Designing an Audio System for Effective Use in Mixed Reality

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What I do

- **Audio Producer:**
  - Recording Engineer
  - Mixing Engineer
  - Mastering Engineer
  - Composer
  - Sound Designer
  - Audio for mixed reality
  - Freelance Engineer

- **Research Associate:**
  - Auditory Perception
  - Experiments in 3D audio
  - Pervasive sound systems
  - Science of sound design
  - Mixed reality audio

Quick Look Ahead

- Importance of Audio Research & Artistic Research
- MR Audio Production Pipeline
- Why do we need high-level audio interfaces?
- What already exists? And why not use it?
- MR SoundDesinger
- Applications of MR SoundDesigner
- Current and Future Development of MR SoundDesigner
- Other research
- Questions

Why audio research is so important

- In combat, simulations, and training
  - 360 degrees
  - Hear through walls, around corners
  - Communication
  - Environmental recognition
  - Information carrying channels
  - Increased sense of presence

Artistic Research

- Crossing the boundary between art and science – by validating artistic technique

- How can sound design increase immersion and presence?

- Can we validate production techniques scientifically?

Production Pipeline

- Capture and/or Synthesize
- Multitracking, Mixing, & Mastering
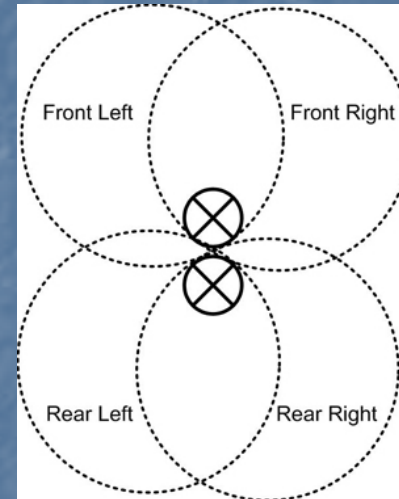- Integration
- Delivery

Capturing Ambience

- Many sound designers rely upon sound effects libraries

- Unfortunately, these approaches rarely yield believable results due to the lack of spatial depth and acoustic reality.

- False training

Surround Capture

- Surround capture for increased sense of presence and ambience

- On land:
  - Two stereo mics placed back-to-back in XY configuration with cardioid pickup patterns
  - MR MOUT

- Underwater:
  - Four omni directional hydrophones attached to an 'X' bar
  - MR SeaCreatures

- Virtual sounds have an increased sense of validity when mixed with real world ambient surround capture
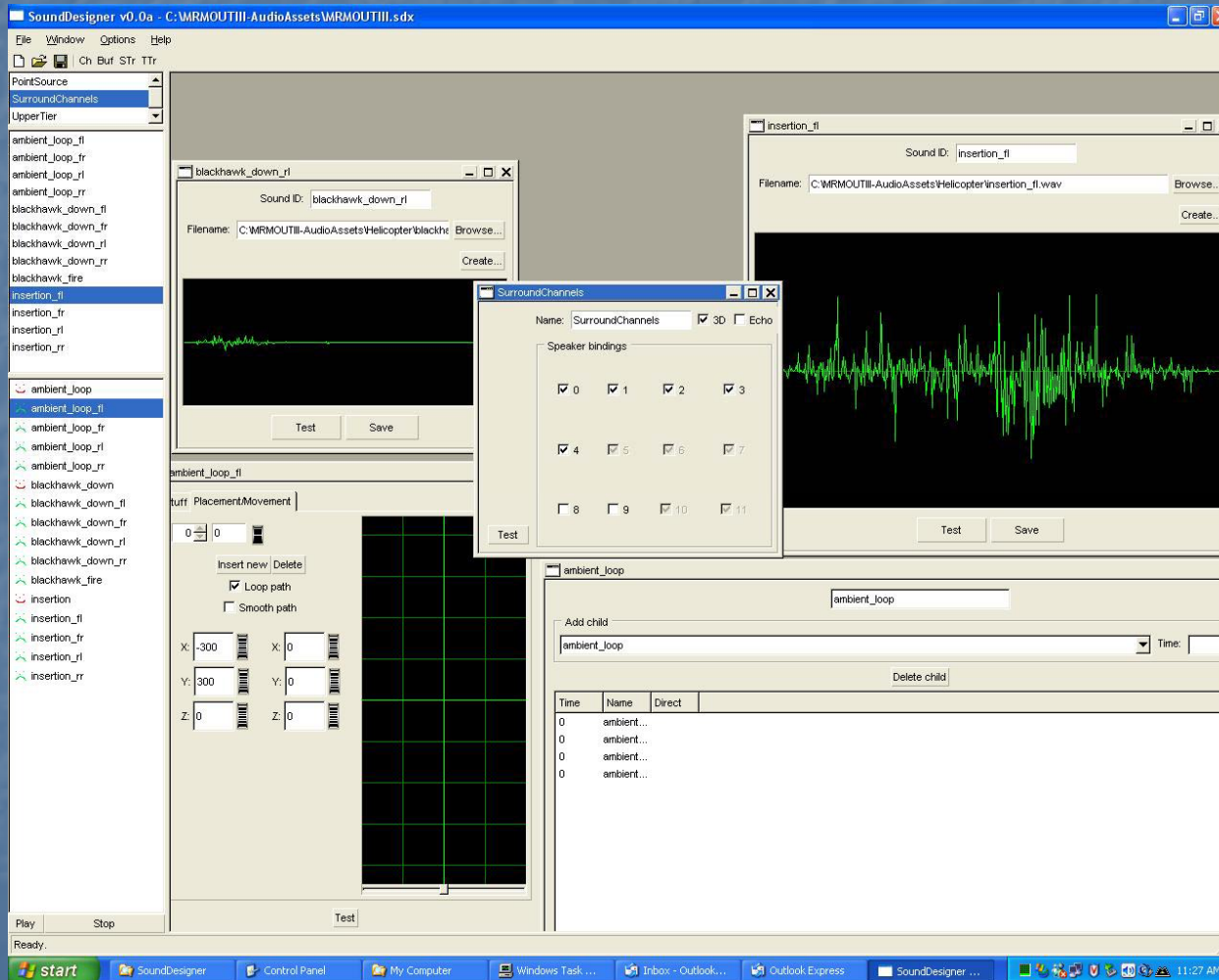
Multitracking, Mixing, & Mastering
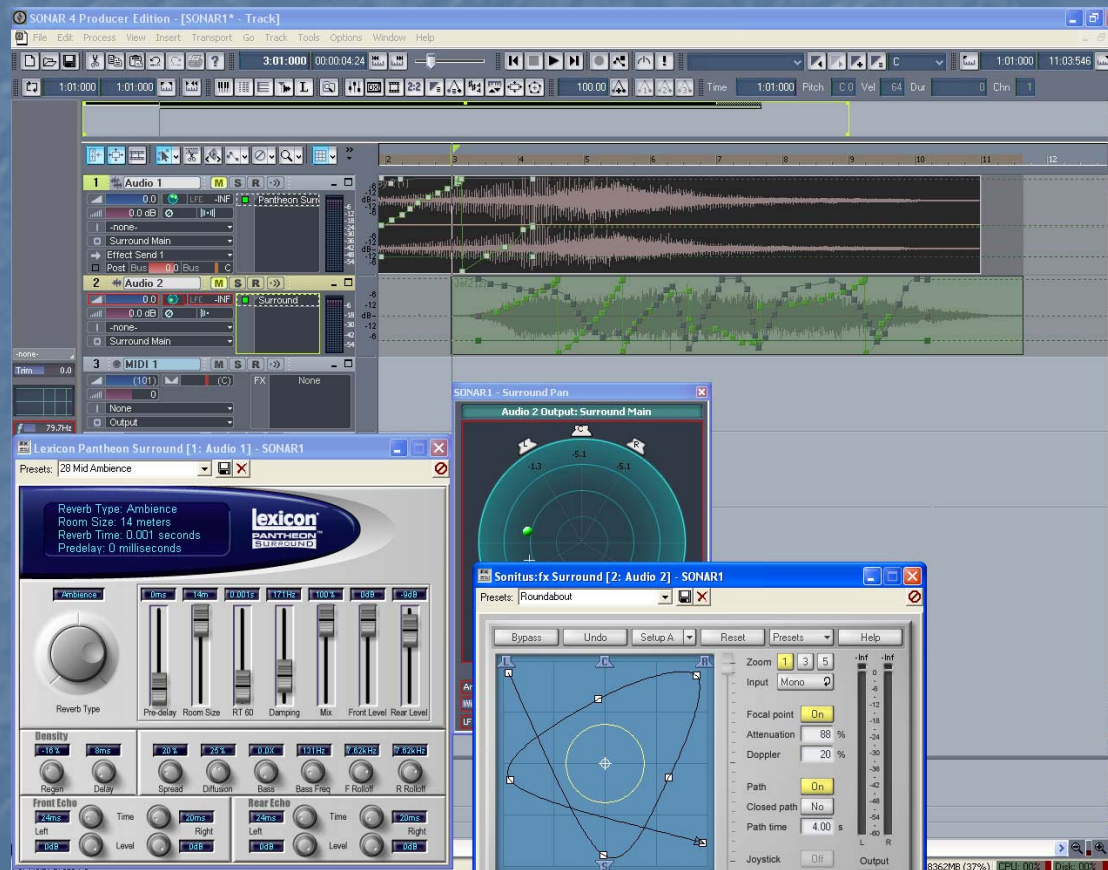
Multitracking, Mixing, & Mastering

- Pulling together captured sources, synthetic sources, SFX libraries
- Layered atmospheres
- Special effects
- "More real than real"

Integration & Delivery

Why do build a high-level audio interface?

- SIGGRAPH 03, ISMAR 03, IITSEC 02/03, IAAPA 02/03, Orlando Science Center, US ARMY's STTC

- Sound designers, trainers, scenario creators should not be burdened with code

- Audio production tools such as ProTools, Sonar, etc. do not provide support for real-time spatialization, dynamic control, or non-standard speaker configurations

- We need a system that can provide a sound designer with a full set of tools and controls that meet the demands of interactive/immersive simulation

Existing Tools

- EAX – very common API used in gaming and simulation
  - Does not however, provide low-level support for creation of DSP effects, or allow direct control over output channels.
  - Cannot create point source channels
  - Consumer hardware
- 3D headphone systems (such as AuSim 3D) while providing realistic 3D impressions are only suitable for VR applications where real-world audio is blocked out or unnecessary

MR SoundDesigner

- Custom audio engine built upon the low level audio API – PortAudio
- Features include
    - Support for 3D sound
    - Assignable channels (3D, point source)
    - Multi-tiered speaker configurations
    - Configurable speaker placement
    - Real-time spatialization
    - User placement compensation
    - Time-line triggers
    - Prescripted paths with waypoints (linear and curved)
    - Real-time capture and playback of sound (with full SoundDesinger support)
    - Basic DSP (echo, reverb)
    - Savable configuration files
    - Standard features: looping, volume control, envelopes
    - Ability to address multiple sound cards

3D Sound Support

- Delivers dynamic audio cues across multiple locations in 3D space

- including locations above, below and at head level

- Vertical placement of sounds is particularly important in mixed reality scenarios where audio events may occur above and below the user, or in places where visual perception may be limited

- The computation of the attenuation factors is based on the techniques for spatialization described in (Naef et al. 2003)

Point Source

- Point source speakers are used for a variety of applications including personal audio (radio traffic), special effects (audio haptic vest), embedded sounds (haptic gun fire), and intimate audio (voices inside your head)

- Used for accuracy at a predetermined position

- As a special effect, alternative speaker locations can be used to heighten tension and mood (ex. speakers placed inside a helmet or close to head)

Additional Features

- Timeline triggers allow for prescripting recurring and predictable sounds without burdening the story or scripting engines

- Support for microphone or line level inputs allow for real-time alteration and presentation of real world sounds (MR Audio)

- The ability to address multiple sound cards as part of an integrated sound system allows for the potential of 'unlimited' output devices (large scale sound design for pervasive environments and large scale institutions)

- DSP effects can be used to match the acoustic signature of real world environments to virtual sounds (impulse response measurements)

MR SoundDesigner in use: MR MOUT

- MR MOUT is a first person shooter training simulation for the US ARMY, currently in phase III.

- SoundDesigner has been a very useful tool for creating effective, dramatic, and dynamic sound in this application

- Radio commands are sent via a point source channel to a walkie talkie

- Real-time and prescribed sounds are played through a two-tiered 8.2 surround set up

- Also used to design audio for MR SeaCreatures, an educational experience for the Orlando Science Museum

Current & Future Development of MR SoundDesigner

- Come up with a new name
- Support for 'live' applications (e.g. improvisational theatre, art installations)
- Improved DSP
- Continue development of MR Audio applications (i.e. real-time manipulation of real world sounds)
- Investigate applications for large scale sound design (e.g. theme parks, universities, hospitals, prisons)
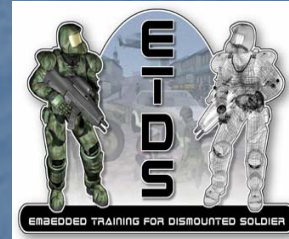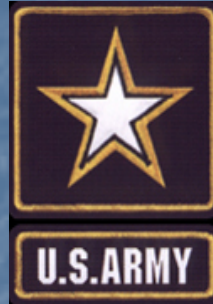
Related Research

- Continuation of expectation studies:
  - More subjects
  - More sounds
  - Specific classifications of sounds
- Validating production techniques:
  - Surround Capture
  - Ambience techniques
- Perception research:
  - Spatial scaling
  - Emotional impact

We wish to thank our partners

Sea Creatures

Questions???

Also…please email me:
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