AUDITORY GAME AUTHORING
FROM VIRTUAL WORLDS TO AUDITORY ENVIRONMENTS

Niklas Röber and Maic Masuch
Games Research Group
Department of Simulation and Graphics
University of Magdeburg
D-39106, Magdeburg, Germany
E-mail: nroeber|masuch@isg.cs.uni-magdeburg.de

ABSTRACT

The majority of information that we perceive from our real-world environment is of audio-visual nature. Virtual worlds, which are utilized in computer games to line out the story's stage, are composed of visual and auditory environments. These environments are designed to provide sufficient information for the interaction and exploration of these worlds. The authoring – or content creation – of such environments can be a very tedious and time consuming task.
In this paper we focus on a specific chapter of game authoring: The authoring of auditory environments for virtual worlds. Many of the tools available for auditory authoring focus on visual cues rather than on auditory cues and common hearing behaviour. We compare several existing programs towards their applicability for authoring audio-visual as well as audio-only applications. In addition, we propose a new system, that allows the authoring of auditory environments through a non-visual interface by solely utilizing sound and specially designed interaction techniques.
Our work is motivated by the current development of such an authoring system for virtual, auditory spaces. The implementation is work in progress and currently exists as prototypic application.

KEYWORDS

Authoring, sound, auditory environments, audio-only applications, sonification, interaction.

1 INTRODUCTION

The design and development of computer games is a very time and resource consuming venture. Unlike during the earlier days, where computer games could be created by single persons or small groups, today's games easily can cost several million dollars and take numerous employees and years to complete. The small fringe market of electronic games has evolved into a huge, global business. Today's games are not only bigger and more complex, they also feature unseen graphic and sound effects, making these games more realistic then ever before.
To develop such games, many groups are working collaboratively for years on various aspects of the game, ranging from 3D game programming, computer graphics and design over concept-art to game authoring (Watt and Policarpo 2000). The authoring of a game can be seen as the final assembly step where all the different parts are put together. The graphics and assets are imported into the game engine and connected with story related game events. The same procedure applies to sound, AI and all the other game elements. Many proprietary tools have been developed for game authoring and are often shipped with freely available game engines (Fly3D).
In this paper we concentrate on the auditory authoring of virtual, 3-dimensional worlds. This authoring includes the setup of auditory environments for audio-visual and with a particular focus also on audio-only applications.
The acoustics of many games in the earlier days was often limited to beeps of varying length and frequency. Later, with the introduction of home computers like the Atari, Amiga or the Commodore C64, midi music and the playback of more complex sounds were possible. With the advent of additional sound hardware in the beginning of the 90s, stereo sound and advanced midi music using wavetable synthesis were possible and warmly welcomed by the gaming industry. Aureal and Creative Labs added a new dimension with the introduction of 3D sound in the end of the 90s (IASIG 1997). Three-dimensional sound moved quickly into the focus of game developers and players and is now a well established standard in many computer games (Menshikov 2003).
Nowadays, the sound engines, which were designed to handle all the audio processing, have evolved by a large magnitude and many game developers devote to audio processing more and more attention. Several technologies have emerged that support software or hardware accelerated rendering of 3D sounds and room acoustics (Gardner 1999).

While playing computer games, the most active senses are vision and hearing. But the visual and the auditory field of view are two independent sensory systems, that respond to different activations and highlight different parts of our local environment (Goldstein 2001). Through these differences, hearing provides us with information that is often distinct from the visual perception and used to enhance the cognition provided by the eyes. Hearing is often considered to drive the attention: *The ears are steering the eyes*. Adopting this understanding to game authoring, methods that highlight on auditory cues rather than visual cues can be used to model acoustic spaces more intuitively.

So far, many of the existing auditory authoring systems used in the industry for film and computer games are based on visual cues, where sound sources are selected through mouse interaction and parameters are defined through visual interfaces (EAGLE 2004). Various programs arrange sounds in virtual tracks, in which they can be composed together for surround sound rendering (Maven3D 2004).

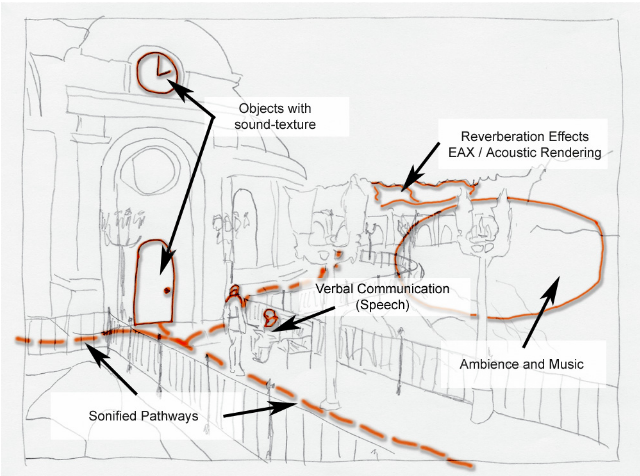
Although, some of the games developed still utilize only stereophonic sound, in this paper we explicitly focus on three-dimensional sound and acoustic rendering. We provide an overview of common auditory authoring software with the focus on creating entertaining audio-visual and audio-only applications. At the end we will concentrate on our new approach for authoring auditory worlds through sound alone.

The paper is organized as follows: In the next section we give an introduction to auditory environments and compare them with their visual counterpart. As the focus is slightly on non-visual applications, special assumptions are made to provide additional information for navigation and orientation within these auditory spaces. The following section discusses state-of-the-art audio authoring applications as they are used throughout the game and film industry. We highlight their advantages as well as show their limitations towards authoring non-visual worlds. In the following section, we explain how the auditory authoring process can be improved and how non-visual authoring tools can be designed to aid in the authoring process. In the end we will summarize the work and state possible directions for future improvements.

2 AUDITORY ENVIRONMENTS

Auditory Environments are much like visual environments. The only difference is that these environments are perceived by hearing instead of vision. The environmental information conveyed through sound is usually different than the one through vision (Goldstein 2001). Auditory elements, such as object sounds, music and speech can be used to model a scene in virtual, auditory worlds and to describe the environment through sound alone (Röber and Masuch 2004). These auditory scenes can vary as much as visual scenes and can also be grouped to form a larger surrounding with smooth transitions from one auditory environment to the other. Special care has to be taken with the modelling of these transitions. For non-interactive environments, like movies, these transitions can be previously defined and setup in advance to precisely match their desired effect. For interactive environments, like computer games, these transitions have to be fine-tuned during the game play depending on the games status and the players actions. By employing a smart blending between the environments, smooth transitions are possible within the auditory display for both, object-sounds and music (Hämäläinen 2002).

(a) Visual scene (Syberia 2002).



(b) Auditory scene.

Figure 1:Visual and auditory environments.

We define auditory environments as the audible analogue of a visual scene which is composed of auditory elements describing the objects in this scenery. Similar to the real world, virtual worlds are constructed of different perceptible environments that are intertwined. In audio-visual applications, each

scene consists of definitions for the visual and the auditory part.
As the visual and the auditory field of view are diverse, the information conveyed through auditory channels is not necessarily the same as the one which is depicted in the visual part. While most applications rely mainly on visual cues to convey the majority of information, many of them utilize sound as additional attractor to increase the efficiency of the display. Some applications have been developed that only use non-speech sound to transmit information. Many of these applications originate from data sonification (Speeth 1961) and applications to aid in the navigation and orientation of the visually impaired (Strothotte 1995).
The focus of so-called auditory displays is to convey information through sound alone. Although most of the applications are developed for the blind, many of the techniques can also be used by sighted operators to utilize sound as enhancement for visual perception or for mobile applications where vision and the demand of free eyes are mandatory. Examples are audio based guiding systems and audio-only games. The Audio Games website (AudioGames) contains some good introductory articles about this topic. Most of these games use the narrative to develop an underlying story and the most successful genre are Adventures. Drewes (Drewes 2000) developed an immersive audio game, employing wearable computing and augmented reality technology. Targett et. al. (Targett 2003) examine the possibilities of using audio-only games for therapeutic applications. They discovered that playing audio-only games is not only fun for both, sighted and visually impaired, but can also be used to develop certain skills in auditory perception.
For the rendering of acoustic scenes, it is more important to focus on the clarity and effectivity of the display rather than on physically accurate rendering. Special sonification and interaction techniques have been developed to convey the information and to provide the player with enough intelligence for orientation, navigation and object interaction (Röber and Masuch 2004).
An auditory environment is composed of object sounds, music and speech. These auditory elements are sufficient to convey all the information needed. Figure 1 shows an example scene which is represented visually (Figure 1a) and through auditory elements (Figure 1b). In general, less information can be transmitted through acoustic channels. To compensate for this deficiency in audio-only applications, the auditory environment has to be enriched and special sonification and interaction techniques have to be employed. Every object that is part of such an acoustic environment is audible and can be described through auditory textures. Each of these sound textures is a collection of different sounds that describes an object in different situations or under varying conditions. Sound types that are used for the compositing of auditory textures are:

- A general object sound,
- Several action or status changed sounds,
- A call sign for the radar, and
- A verbal description.

The general object sound is the acoustic representation for this object in its usual state. This sound is audible if the player is within a pre-defined range for this object. Action and status changed sounds are used to characterize a current activity or changing situation for this object. These sounds are played only once, e.g. clicking a button, but can also activate a different general representation for this object, e.g. switching on a radio. The radar call sign and the verbal description are two additional auditory icons, that are used to describe the object and to identify its position. These are activated on request and only played once.

Auditory Texture

General Sound	Silent or auditory Icon (ringing)
Status changed	Incoming call (loud ringing)
Status changes	Broken (auditory icon)
Action	Pick up phone (auditory icon)
Action	Dialing (beeps)
Action	Talking (silent)
Action	Ring off (auditory icon)
Radar call	Auditory icon (ringing)
Verbal description	Speech: "Telephone"

Figure 2:Auditory texture (Telephone).

Figure 2 sketches the idea of auditory textures using a telephone as an example. The sound texture consists of a total of 9 sounds including silence, four action sounds and three status changed sounds.
Some objects may only have one general object sound, like a wall we can bump into, while other objects can have many layers of different sounds. Which sounds are selected for the object representation depends on the underlying story engine and the player's interaction. The selections of sounds can be managed through a story engine to assist the player in the game play and to push the story forward. Therefore, these acoustic textures can also be classified as *story-related* sound textures. Similar to story-related sound objects are environmental sound textures, which are mentioned here for completeness, but are not further discussed in this paper. These textures describe an objects physical state and the interaction between several objects. Story- and environment-related sound textures share many similarities. The environmental audio texture is

composed of sounds that characterize the object in different situations. Depending on the physical state of this object, one or more of these sounds are selected and composed together. An example would be the difference in sound at varying weather or road conditions from the tires of a moving car. The authoring of these textures works similar as with the story-related textures, except that here several sounds can be composed together to precisely meet the current environmental settings. Which sounds are used depends on the underlying physic engine which models the environment.

The field of auralization is concerned with the correct rendering of the acoustics in a virtual scene. Often used techniques involve 3D sound rendering through binaural differences and HRTFs[1] as well as an acoustic simulation model for environmental reverberation (Begault 1994). For the latter, statistical approximations like EAX are commonly used to simulate the reverberation for a specific environment. These approximations are often sufficient enough to convey general information about the environment, but fail in the recognition of special places where information is acquired through the analysis of reflected sound.

Another – still game related – interface are in-game or shell menus, which are used to adjust game specific parameters, like loudness, or allow to load a previously saved game. In audio-visual applications, especially in computer games, many commands are additionally commented through an auditory feedback sign. With the focus on non-visual applications, auditory displays and auditory user interfaces (AUI) are utilized for these settings (Begault 1994). For the interaction with these menus, similar methods apply as for the non-visual authoring, see Section 4.

Depending on the type of application (audio-visual or audio-only) different auditory environments have to be created to communicate the information that is necessary for the later orientation, navigation and object interaction. In the following sections, a rough overview of state-of-the-art audio authoring tools and a definition of requirements for non-visual authoring is presented. In the section after, we focus on our new approach, highlighting a non-visual authoring environment for audio-only applications.

3 AUDITORY AUTHORING OF GAMES

Auditory authoring is the process of designing, editing and integrating auditory information into a virtual environment. This is done in two steps, where first the required sounds and music are arranged and composed and later integrated into the virtual environment. This integration includes the definition and the connection of sounds and music to gameplay events.

For the auditory authoring we mainly focus on the second part, the integration of sounds into the virtual environment. Music and speech are both placed at areas within the environment and activated through the story engine. Additionally, the narrator can be triggered through the player for assistance and for verbal scene descriptions. Based on virtual, auditory environments, two groups can be identified for the authoring process:

- Environment-related and
- Story-related authoring.

The integration of sound in the environment includes the specification of the sounds location and the possible connection to geometrical objects or regions. Additionally, it can include the setup of parameters like loudness, range or directional performance. For the integration into the story line, events are defined that act as switches between the different layers of the objects story-related auditory texture. If an object additionally uses an environment-related auditory texture, these events are defined by the physics engine of the environment.

For the authoring we assume that the sounds are already engineered and we have a large variety of sounds which *only* need to be integrated into the game and connected with the game play events. With the focus on audio-only environments, we distinguish between authoring for audio-visual and audio-only applications.

Some basic functionalities which have to be supported by the authoring environment include the import and a proper sonification of the underlying geometrical data of the virtual environment, as well as standard preview and exploration techniques that allow for orientation, navigation and object interaction.

For the sound authoring, we have to be able to perform the following tasks:

- Select, create and remove sound sources,
- Placement of sound sources (connection to objects or areas),
- Setup of sound parameters (loudness, range, attenuation etc.), and
- Setup of background sound sources.

Sound sources are created within the geometrical representation of the environment and can be either autonomous or connected with scene objects. Sounds or auditory textures are selected and assigned to these sound sources and parameters with sound typical properties like volume, range or attenuation can be adjusted.

Many programs additionally allow the setup of music and the integration of narrator's comments, as well as

[1] Head-related Transfer Functions

simple settings for general background and environmental sounds.
The object sound authoring is performed in combination with the environmental sound setup and includes the following actions:

- Definition of sound textures,
- Selection of sounds,
- Setup of sound parameters (loudness, range, attenuation etc.),
- Definition of events and actions, and
- Switch on/off sound sources or sound groups.

This is basically the construction of story-related auditory textures and the definition of events that switch between these different object sounds. This includes parameter specifications for the individual sound layers as well as the group behaviour of sound objects. These audio textures are now assigned to sound sources created during the environmental authoring step.
In most existing applications, the sound setup is handled with the help of a 3D modelling program that displays the game's geometrical data and shows features of the game play. The sound sources are arranged and eventually connected to *real* objects and events. An auditory preview of the scene allows a verification of the designed auditory environment. Some programs combine the design and the sound authoring in one convenient environment.

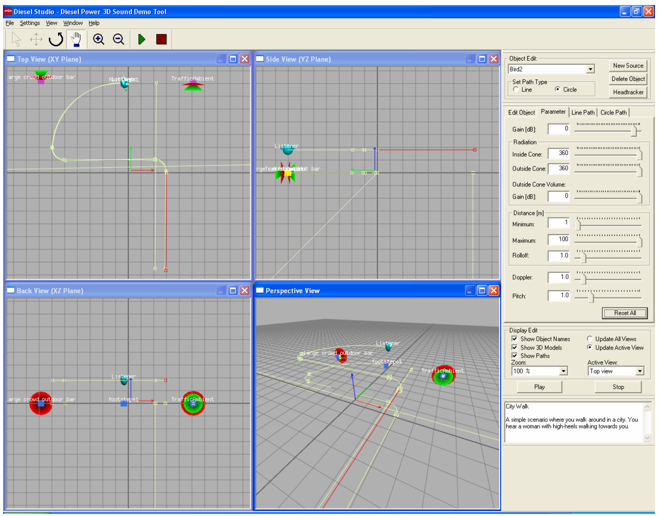


Figure 3: Screenshot of DieselStudio from AM:3D (AM:3D 2004).

Tools that are solely used for design and composition are Sonic Foundry's Soundforge for wave data (SoundForge 2004) and the Cubase (Cubase 2004) and Cakewalk (Cakewalk 2004) program families for midi editing. These programs are used ahead of the final authoring step to design the sound and music samples.
The functionality of the authoring programs varies depending on the target platform and the sound engine used. Professional tools are the new XACT system for auditory game authoring which is part of Microsoft's new XNA game development platform (XNA 2004).
Other professional authoring applications include Sony's SCREAM for the PS/2 (SCREAM 2004), Sensaura's gameCODA2 API and authoring environment (gameCODA 2004) as well as Creative Lab's EAGLE for EAX environmental authoring (EAGLE 2004).

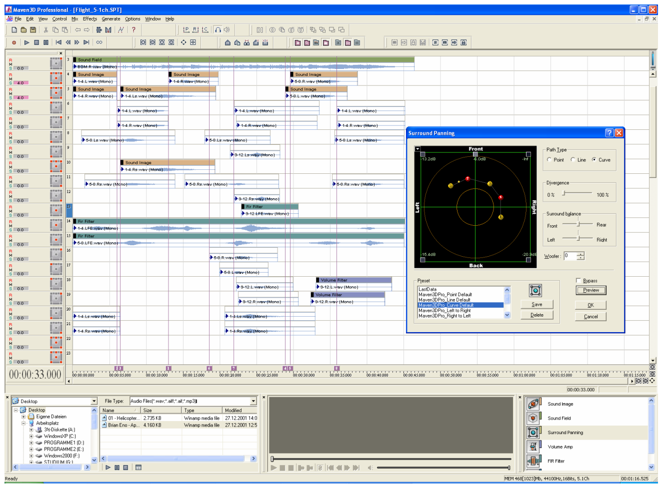


Figure 4: Screenshot of Maven3D (Maven3D 2004).

A popular API for software rendering of spatialized sounds is AM:3D's DieselStudio (AM:3D 2004). It includes an API for programming 3D sound, as well as a simple editor, that can be used to author simple scenarios, Figure 3. It allows the animation of sounds along pathways and the inclusion of geometry to find the correct sound placement within the environment.
An example for a track based authoring system is Maven3D from Emerging Systems (Maven3D 2004) and the Soundfactory from CRI Middleware (Soundfactory 2004). Both allow the design and setup of 3D sounds and their integration into the game environment. Figure 4 shows a screenshot of Maven3D Professional, mixing several tracks for a 5.1 audio project. Maven3D also allows for cross-talk cancellation and some specifications in acoustic rendering.
Interesting and unconventional ideas for user interfaces to perform sound setup, design or authoring can be found in art and research projects. An overview of alternative music instruments can be found in the Master's Thesis of Jörg Piringer (Piringer 2001). Although, many of these interfaces abjure visual interaction (Flür 1976), most of the authoring systems designed for the authoring of virtual environments use visual metaphors (Väänänen 2003).
Most of these authoring tools have evolved over many years and are appropriate for the authoring of audio-visual applications, but do not met the requirements for the setup of audio-only environments. For these applications, special techniques have to be used to

integrate additional information, that is required for the successful sonification of these environments. The next sections focus on these problems and introduce a new authoring idea that uses the same media: sound and a non-visual interface for the authoring of acoustic spaces.

4 NON-VISUAL AUDITORY AUTHORING

We propose that for a more immersive and realistic setup of acoustic environments, especially with the focus on audio-only applications, the authoring should take place in and with the same media: sound and a non-visual interface. This is both challenging and rewarding. Challenging, as we have to express non-auditory information trough acoustics, and rewarding, as we do not break the illusion of being immersed in a virtual, auditory world. For the authoring of non-visual environments, we have to include additional information for non-visual perception. This includes auditory textures that describe scene objects as well as data to aid in navigation and orientation. Furthermore, music and a narrators voice have to be integrated into the environment to support the story and to deliver extra information.

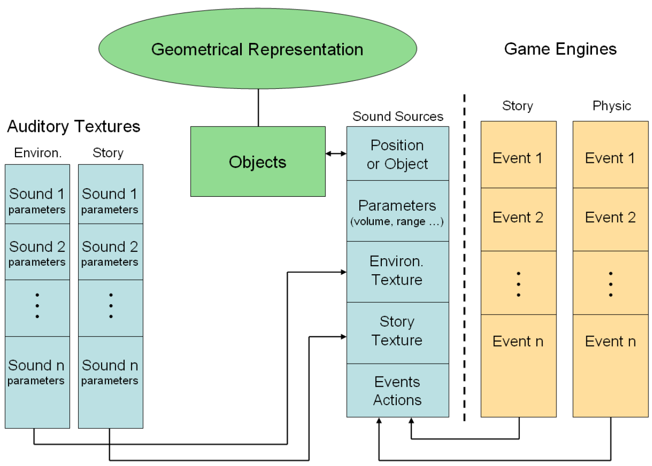


Figure 5: System overview.

The non-visual authoring of auditory environments works similar to the authoring of audio-visual worlds. The only difference is the media of interaction and the utilization of specific interaction and data sonification techniques (Röber and Masuch 2004).

The user is provided with the geometrical representation of the virtual environment that is acoustically displayed using data sonification techniques. Within this environment, the user is able to use a 3D auditory pointing device to select locations or objects from this data on which sound sources can be placed. Parameters and sound textures are defined through gestures and audio widgets. Additionally, head-tracking is used to allow for an easier navigation and orientation within the data sets.

Figure 5 shows an overview of the system. The authoring itself is split into two parts: the construction of auditory textures and the integration of sound sources into the environment. At desired places, sound sources can be constructed and parameters are setup for these sources. Both auditory textures, environmental and story-related, can be assigned to the sound source, and their internal sounds are linked with the events from the story, respectively the physics engine.

Most of the interaction techniques used for the authoring can also be applied to playing audio-only games (Röber and Masuch 2004). Supported techniques are:

- Head-tracking,
- 3D auditory pointing devices,
- Auditory widgets,
- Gestures and a
- Gamepad.

Head-tracking and other tracking devices allow intuitive operations with the environment by using natural hearing behaviour and gestures as interactive media. A 3-dimensional pointing device, that is part of the tracking system, is used for sound positioning and the specification of parameters. These parameters are defined through a combination of auditory widgets and gestures. A gamepad is utilized for navigation and listener orientation as well as for object and sound selection to construct auditory textures and to set up sound sources.

Figure 6 shows a simple scene which shall be used to exemplify the authoring process. The player is located inside a locked room and has to find the keys to open the door. Basically three main sound groups are present in this scene. Sounds “S1” and “S2” represent ambient sounds from the outside of the building and are used as landmark for orientation purposes. Other sounds can be added to make the scenery more realistic, but care has to be taken to not clutter the auditory display with too much information.

Through interaction the player will notify that the door is locked “S4”. While looking around, the player can find the keys “S3” and open the door to proceed. For the moment, the focus is not on the interaction to accomplish this task, rather on how to model and authorize this scene. Sounds “S1” and “S2” can easily be defined as a mixture of ambient sounds representing noise on the street. If no further interaction is aimed, the associated sound texture consists of only one sound. The auditory texture of the door “S4” has at least three sounds, one that represents a locked door, one for an open one and another one for unlocking the door. The key object “S3” on the other hand only needs a prominent sound that identifies itself as *key* object. The story engine can control the effectiveness of this

sound and make it more distinctive or more ambient, depending on the player's intuition.
The authoring itself is straight forward. The mesh of the environment is imported and sonified and the author can walk around freely. Mesh objects are identified through their names and groups, but can also be selected from an auditory menu. During the 3D modelling of the mesh, dummy objects (simple boxes) can be placed at positions which are later used to identify sound object positions. The author can now select these objects and connect them with an auditory texture.

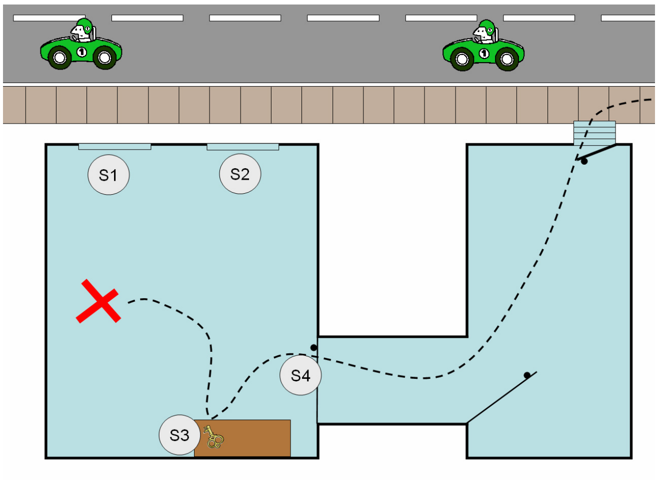


Figure 6: Example Scene.

These auditory textures are created using an auditory menu in which gestures and real 3D pointing devices play an important role. As the sounds are readily composed, one only needs to select the number of slots for the auditory texture and fill them with data. After this, each sound and the sound object as a whole can be fine tuned by specifying parameters, like direction, range etc. These parameters are again specified using an auditory menu. The development of a story engine and the connection of events with this story engine is currently under development.
The system is currently work in progress and at the time of writing existent as prototypic implementation. This prototype will be extended by additional sonification and interaction techniques and the resulting application examined in user studies.
The applications for such an authoring tool include audio-visual as well as audio-only applications. The main benefits are that it allows the creation of additional sound sources that provide enough information for non-visual applications, such as auditory displays or audio-only games. Other advantages are that the authoring is accomplished within the same environment and using the same media. This simplifies the preview process and the auditory compositing. A challenging task still is to provide enough information for the navigation and orientation within this auditory world. Sighted users need to rethink their auditory perception and gather some experience prior using this system most efficiently.

5 CONCLUSIONS AND FUTURE RESEARCH

With the increased demand of mobile applications in the near future, other senses come in the range of interest besides vision, VR and augmented reality. Mobile auditory applications have the advantage that they are easy to build, affordable and with the appropriate interaction techniques easy and intuitive to use. The biggest benefit is that no vision is required, making these systems usable by visually impaired as well as by sighted users which need their vision to observe other tasks.
Computer Games are often cutting edge applications and lead the way for new technology. Mobile games already play a large role, including handheld gaming platforms like the GameBoy or cell phone based games. All of them have in common that they implement the classic way of audio-visual gaming. Some audio-only games have already been developed (AudioGames), but mainly with the focus for the visually impaired and are not widespread.
When comparing the information that is perceived by visual and auditory senses, less and different information is conveyed through hearing than through vision. For real audio-only applications, techniques have to be developed that focus on auditory cues and allow the integration of additional information in the *natural* auditory environment. The authoring software has to support these techniques and allow for an authoring of such environments.
Although many auditory authoring systems exist, most of them are developed for the authoring of audio-visual computer games. The authoring within these tools is often limited to the integration of various sounds and music into the game environment. They are insufficient for the increased authoring of non-visual environments as they do not allow the integration of additional information, which is essential for most audio-only applications.
The system that was introduced in Section 4 allows both, authoring for audio-visual as well as for non-visual applications. As an additional benefit, the authoring takes place using the same media and in the same environment. This is a huge advantage, as the authoring process does not break the illusion of being immersed in a virtual, auditory world. This fact should not be underestimated, as the visual authoring of an auditory world is different from non-visual auditory authoring. This is of course different for audio-visual applications. Given an adequate interface, non-visual auditory authoring is superior for audio-only

applications. One limitation of the proposed method is that sighted users have to practice this new form of authoring, as the only form of perceiving information is through sound. Beneficial is that non-sighted users are able to use these tools as well.
As the system is currently under development, extensive tests and user studies have to be performed in the near future as well as the integration of additional sonification and interaction techniques to improve the non-visual authoring.

6 ACKNOWLODGEMENTS

The authors would like to thank Daniel Bergner and Daniel Walz for fruitful discussions and their help in the implementation of parts of this project.

7 REFERENCES

(AM:3D 2004)
Sven Vestergaard and Preben S. Nielsen, "Website AM:3D", *http://www.am3d.com, 2004*

(AudioGames)
Richard van Tol and Sander Huiberts, "Website AudioGames", *http://www.audiogames.net*, 2004

(Begault 1994)
Durand R Begault, "3D Sound - For Virtual Reality and Multimedia", *AP Professional*, 1994.

(Cakewalk 2004)
Twelve Tone Systems, "Cakewalk", PC, 2004

(Cubase 2004)
Steinberg, "Cubase", PC, 2004

(Drewes 2000)
Thomas M. Drewes and Elizabeth D. Mynatt and Marybeth Gandy, "Sleuth: An Audio Experience", *ICAD*, 2000.

(EAGLE 2004)
CreativeLabs, "EAGLE" PC,.2004

(Flür 1976)
Wolfgang Flür and Florian Schneider, „Der Käfig", KRAFTWERK, Germany, 1976

(Fly3D)
Fabio Policarpo. "Fly3D Game Engine", *http://www.fly3d.com.br*, 2004

(gameCODA 2004)
Sensaura, "gameCODA", *http://www.gamecoda.com*, 2004

(Gardner 1999)
William G. Gardner, "3D Audio and Acoustic Environment Modeling", *Wave Arts Inc.*, 1999

(Goldstein 2001)
E.Bruce Goldstein, "Sensation and Perception" *Wadsworth Publishing Company*,2001

(Hämäläinen 2002)
Perttu Hämäläinen, "3D Sound Rendering and Cinematic Sound in Computer Games", *Technical Report HUT, Telecommunications, Software and Multimedia Laboratory,* 2002

(IASIG 1997)
Interactive Audio Special Interest Group - 3D Working Group, "3Dxp DirectSound 3.0 Extension API", *http://www.iasig.org/pubs/3dxp.pdf*, 1997

(Klante 2003)
P. Klante, "Visually supported design of auditory user Interfaces", *Volume 2 of the Proceedings of the 10th HCI International*, Page 696-700, 2003

(Maven3D 2004)
Emerging Systems, "Maven3D Professional", PC, 2004

(Menshikov 2003)
Aleksei Menshikov, "Modern Audio Technologies in Games", *Game Developers Conference,* 2003

(Piringer 2001)
Jörg Piringer, „Elektronische Musik und Interaktivität: Prinzipien, Konzepte, Anwendungen", Master's Thesis, TU Wien, Austria, October 2001

(Röber and Masuch 2004)
Niklas Röber and Maic Masuch, "Interacting with Sound: An interaction Paradigm for virtual auditory Worlds", *Proceedings of 10th ICAD*, 2004

(SCREAM 2004)
Sony Corporation, "SCREAM", *Game Developers Conference,* 2003

(Soundfactory 2004)
CRI Middleware, "CRI Sound Factory", PC, 2004

(SoundForge 2004)
sonicfoundry, "Sound Forge", PC, 2004

(Speeth 1961)
S. D. Speeth, "Seismometer Sounds", *Journal of the Acoustical Society of America*. Vol.33, pp.909-916, 1961

(Strothotte 1995)
Thomas Strothotte and Helen Petrie and Valerie Johnson and Lars Reichert. "MoBIC: An aid to increase the independent Mobility of Blind and elderly Travellers" *2nd TIDE Congress.* 1995

(Syberia 2002)
Microids Adventure, "Syberia", PC, 2002

(Targett 2003)
Sue Targett Mikael Fernström, "Audio Games: Fun for all? All for fun?", *ICAD*, 2003

(Väänänen 2003)
R. Väänänen. "User interaction and authoring of 3D sound scenes in the Carrouso EU project", 114th Convention of the Audio Engineering Society (AES), Amsterdam, March 2003

(Watt and Policarpo 2000)
Alan Watt and Fabio Policarpo, "3D Games Vol.1", *Addison Wesley*, 2000

(XNA 2004)
Microsoft Corporation, "XNA development platform", *http://www.microsoft.com/xna*, 2004

AUDITORY GAME AUTHORING

FROM VIRTUAL WORLDS TO AUDITORY ENVIRONMENTS.

Niklas Röber and Maic Masuch
Games Research Group
Department of Simulation and Graphics
University of Magdeburg
D-39106, Magdeburg, Germany
E-mail: nroeber|masuch@isg.cs.uni-magdeburg.de

KEYWORDS

Authoring, sound, auditory environments, audio-only applications, sonification, interaction.

ABSTRACT

The majority of information that we perceive from our real-world environment is of audio-visual nature. Virtual worlds, which are utilized in computer games to line out the story's stage, are composed of visual and auditory environments. These environments are designed to provide sufficient information for the interaction and exploration of these worlds. The authoring – or content creation – of such environments can be a very tedious and time consuming task.
In this paper we focus on a specific chapter of game authoring: The authoring of auditory environments for virtual worlds. Many of the tools available for auditory authoring focus on visual cues rather than on auditory cues and common hearing behaviour. We compare several existing programs towards their applicability for authoring audio-visual as well as audio-only applications. In addition, we propose a new system, that allows the authoring of auditory environments through a non-visual interface by solely utilizing sound and specially designed interaction techniques.
Our work is motivated by the current development of such an authoring system for virtual, auditory spaces. The implementation is work in progress and currently exists as prototypic application.

BIOGRAPHY

Niklas Röber received his Diplom (Master's degree) from the Otto-von-Guericke University of Magdeburg in 2002. He is currently working on his PhD, focusing on sonification and interaction techniques for virtual, auditory worlds. His current research interests include auditory interfaces, acoustic rendering as well as non-photorealistic rendering techniques. Previous work contains research in computer graphics and scientific visualization. He is a member of the IGDA Society.

Maic Masuch PhD in computer animation, graduated at University of Magdeburg, Germany where he is now Germany's first professor for computer games. He has been teaching and researching on computer game programming for six years.
Research focuses on authoring of virtual worlds, user interfaces, audio-only-interfaces and graphics for games, especially real-time non-photorealistic rendering techniques for game engines. He supervised several game-related student projects and works as a game consultant for game development companies and the German ministry of research. In addition, Prof. Masuch is co-founder of Impara, a technology think tank that is developing media systems for playful learning.