allows faster dissemination of knowledge to address their current needs, without having to search through extensive literature.

WORKSHOPS FOR KNOWLEDGE MOBILIZATION

Workshops have been identified as a preferred method of knowledge transfer between academics and PBEs, as it facilitates interactions between PBEs and soundscape experts in small group settings [4, 5]. Our Sounds in the City team has organized four knowledge mobilization workshops with local (Montreal) and international PBEs in the last three years (e.g., [5]) to encourage sound awareness among PBEs as well as offer practical “translated” evidence that PBEs could use to integrate sound in their projects. These utilized different methods, including site visits with soundwalks, academic presentations, laboratory presentations, and collaborative design exercises. These workshops help train future leaders of soundscape-aware practitioners through close interaction with academics. While these workshops will continue, it is also realized that such workshops are labor and time-intensive and only reach a limited audience of professionals. Unfortunately, there are far more professionals than soundscape academics for regular and timely interactions. As such, other strategies for a less personal, but more scalable approach is suggested to reach a larger audience (below). Through this combined approach of small and personal workshops + less personal but scalable options, we aim towards a tangible shift in city-wide conversations on sound and design.

To complement these workshops, a short curriculum of foundational material in urban soundscape design is currently being developed in parallel by our team and will be first delivered through further in-person training workshops. Through learning to utilize sound as a resource, professionals can e.g., help promote public space utilization [2], foster social interactions [2], and promote stress recovery by providing a calm environment [3]. Example topics include an introduction to the different aspects of soundscapes (figure 1), including different techniques to utilize sound resources, such as sound masking, e.g., using a sound source such as a fountain or a speaker to mask the sound of traffic or HVAC systems. After validating our curriculum material, subsets of these lessons will be delivered through integrated learning modules in the widely distributed VR software/tool, to reach more professionals.

DESIGNING AN IMMERSIVE TOOL

The ability to utilize a controlled environment through the use of an immersive tool is beneficial for both researchers and PBEs, as it allows for fast prototyping and testing away from on-site locations throughout the design process. Furthermore, people are at the mercy of the existing context of a soundscape when on location. Such contexts may include the time of day/week/year, inclement weather, local events, pandemics, etc. Thus, being able to control for external factors, manipulate the soundscape to simulate interventions, and switch back and forth between multiple options can be a great boon to either researchers or PBEs. Yet, the needs of PBEs differ greatly from the needs of researchers. While researchers currently place high importance on ecological validity, PBEs need flexibility to be creative and interact with and manipulate different soundscapes (in an ecologically valid manner).

UTILIZING A USER-CENTERED DESIGN PROCESS FOR PBEs

A user-centered design process is being utilized to gain an insight regarding the needs of PBEs throughout the development process. Initial user requirements gathering took the form of a literature review, and was complemented by further confirmatory qualitative requirements through our workshops. This is followed by the development of the immersive tool (in progress), which will include usability testing at different development intervals to gain further feedback from PBEs and keep bidirectional lines of communication open during the development process.

The initial literature review has identified the aforementioned state of existing VR soundscape tools, the importance of ecological validity, as well as the preferred training methods for PBEs. Having completed this review, a workshop was held in July 2019 to introduce PBEs to different immersive technologies to further gauge their experience, interest levels, and wanted features. We provide a short explanation of the two different methods for interacting with reproduced soundscapes followed by a summary of this workshop.

METHODS FOR INTERACTING WITH REPRODUCED SOUNDSCAPES

Soundscape reproductions can take either of two forms: First, ‘As-is’ reproductions, which directly record soundscapes and play them back (through microphone and sometimes video camera); Second are simulators which are built digitally from the ground up using multiple sound sources and objects in a virtual space (as typically built using video game physics engines). Both methods provide advantages and disadvantages over the other.

As-is reproductions are often placed into archives and treated as snapshots of a particular time and space. Due to the static nature of audio and video recordings, users cannot interact with these reproductions directly beyond experiencing them as originally recorded. However, each of these recordings can be accompanied by metadata that describes the soundscape. Furthermore, by switching between the different reproductions, the user can learn to appreciate the differences in each design through comparison. Several such projects exist already.

The Urban Soundscapes of the World project [17] featured different recording sites that were selected systematically based on perceptual criteria, as experienced by local experts, and recorded with binaural, first-order Ambisonics, and 360° video recordings. Similarly, the I Hear NY3D project [18] captured 3D soundscapes in New York City via first-order Ambisonics recordings of locations in Manhattan, with a goal of offering an interactive interface to experience these soundscapes on either a multichannel or binaural system. Such archives serve as good examples of what soundscapes can be, and may serve for raising soundscape design awareness and inspire creativity. However, as-is reproductions remain limited in that one

cannot engage in active design with them. As such, they are of limited value to PBEs at design time.

Simulators, on the other hand, distinguish themselves from as-is recorded reproductions by allowing its creator to directly manipulate any aspect of a virtual environment, thereby giving its creator a greater level of control at design time. While the visual renderings will not be as good as the as-is reproductions, this added malleability is a crucial element for any PBE at design time. While simple simulators can be presented in the same manner as as-is recorded reproductions, the true value of a simulator will come from giving its users a degree of interactivity with the soundscape. Various simulators have been produced, focusing on different aspects (e.g., [19-21]) although none to date have been fully interactable with immersive spatial visuals in VR. As such, there is still much room for growth in creating an immersive multisensory tool for both PBEs and researchers, which has been identified by researchers as being a primary concern for advancement of the field [22, 23].

Both of these methods have been utilized in our July 2019 workshop to draw feedback from PBEs.

SUMMARY OF JULY 2019 WORKSHOP¹

To help validate our findings and seek further input from PBEs, the Sounds in the City team held a workshop with approximately 25 PBEs to showcase different immersive technologies, demonstrate different methods of interacting with soundscapes, and allow for interaction with soundscape experts. During so, three sessions were repeated with three different groups: 1) an 'immersive playground', to give experience with different immersive technologies to PBEs and gauge interest levels; 2) a participatory design session using a built in-house audio-only simulator; and 3) focus groups to confirm initial requirements gathering and seek further feedback.

During the immersive playground session, PBEs were given the opportunity to experiment with VR soundscape renderings and 360° videos of soundscapes on a variety of devices (e.g., HTC Vive Pro, Oculus Go, smartphone HMDs, and various laptop simulations. PBEs were generally interested in how these could be used for design in earlier stages of the process and had a high desire to interact with the virtual environment. Those who had prior work-related experience with these had only used them before when showing off final designs to clients, and did not allow for further interaction with rendering beyond simple observation.

In session two, our in-house audio-only soundscape simulator was utilized for a participatory design of different soundscapes over a loudspeaker system with Ambisonics. To assist in sound planning, a 2D map display was utilized to display where sounds were located in the 3D space [24]. Different soundscapes were created by attendees, with the goals of A) introducing notions of spatial audio; B) illustrating principles of sound design and planning; and C) eliciting participants to take an active role in soundscape design. The participating PBEs reported a high level of interest and engagement with the activity, especially as it allowed multiple people to listen and discuss together; as well as reported a high level of realism from the tool, even without any immersive visuals.

The third session consisted of focus groups that facilitated discussion of how these immersive technologies could be utilized in their everyday work. PBEs saw potential usefulness of such tools and provided feedback on some features that they may find useful if they were to utilize the technologies, themselves. That said, they also expressed concerns on whether they could operate them on their

own and sought further guidance on this – both in how to use the technology itself, as well as how to utilize it for soundscape design. These concerns have been a recurring theme throughout past workshops and presents a challenge moving forward. Fortunately, this also validated the current direction of the project and signals that we are on the correct path. Through utilizing a user-centered design process, we will keep communication lines open between both researchers and professionals to help bridge this gap during development.

USABILITY REQUIREMENTS FOR A SIMULATOR FOR PBEs

Through these previous works, a preliminary list of features has been identified for implementation.

1) Manipulate sound sources

The most basic requirement of an interactive soundscape tool is that it allows the user to add, remove, and move sounds around in a realistic 3D space. As such, it must be created from the ground up as a functioning simulator.

2) Visualize sounds

Visual representations of the sound sources must also be present in order to give its users a tangible object to manipulate, as PBEs have a preference for working with visual material [4].

3) Provide a full sensory experience

Despite the focus on sound design, the full auditory experience cannot be isolated from our other senses, such as vision [6, 7]. As such, a representation of the visual surroundings helps make informed design choices. This also helps avoid any auditory-visual disconnects which may pull the user away from the experience. For example, if a car is heard driving by, the user should also be able to see the car.

4) Manipulate time

The user should be able to experience the designed soundscape at different periods of time to experience how a soundscape will change at predictable intervals, with a single design. e.g., traffic changing during peak hours vs. night, children's laughter at parks during the day, and pubs being loud at night, but quiet during the day. This feature is in high demand and not available through existing soundscape simulators.

5) Impart knowledge

A training module must be incorporated into the software to simultaneously train users in both the fundamental techniques of soundscape design, as well as in how to use the software, itself.

6) Integrate existing models

While both training and experimentation with soundscape design can occur in any 3D rendered environment, PBEs must eventually be able to import their own models into the simulator to actively design their own projects.

7) Ecological Validity

The above must be implemented in a way that remains ecologically valid so that participants process the simulated soundscapes using cognitive processes elaborated in everyday situations. In addition, instructions can be given to orient their listening strategy and contextualize their experience.

Through implementing these above steps, we hope to help provide both training in fundamental soundscape design techniques to a larger audience than workshops currently allow, as well as provide

¹ This article provides a short report of the workshop activities. Further results and methodology are forthcoming.

PBEs with a tool which they can utilize for proactive sound planning of urban spaces.

EXPLORING REMAINING FACTORS WITH CONCEPTUAL MODELS

While we expect the above steps to produce an effective first prototype, there are two further factors that are worth exploring to help ensure the quality of the final tool. First is the concept of presence [25], which is hypothesized to play a role in maintaining ecological validity over extended periods of time. Second utilizes the user engagement model to both help check quality during development, as well as lay groundwork for future adoption.

INVESTIGATING FURTHER ECOLOGICAL VALIDITY THROUGH PRESENCE

Presence is “the strong illusion of being in a place in spite of the sure knowledge that you are not there” [25]. This concept is relevant to any VR environment, as it provides a simple estimate of how believable the virtual environment is. However, this concept has been underutilized by soundscape researchers, and may play an important role in both future soundscape research, as well as in producing an immersive tool for PBEs.

Presence itself is facilitated by both A) immersion – the technological ability to produce audio, visual, and tactile content which can then be perceived by the user to experience the illusion, and B) plausibility – “the illusion that what is apparently happening is really happening (even though you know for sure that it is not)” [25], e.g., tree branches that do not move in the wind, or people not reacting to events around them.

To date, soundscape researchers have placed a large focus on the second point of ecological validity, but not the third. When translating these points to the presence model, one can say that researchers have placed a large focus on identifying and validating perceptual adequacies as facilitated by *immersion*. However, little work has been placed on producing tasks that are more representative of activities that participants may actually perform in a city space. This third point of ecological validity is expected to rely heavily on maintaining *plausibility* during the activity.

That said, creating a realistic simulation of, for example, a shopping experience during a festival, requires more interaction with the virtual environment than a simple observe and rate a soundscape task. As such, an opportunity to break plausibility may not have been given opportunity to rise in past experiments and may signal future problems if not addressed. For example, it has been shown that short breaks in immersion (e.g., a visual or audio glitch) are quickly recovered from. However, breaks in plausibility will break the sense of presence, and are more difficult for the user to recover from [26]. This break in presence could be detrimental for the tool for various reasons, including potentially influencing soundscape ratings; such conditions have never been tested for necessity, as of yet. At the very least, this can break the user’s flow and cognitively remove them from the soundscape, causing interruptions in one’s workflow. More positively, however, when presence is maintained, this sense of presence is expected to feed directly into positive user engagement.

PLANNING FOR CHANGE, BEGINNING WITH USER ENGAGEMENT

An essential fact of product development is that just because a tool is usable (and/or ecologically valid), it does not mean it will be adopted into regular usage. Many factors can affect adoption, such as the product not being designed with the user in mind [27, 28], the product being unappealing or not engaging to use [29], a lack of diffusion of the product to the world due to missing communication channels and social support systems [30], as well as a lack of

institutional support to facilitate the resources required for these changes and maintenance [31].

While this project acknowledges the importance of these many different factors and stages, the emphasis of this current research project stands at the initial steps of this long process by encouraging widespread knowledge transfer and facilitating the next steps towards applying that knowledge in one’s own professional lives. Since there are currently no strong external factors yet leading this change in sound design practices around the world (e.g., strong government regulations), we look to the intrinsically motivated factors of individuals to help encourage this change in sound planning practices; it will take everyone working together to meet the challenge of making our cities sound better.

As such, the user engagement model [29, 32] (figure 2) has been selected to accompany the development process and serve as a guiding principle. Formally, “User engagement (UE) is a quality of user experience characterized by the depth of an actor’s cognitive, temporal, affective and behavioural investment when interacting with a digital system” [33]. More generally, user engagement is utilized to evaluate a user’s intrinsic motivation to use and potentially adopt a product into regular usage. This model is useful as it is accompanied by a validated set of scales that can be utilized during usability testing [33].

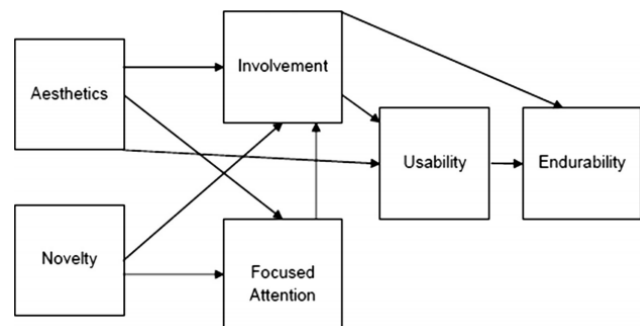


Figure 2 : Model of User Engagement [32]

As the soundscape method is still rarely utilized for urban planning, we have not yet approached the point where we can comparatively examine different techniques to create better sounding urban soundscapes effectively. Rather, until a higher level of sound-related discourse is regularly brought to the planning table, our goal is to simply promote pleasurable, extended interactions with foundational soundscape design to facilitate this professional growth. Once PBEs become more experienced in planning the auditory aspect of cities, we expect to receive further feedback and learn from them what our next steps may be through stronger bidirectional knowledge sharing between academics and professionals.

SUMMARY: A SCALABLE LEARNING EXPERIENCE AND TOOL

From the outset of this paper, a claim was made that in order to help reduce noise pollution and make better sounding cities, PBEs need both foundational training in urban soundscape design methods, as well as better tools to help them do so. Through a literature review of existing tools and what they are capable of, they were deemed insufficient for the needs of PBEs, as they were not created with their needs in mind. Further requirement gathering was performed through a workshop with PBEs to better determine what they want the tools to do and to confirm that we were on the correct track. Herein we provided seven strong initial requirements for what an immersive

soundscape simulator must provide, as well as discussed the two conceptual frameworks of presence and user engagement to help fill in further gaps.

As there are so few regulations that require PBEs to utilize non-decibel related sound planning methods, our goal is to facilitate an engaging learning experience that encourages usage over sustainable periods of time. With this, we hope to raise the overall level of discourse regarding sound at the planning table and move forward towards adoption of new standards for how cities should sound. As such, development as part of a user-centered design process is crucial, and we encourage anyone interested to contact us and let your voice be heard.

ONGOING WORK

This project is ongoing, with development underway on the first prototype of the interactive simulator. Running in parallel to this is the development of the curriculum in fundamental soundscape design techniques, which will feed into the training module of the interactive simulator. Finally, once an adequate prototype is functional, several experiments are planned to answer some of the outstanding questions, including how much immersion and context is required for design tasks, as well as the effects of plausibility on both usability and user engagement.

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