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## Schedule for Tuesday, August 18



All Times are PDT = Pacific Time, West Coast USA

Time	Room	Plenary Session 2
9:00 - 9:10	AVAR Keynotes	Opening Remarks, AVAR Conference Organizing Committee
9:10 - 9:30	AVAR Keynotes	Introductions and Comments: VALVE Audio Team
9:30 - 11:00	AVAR Panels	Panel Discussion: <i>When Worlds Collide: Audio Development of the Valve Index and Half-Life: Alyx</i>
11:00 - 11:30	AVAR Lobby	Coffee Break
Time	Room	Parallel Sessions
11:30 - 1:30	AVAR Papers	Paper Session 3: Spatial sound Reproduction and HRTF's II
11:30 - 1:30	AVAR Workshops	Workshop Session 3: Immersive Music
1:30 - 2:00	AVAR Lobby	Coffee Break
2:00 - 3:30	AVAR Papers	Paper Session 4: XR Audio Capturing, Modeling, and Perception
2:00 - 4:00	AVAR Workshops	Workshop Session 4: Immersive Mixing and Production
4:00 - 5:00	AVAR Lobby	Open Chat

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**9:00 - 9:15 Opening Remarks, AVAR Conference Organizing Committee**

**9:15 - 9:45 Introductions and Comments, VALVE Audio Team**

**9:45 - 11:00 Panel Discussion:**

### *When Worlds Collide: Audio Development of the Valve Index and Half-Life: Alyx*

One year after its release, the team behind VALVE's Index virtual reality headset and Half-Life: Alyx, a showcase VR launch title for the Index, will discuss their unique approach to assembling a plane while in flight balancing technical and creative, research and production domains into compelling audio solutions to create the experiences that launched a new VR platform. The team will discuss some of the challenges they overcame in simultaneously developing state of the art hardware, software, and experiences that were immersive, dynamic, and emotionally resonant, as well as what they had to learn (and unlearn) during the development process.

#### **Panel Members:**

- **Emily Ridgway, VALVE**
- **Scott Seflon, moderator Facebook Reality Labs**
- **Robin Walker, VALVE**
- **Joy Lyons, Harman International**
- **David Feise, VALVE**
- **Anish Chandak, VALVE**

#### **About the Panelists:**

##### **Emily Ridgway, Audio Director, VALVE**



Emily Ridgway currently works at Valve Software as an interactive audio specialist, writer and hardware designer. Before joining Valve Emily was best known for her work as Audio Director and sound designer on award winning video game titles such as Bioshock, Brutal Legend and Destroy All Humans to name a few. Since joining Valve 8 years ago, Emily has championed immersive audio across VR in both hardware and software domains. She is the driving force behind the Valve Index Off-Ear Speakerphone design, the acquisition of Steam Audio, as well as much of the sound design in The Lab VR and Counter-Strike: Global Offensive. Most recently Emily contributed as a writer and sound designer on Valve's flagship virtual reality game, Half-Life: Alyx, released on March 23, 2020. She enjoys windsurfing on hydrofoils and listening to synthwave in her spare time.

## About the Panelists:

### **Scott Selfon (Moderator), Audio Experiences Lead, Facebook Reality Labs**



Scott Selfon is the Audio Experiences Lead at Facebook Reality Labs (formerly Oculus Research), exploring and inventing the technical, creative, and design languages of sound for virtual and augmented reality. Prior to that, he was engaged in developer consultancy, education, and support efforts across three generations of the Xbox game console and broader Windows audio efforts at Microsoft. Scott has composed music for a wide range of media, including film, television, games and live performance, and is a violist with the Puget Sound Symphony in Seattle. A member of the Game Audio Network Guild (G.A.N.G.) advisory board, Scott has been a faculty member of both the Pacific Northwest Film Scoring Program and the University of Southern California, has coordinated and lectured at the Game Developers Conference Audio Boot Camp tutorial sessions for more than fifteen years, and has spoken at the conferences worldwide on audio, interactive entertainment, and real-time sound implementation techniques and technologies. Scott is an alumnus of the University of Southern California, where he obtained dual degrees in music composition (film scoring emphasis) and computer engineering/computer science.

### **Joy Lyons, Senior Director of Audio Technology, Harman International**



Joy Lyons is an applied scientist who specializes in bringing research out of the lab and into the hands of consumers through innovative, category defining products. In her current role, she is a Senior Director of Audio Technology at Harman International in the corporate research division, Harman X, focused on intelligent and immersive audio. Prior to this she worked at Valve corporation on the Index VR headset, at OSSIC on 3D audio technology, and at Logitech/Ultimate Ears on acoustical systems and product development. She has degrees in Physics (BS) and Music (BA) from the University of Washington (Seattle), and Physical Acoustics (MS) from the Pennsylvania State University and combines the theory with practical application and industry experience.

### **Robin Walker, Game Designer and Developer, VALVE**



Robin Walker is a game designer and programmer at Valve who began his career working on Team Fortress as a mod for id Software's QuakeWorld in 1996. The success of Team Fortress lead Robin and his team to be hired by the then-small Valve to work on Team Fortress Classic and later on Team Fortress 2. Since then, Robin has worked broadly in development roles across multiple Valve games, including Half-Life 2 and Dota 2. During this time, Robin has become a respected voice on the intersection of economics and game design, largely due to the success of transforming Team Fortress 2 from a Triple A retail product into a free-to-play, customer service based game as well as his work on Dota 2. Most recently, Robin worked as a programmer on Valve's flagship virtual reality game, Half-Life: Alyx, released on March 23, 2020.

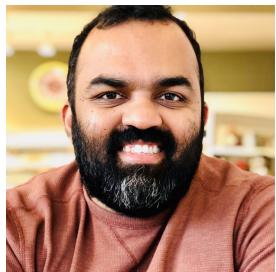
## About the Panelists:

### **David Feise, Sound Designer, VALVE**



Dave Feise works as a Sound Designer at Valve focusing specifically on sound effect creation as well as in-game audio systems, audio tools, and scripting. Prior to his work on Half-Life: Alyx, Dave worked on other Valve titles including The Lab, Portal 2, and Left 4 Dead 2. Dave was previously a Sound Designer at Electronic Arts where he created sounds for several games, most notably Dead Space. He has a BA in audio production from Expression College in Emeryville, California.

### **Anish Chandak, Software Engineer, VALVE**



Anish is a software engineer at Valve. He is one of the main developers of Steam Audio and has worked on integrating spatial audio technologies in Counter-Strike: Global Offensive and Half-Life: Alyx. Before joining Valve, Anish was the co-founder and CEO of a VR audio tech startup Impulsonic. He did his undergraduate in Computer Science from IIT Bombay in 2006 and received his Ph.D. from UNC Chapel Hill in 2011.

Room: AVAR Papers

Session Chair: Peter Jax

**11:30 - 11:55    Tuesday, August 18****AUTHORS: Zamir Ben-Hur, David Alon, Ravish Mehra and Boaz Rafaely****TITLE: Binaural Reproduction using Bilateral Ambisonics**

Binaural reproduction plays an important role in virtual and augmented reality applications. The rendering of binaural signals using Spherical-Harmonics (SH) representation gives the flexibility to control the reproduced binaural signals, by using algorithms that operate directly in the SH domain. However, in most practical cases, the binaural reproduction is order-limited, which introduces truncation error that has a detrimental effect on the perception of the reproduced signals. A recent study showed that pre-processing of the Head-Related Transfer Function (HRTF) by ear-alignment reduces its effective SH order. In this paper, a method to incorporate the pre-processed HRTF into the binaural reproduction process using binaural representation of the sound-field is presented, and shows a significant reduction in errors caused by the limited-order reproduction.

**12:00 - 12:25    Tuesday, August 18****AUTHORS: Moti Lugasi and Boaz Rafaely****TITLE: Enhancement of Ambisonics Signals using time-frequency masking**

Spatial audio is an essential part of virtual reality. Unlike synthesized signals, spatial audio captured in the real world may suffer from background noise which deteriorates the quality of the signals. The aim of this work is to investigate the impact of applying time-frequency masking on spatial signals to attenuate undesired components, while preserving the desired components with minimum distortion. Two masks were investigated: one in the spherical harmonics (SH) domain, and the other in the spatial domain. Subjective analysis was conducted to estimate the performance of these methods, and showed that the spatial mask preserves the desired sound field better, while the SH mask preserves the spatial cues of the residual noise better.

**12:30 - 12:55    Tuesday, August 18****AUTHORS: Maximilian Kentgens and Peter Jax****TITLE: Translation of a Higher-Order Ambisonics Sound Scene by Space Warping**

We propose a novel approach for sound field translation of higher-order Ambisonics with applications in spatial audio and virtual reality. Our proposition is based on space warping allowing to change the origin of a sound field representation even for displacements beyond the sweet spot. The basic idea is to squeeze and stretch the angular source distribution according to a geometric model with known source distance. We propose to resign from correct phase reconstruction in favor of optimizing towards psychoacoustically motivated performance indicators. Furthermore, we show how an existing sound field method can be related to the empiric mathematical framework of space warping. In an experiment with different translation techniques, our approach achieves superior performance in terms of different instrumental metrics.

**1:00 - 1:25    Tuesday, August 18**

**AUTHORS:** **Christoph Porschmann, Johannes Mathias Arend, David Bau and Tim Lubeck**

**TITLE:** **Comparison of Spherical Harmonics and Nearest-Neighbor based Interpolation of Head-Related Transfer Functions**

Spatial upsampling of head-related transfer functions (HRTFs) measured on a sparse grid is an important issue, particularly relevant when capturing individual datasets. While early studies mostly used nearest-neighbor approaches, ongoing research focuses on interpolation in the spherical harmonics (SH) domain. The interpolation can either be performed on the complex spectrum or separately on magnitude and unwrapped phase. Furthermore, preprocessing methods can be applied to reduce the spatial complexity of the HRTF dataset before interpolation. We compare different methods for the interpolation of HRTFs and show that SH and nearest-neighbor based approaches perform comparably. While generally a separate interpolation of magnitude and unwrapped phase outperforms an interpolation of the complex spectra, this can be compensated by appropriate preprocessing methods.

Room: AVAR Papers

Session Chair: Pablo F. Hoffmann

**2:00 - 2:25    Tuesday, August 18****AUTHORS: Amit Barde, Matt Ward, Robert Lindeman and Mark Billinghurst****TITLE: The Use of Spatialised Auditory and Visual Cues for Target Acquisition in a Search Task**

Spatialised auditory and visual cues were delivered via a wearable interface Google Glass and a Bone Conduction Headset to aid a search task. The aim of the study was determine which of the cues auditory, visual or a combination of the two would lead a user to a target in the shortest time with a minimal demand on the users attention. The results demonstrate that the static visual cue performed the best. The static auditory cue displayed a good level of usability and intuitiveness, especially when no visual cue was provided alongside. Our findings demonstrate that there is significant value in providing auditory or visual cues to aid a search task without inhibiting the environmental awareness.

**2:30 - 2:55    Tuesday, August 18****AUTHORS: Brent Cowan, Bill Kapralos and Karen Collins****TITLE: Realistic Auditory Artificial Intelligence: Spatial Sound Modelling to provide NPCs with Sound Perception**

Despite advancements in AI for virtual environments, non-player characters (NPCs) still do not perceive the world in a realistic manner. Acoustical occlusion and sound propagation must be approximated in order to simulate the NPCs sense of hearing. Building on our previous work that saw the development of a spatial sound framework capable of modelling the propagation of sound through complex three dimensional virtual environments in real-time, here we apply this method to NPCs, providing them with the ability to perceive sounds in a more realistic manner, ultimately leading to more realistic NPCs.

**3:00 - 3:25    Tuesday, August 18****AUTHORS: Yosuke Tanabe, Genta Yamauchi, Toru Kamekawa, and Atsushi Marui****TITLE: Tesseral Array for Group Based Spatial Audio Capture and Synthesis**

We propose a microphone and loudspeaker array named the tesseral array that is in the form of a tesseral crystal for spatial audio capture and synthesis. Because of the high symmetry of the array in terms of the position of the microphone and loudspeaker, the rotation and reflection of a spatial sound field can be represented by simple matrix operations on the basis of group theory. We present a 26 channel array having 48 symmetries in which microphones and loudspeakers are positioned on the vertices of a cuboctahedron and its dual rhombic dodecahedron.

Room: AVAR Workshops

**11:30 - 12:25    Tuesday, August 18**

**Przemyslaw Danowski, Fryderyk Chopin University of Music**

**TITLE: Envelopment versus directivity - a golden rule for VR phonography**

VR documentation of music performances is a challenge. We want to create feeling of immersion which should be provided by the most naturalistic sound that is possible to achieve. But is this truly the case for VR? Due to the limitations of cameras and HMD headsets we are forced to use on the stage perspective which is not natural way of experiencing music performance for the audience. On the other hand there are technical problems such as tone colorisation by the convolution of generalised HRTFs and headphones, limited possibilities of VR players regarding orders of ambisonics and overall lack of standardisation. In this workshop I would like to present some of my ways to address these and other issues.

**12:30 - 1:30    Tuesday, August 18**

**Aaron Berkson, USA**

**TITLE: The Past, Present, and Future of Immersive Music: A Survey of Key Developments from Gabrieli to Virtual Reality**

Standards like Atmos and Ambisonics, and platforms like VR, are growing. For composers, what possibilities do these platforms create for immersive music? This paper surveys commonalities across historical and contemporary musical contexts, including Gabrieli (1550s), Verdis Requiem (1874), and Stockhausens Gruppen (1958). Steven Price's score for Gravity (2013) is freed from the tyranny of the center speaker. Vader Immortal (VR) gives the player agency over the narrative. David Byrne said, the same music placed in a different context can not only change the way the listener perceives that music, but it can also cause the music itself to take on an entirely new meaning. This paper explores how these immersive technologies might be utilized by composers to create new experiences.

## Workshop Session 4: **Immersive Mixing and Production**

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Room: AVAR Workshops

**2:00 - 2:55    Tuesday, August 18**

**Scott Selfon, Facebook Reality Labs**

**TITLE: Real-time Mixing and Monitoring Best Practices for Virtual, Mixed, and Augmented Reality**

Are there truly converging best practices for presenting sound in the nascent and evolving environment of virtual, mixed, and augmented reality? Building on knowledge gained from nearly a century of linear media mixing, more than 30 years of interactive game mixing, and an increasing body of shipped VR/MR/AR experiences, this talk surveys the current techniques to build coherent, believable, and emotionally resonant soundscapes for new realities. We'll dive into the current state of the art for production and implementation processes for mixing and monitoring, including standards and robustly handling the sheer variety of experiences, playback environments, and scenarios.

**3:00 - 4:00    Tuesday, August 18**

**Jeff Stone, Artisyns Audio**

**TITLE: Immersive Music Production - Mixing Strategies and Observations**

Immersive music has the potential introduce a new aesthetic to the consumer and open avenues of new expression to artists, but before that can happen engineers and producers will have to become fluent in this new aesthetic to satisfy the demands of the artist, consumer, and industry. This workshop will focus on the production workflow, aesthetic considerations, and production techniques for mixing immersive music that leverage this new aesthetic using traditional tools and methods and will include listening examples, as well as a few observations I have made of the differences between traditional music mixing and this new aesthetic for recorded music.