Game Sound Technology and Player Interaction:
Concepts and Developments

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Chapter 7
An Acoustic Communication Framework for Game Sound:
Fidelity, Verisimilitude, Ecology

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ABSTRACT

This chapter explores how notions of fidelity and verisimilitude manifest historically both as global cultural conventions of media and technology, as well as more specifically as design goals in the production of sound in games. By exploring these two perspectives on acoustic realism through the acoustic communication framework with its focus on patterns of listening over time, acoustic communities, and ecology, I hope to offer a model for future theorizing and exploration of game sound and a lens for in-depth analysis of specific game titles. As a novel contribution, this chapter offers a set of listening modes that are derived from and describe attentional stances towards historically diverse game soundscapes in the hopes that we may use these to not only identify but also evaluate the relationship between gaming and culture.

INTRODUCTION

Within game studies—a relatively young discipline itself—the field of game sound has already experienced growth, however there are still scarce resources and analytical frameworks for understanding the role of sound for purposes of cultural critique, historical analysis or cross-media examination. Frameworks such as the IEZA one (Huiberts & van Tol, 2008; Wilhelmsson & Wallén, 2011), which builds on several existing design guideline systems for game sound (Ekman, 2005; Grimshaw & Schott, 2007; Jørgensen, 2006; Stockburger, 2007), and particularly Grimshaw's (2008) conceptualization of an acoustic ecology in first-person shooter games are beginning to pave the way for more in-depth explorations into understanding, analyzing and representing the role of sound in games.

In addition to the more established foundations of game sound in music synthesis, algorithmic sound generation, and real-time implementation of

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sound effects (Brandon, 2004; Collins, 2007; Friberg & Gärdenfors, 2004; Roeber, Deutschmann, & Masuch, 2006), there is a need for building more general theoretical and analytical frameworks to describe the various elements of game sound and their role within the game's designed soundscape and its informational ecology. Examples of rich theoretical works on game sound are still few (Collins, 2008; Grimshaw, 2008). I would like to propose a framework for studying game sound that engenders a multi-disciplinary perspective with a specific focus on listening as a dynamically developing, socio-cultural activity influenced by and influencing cultural production and experience. This framework, based on the acoustic communication model developed by Barry Truax (2001) and inspired by R. Murray Schafer (1977) combines media histories with the current technological and cultural reality and takes a critical analytical stance towards discussing the way media shapes our world.

Delivering a full history of any game sound predecessors and tracing critical, socio-cultural perspectives of every game genre in existence is not only an ambitious task, but is one that has been done in parts by both scholars and game writers (Collins, 2008; McDonald, 2008). Instead, I will focus on two particular aspects of game sound—fidelity and verisimilitude—and situate them within the interdisciplinary framework of analysis that the acoustic communication model offers. They are two sides of the same idea representing notions of *realism* or *reality* in game soundscapes. They reflect long-standing cultural ideals and production values whose histories transgress radio, cinema, and real-world environments. By juxtaposing the two ideas in this manner I hope to elucidate qualities and features of game sound both in a richer way and within a socio-historical discursive context. Fidelity reflects the development of sound in games from a technological perspective while verisimilitude reflects the cultural emergence of authenticity, immersion and suspension of disbelief in cinema, and characterizes the *magic flow* state in games. Finally, I'd like to connect both these ideas to acoustic ecology and particularly to the concept of *acoustic community*, which includes the real situation of a player's own acoustic soundscape in addition to the game's sonic environment, interlaced in a complex ecology.

THE ACOUSTIC COMMUNICATION MODEL: BACKGROUND AND RELEVANCE TO GAME SOUND

The concept of *acoustic communication* articulated by Truax (2001) is a framework that attempts to bring multi-disciplinary perspectives into the study of sound reception as well as sound production and that provides a structure for analyzing and understanding the role of sound in contemporary culture, in media, and in technology. Its roots lie in the tradition of acoustic ecology that was the basis of Schafer's work in the late 1960s and 1970s: work that is already referenced by several authors (Grimshaw, 2008; Hug, 2011). The following history helps contextualize and focus the particular perspective that acoustic communication has taken on.

A pioneer in the field of acoustic ecology, Schafer first defined the notion of a *soundscape* to mean a holistic system of sound events constituting an acoustic environment and functioning in an ecologically balanced, sustainable way (Schafer, 1977). Born out of the threat of urban noise pollution, Schafer focused on conceptualizing and advocating an ecological balance in the acoustic realm. He developed the terms *hi-fi* and *lo-fi* to describe different states of aural stasis in the environment. A hi-fi soundscape, exemplified in Schafer's view by the natural environment, is one where frequencies occupy their own spectral niches and are heard distinctly, thus creating a high signal-to-noise ratio. A lo-fi soundscape, on the other hand, often exemplified by modern urban city settings, is one where amplified sound,

traffic, and white noise mask other sound signals and obstruct clear aural communication, creating a low signal-to-noise ratio (Truax, 2001, p. 23).

Following Schafer's work, Truax developed a multi-disciplinary framework for understanding sound based on notions of acoustic ecology as well as communication theory. This framework models sound, listener and environment in a holistic interconnected system, where the soundscape mediates a two-way relationship between listener and environment (Truax, 2001, p. 12). It also places importance on the role of context in the process of listening, emphasizing the listener's ability to extract meaningful information from the content, qualities, and structure of the sound precisely by situating this process in their knowledge and familiarity with the context and environment (p. 12). Yet Truax also recognizes listening as a product of cultural and technological advances, subject to macro shifts and patterns over time. Such a multi-disciplinary understanding of sound allows us to bring socio-cultural considerations into the soundscape paradigm alongside auditory perception and cognition.

Traditional models of auditory perception conceptualize listening as a process of neural transmission of incoming vibrations to the brain (Cook, 1999) that, shaped by our physiology, allows us to experience sound qualities. In fact, as pointed out by Truax (2001) and others, listening is a complex activity involving multi-level and dynamically shifting attention, as well as higher cognitive functions (inevitably dependent on context) such as memory associations, template matching, and foregrounding and backgrounding of sound (p. 11). Again, this model points to the importance of understanding listening as a physiological as well as a cultural and social practice. From a design perspective, it is also imperative to understand that listening is a dynamic and fluid activity that in turn affects the perception and experience of sounds in the acoustic or electroacoustic environment and helps mediate the relationship between actor, activity, context and environment. Two major classifications of listening are *everyday listening* as put forward by Gaver (1994, p. 426) —an omni-directional, semi-distracted, adaptive-interactive listening that focuses on immediate information-processing of sound–and *analytic listening* (Truax, 2001, p. 163) —listening that has attention to detail and which is an expert activity focused on an aesthetic or analytical experience of sound that is rooted in context as its frame of reference for the extraction of information from sound characteristics. Based on the idea of different classifications of listening, Truax developed a number of categories exemplifying major listening modes and processes (pp. 21-27): see Table 1.

Clearly, this ontology of listening needs a significant degree of modification in order to fit the complexities of listening in gameplay contexts, and we will continue returning, adding to, and re-conceptualizing the idea of listening positions with regard to game soundscapes. This set of listening types is simply a beginning, allowing us a way to access the historical evolution of listening stances as media, technology, and design have changed. These types of listening, as part of the acoustic communication framework, directly represent macro shifts in the historical and cultural reality of acoustic, electroacoustic, and media listening, and, as an extension, game listening. In analyzing game sound then, this set of listening attentions is to be amended in a similar fashion to uncover and elucidate macro shifts directly procured by the socio-historical experience of sound in games.

The notions of fidelity, verisimilitude, and ecology are a particular choice too, yet the concept and drive towards realism is one that I see as not only one aspect of game design and game culture but a more symbolic movement intersecting many media genres and technologies. Rather than simply a design requirement, it is an ideology of contemporary mediated expressions. Examples span from immersive cinematic soundscapes for the big screen and surround sound aesthetics

Table 1. List of Listening Positions from the Acoustic Communication framework (Truax, 2001)

Listening Positions	Description
Listening-in-search	Active attentional and purposeful listening, a questing out towards a sound source or soundscape. Sometimes listening-in-search involves a determined seeking of a particular sound template in an aurally busy environment. The *cocktail party effect,* for example, is a special mode of listening-in-search, which involves a zooming in on a particular sound source—often semantic-based (speech) and familiar in an environment of competing sound information in the same spectrum (Truax, 2001, p. 22).
Listening-in-readiness	Listening-in-readiness involves background listening with an underlying expectation for a particular sound or set of sound signals (such as a baby's cry). It is a sub-attentional listening in expectation of a familiar sound or signal, a latent alertness.
Background Listening	A non-attentional listening, a receptive stance without a conscious attention or interpretation of sounds or soundscape heard.
Media Listening	An adaptation of media's *flow* of perceptual and attentional cues as delivered through sound. Media listening and distracted listening are two positions of listening that Truax (2001) argues are a direct result of the transition to electroacoustic sound and especially the way in which sound has evolved in its use in media. Since much of media is experienced as a background to life, often in the visual background, programming flow has developed sophisticated and strong aural cues in order to manage and direct listeners' attention to the next item on the media program.
Analytical Listening	A focused, critical expert listening to particular qualities of electroacoustic sounds and recordings.

taking the viewer into a powerful suspension of disbelief, to complete virtual reality, ambient intelligent environments, and computer-augmented physical spaces which have become the norm for contemporary museums and art galleries. There is also the ever-so-popular genre of *reality TV*, which has reared and acculturated a version of *society of the spectacle* generation of audiences.

FIDELITY

Literally, fidelity means *faithfulness*. In relation to sound, fidelity signifies the accuracy and quality of sound reproduction, that is, the degree to which an electroacoustic iteration faithfully represents the original acoustic source. From there, the notions of hi-fi (high fidelity) and lo-fi have emerged and are now commonly applied to refer to quality of audio equipment, specific recordings and (cinematic) listening experiences. As noted in the previous section, Schafer (1977) also utilized these two distinctions of fidelity, except he applied them to refer to a soundscape's ecological balance in terms of a signal-to-noise ratio. In this section, we'll focus on fidelity as a concept representing the move from abstract musical *chiptunes* (8-bit synthetic tunes) to realistic sampled sounds in the design of game soundscapes. Fidelity here will exemplify the technological changes in game sound's *realism*.

Role in Game Sound: Socio-Cultural History

In tracing some of the history of game sound, Stephen Deutch (2003) makes a convincing point about the trajectories that sound for games has taken historically. As he points out, the first game sound designers were essentially musicians and/or experimental composers (p. 31). In that, historically there was a split between those who followed Pierre Schaffeur's *musique concrète* tradition and those who were interested in electronic music. The second group ended up getting involved in game sound production and laying the foundations of contemporary game sound. The way in which this fact concerns fidelity is that while *musique concrète* works with sampled sound—that is, *real* acoustic sources—as material for sonic expressions, electronic musicians were fascinated with the purely abstract world of the synthesizer and

the completely un-real soundscapes it produced. From here we have the tradition of *chiptunes*: 8-bit synth tunes encoded directly on the microchip of the game console. Initially, of course, space and memory were some of the pragmatic issues driving the minimalistic and synth-based soundscapes in games. With technological improvements, such constraints are no longer relevant, however the demographic of game sound practitioners still exerts a formative role not on what is *possible* but on what is *realized* in game sound today and how associations between sounds and their meanings in a game become forged. As Deutch puts it, even though game sound emulates film sound in its "filmic reality" of representation, it is often too literal—"sound effects as opposed to sound design" (p. 31) —see Figure 1.

Invoking what Schafer (1977) might call the *listener as composer*, many games today utilize adaptive-interactive audio, that is, each player constructs her own unique soundscape by moving and interacting with their avatar. Yet even then sound effects are "loopy": they often come from generic sound banks, (see Figure 3) and are exactly the same each time they sound, sometimes getting cut off if the player's actions are faster than the sound file's duration. They get called up and filtered according to the spatial/contextual demands of the character's progression, however, it is only in high-end games, typically in first-person shooters (FPS) where the richness of a complex soundscape really comes through with 3D audio rendering and spatialization (Grimshaw, 2008) to account for acoustic coloration and atmospheric variables. FPS games afford the player the unique position of literally listening with the character's ears since the game presupposes the player is that character. Any other POV (point of view) character stance by definition distances the player from the soundscape, making

Figure 1. Note the compressed, repetitive nature of the waveform, reflecting synthetic strings of sounds, often separated by little sine tone clicks and artificial silences

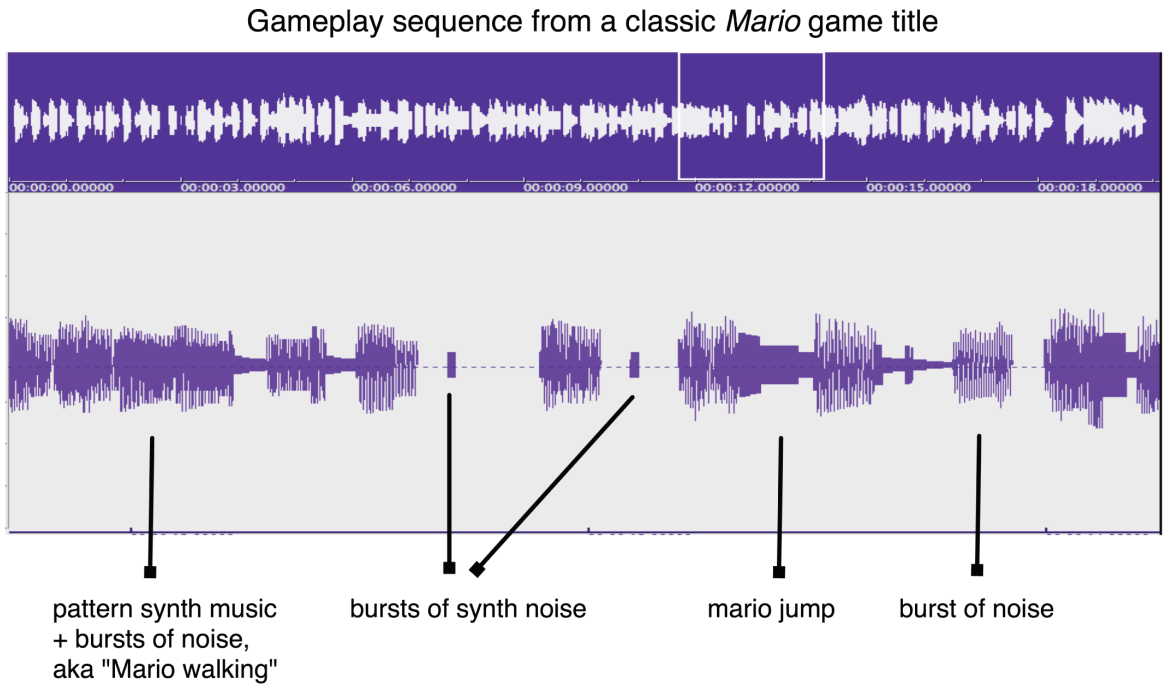
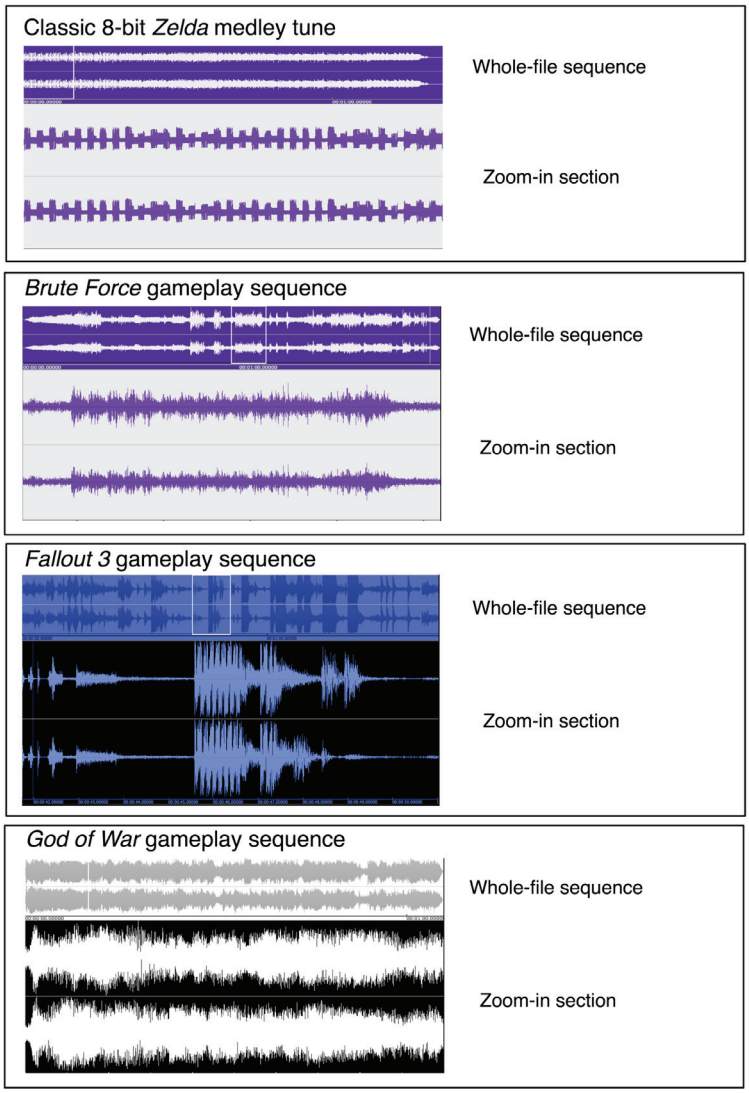
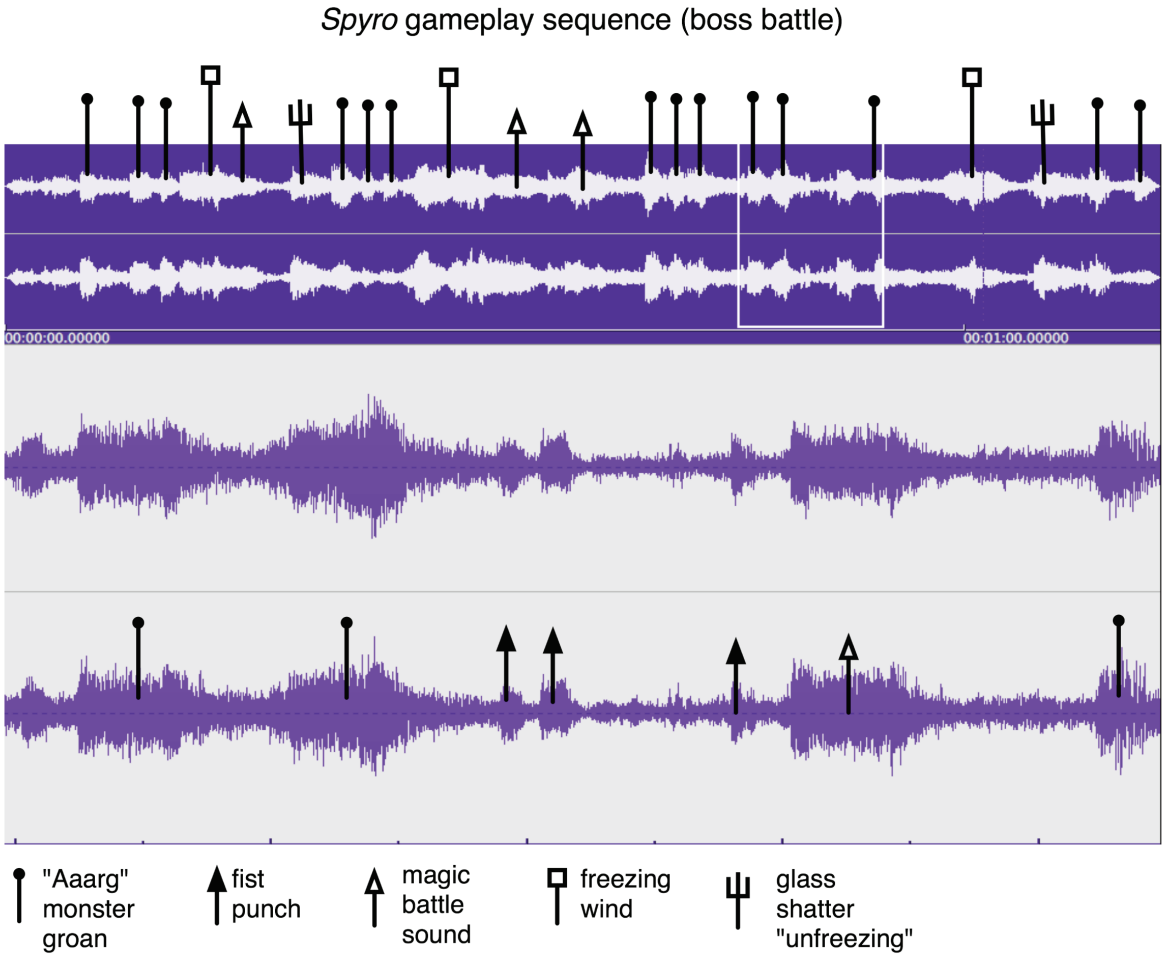


Figure 2. Historical and cross-genre, cross-platform example of game soundscapes. In the first two examples we see a progression from 8-bit sound to polyphonic synthesized sound, while Fallout 3 reflects a 3D spatialized environment of varied and large dynamic range (highs and lows) to avoid masking and maximize clarity; finally God of War features a broadband soundscape where many (high-quality sounds) are mixed in, competing and somewhat masking each other



them more of an audience member as opposed to a true participant in that acoustic ecology. This current model of game sound design has slowly shifted to reflect the interactive, dynamic and personalized nature of game soundscapes, departing from the cinematic tradition and the early game 8-bit sound. It uses sound samples organized in banks that are called up in real-time to be filtered and mixed in as a player progresses through a game, reflecting the quality of a space, sound behaviour and ambience in real time as well. For example, if our avatar is in an ocean setting we will hear waves, wind and seagulls; similarly, if the avatar is moving down a tunnel looking to

Figure 3. Note the flow of gameplay, comprised of series of loops, varied slightly, however having a uniform attack-sustain pattern thus still sounding "loopy", and often triggered out of temporal sync, resulting in unrealistic interruptions and overlap. Also, the stereo zoom-in reveals little if any spatialization. Elements that aren't identified on the diagram are the background music and cave ambiance, as well as a few other uniform sound effects such as footsteps



avoid or preempt enemy attacks, out-of-frame sounds are heard as coming from their respective (implied) locations and from the appropriate distance.

There are three ways in which we can examine the shifts of game sound fidelity over time. As pointed out in other game sound histories (Collins, 2008; McDonald, 2008), 8-bit sound from early fantasy and arcade-style games has evolved to polyphonic MIDI orchestrations, higher quality rendering, and richer textures but with essentially the same melodies and game sound conventions. On the other hand, shifts in interactive-adaptive audio, as a relatively contemporary design standard, are less evident historically, but manifest themselves across different game genres and platforms. For instance, portable platforms feature only a limited sonic variety in representative/environmental sound effects, relying heavily on synthesized polyphonic mixes; more affordable

consoles such as the *Gamecube*, the *Wii*, and the *PlayStation 2* tend to feature games with more authentic soundscapes and variety, and higher-end consoles such as the *PlayStation 3* and *Xbox 360* flaunt stellar graphics as well as multi-channel, 3D sound capabilities capable of delivering that precision of spatialization and timbre characteristic of FPS games. Similarly, fantasy and action role playing games (RPGs) such as *Final Fantasy*, *Prince of Persia*, *Assassin's Creed 2,* and *God of War*, to mention a few, use limited and uniform sound effects banks to build environments with minimal acoustic properties: even though the audio is less compressed in quality then in their predecessors. Higher-end military, FPS and strategy games such as *Hitman*, and *Metal Gear Solid* often combine a rich variety of high-quality sound effects rendered with 3D sound spatialization techniques and sound behaviour physics engines to simulate the temporal and spatial trajectories of competing sonic information in the game space.

Finally, fidelity changes in game sound can also be discussed in terms of Schafer's classifications of hi-fi and lo-fi soundscapes (1977; Truax, 2001, p. 21) reflecting the ecological acoustic balance in a given environment. Quite simply, as game sound has become more complex, richer in textures, and in need of accommodating an ever-expanding variety of alert cues and signals, game soundscapes have become sites for much sonic masking. If we look at Figure 2 we see a transition from a one-track synthesized music model, which lacks authentic fidelity but has little masking; to more complex games where the soundtracks become a constant broadband spectrum of high-quality music, environmental sound effects, alerts and signals, and ambience coloration.

However, the newest trend in game sound design (Collins, 2008; Farnell, 2011; Hug, 2011; Phillips, 2009) might be to return to synthesis utilizing much more sophisticated tools - physical modeling and real-time sound synthesis to realistically convey not only every sound occurring in a game but its every unique variation, coloration, temporal and spatial character, in interaction with other sounds within the electroacoustic environment. Such an approach to game sound synthesis would make the game soundscape truly personalized through subtlety and non-repetition, and it would reverse the tendency to use substitute aural objects or *sound images* from the cinematic tradition, essentially returning game sound to a realistic modelling of acoustic phenomena. However, would such a turn eliminate the necessity for purposeful sound design? Would it make it all about programmatic representation? After all, sound's role in games is not simply descriptive, one of reflecting *reality* in a high-fidelity manner, but it is largely about function! Interface sounds, warning sounds, alerts, and musical earcons must continue to be part of this acoustic ecology, subject to issues of acoustic balance, masking and fidelity, as well as the informational ecology of interactive play.

The Listening Experience

So what types of listening do these aspects of fidelity foster in game players/listeners? Listening is essentially a particular way of paying attention. Truax (2001) describes this phenomenon in terms of listening positions that we have developed both with regard to everyday listening and when engaging with different forms of media (pp. 19-23). Film theorists such as Chion (1994) and Murch (1995), among others, have already spoken about different *listening modes*: The one proposed by Chion has also been discussed and augmented by Grimshaw and Schott (2007) in their discussion of FPS games. Tuuri, Mustonen, and Pirhonen (2007) provide a more recent compelling account of listening modes in gameplay, identifying a hierarchical attentional structure of listening. Table 2 attempts to summarize popular notions of listening to game sound and organize them according to existing typologies of game functions (Jorgensen, 2006), attentional positions (Stockburger, 2007)

Table 2. An attempt at linking attentional and listening positions with game functions and examples of game sound

Attentional Position	Game Functions	Listening Position	Examples from Gameplay	Reference Frames		
Foreground	Action-Oriented Functions	Analytical Listening (Truax, 2001) Listening-in-search (Truax, 2001) Semantic Listening (Chion, 1994) Causal Listening (Chion, 1994) Functional, Semantic and Critical Modes of Listening (Tuuri, Mutsonen, & Pirhonen, 2007)	Alerts: notifications, warnings, confirmation and rejection Interface sounds	Trans-diegetic		
Mid Ground	Orienting Functions Identifying Functions	Media Listening (Truax, 2001) Navigational Listening (Grimshaw & Schott, 2007) Causal & Empathetic Modes of Listening (Tuuri, Mutsonen, & Pirhonen, 2007)	Contextual sound effects Auditory icons Earcons	Diegetic		
Background	Atmospheric Functions Control-related functions	Background Listening (Truax, 2001) Reduced Listening (Chion, 1994) Reflexive & Connotative Modes of Listening (Tuuri, Mutsonen, & Pirhonen, 2007)	Musical score Environmental soundscape	Extra-diegetic		

and states of diegesis (Chion, 1994; Grimshaw, 2008; Huiberts & van Tol, 2008; Jørgensen, 2006). As a side note, Jørgensen's (2011) newest work in this book brings an important critique of the very usefulness of discussing game sound in terms of diegesis given that sound in games needs to function on many different levels besides a descriptive/immersive one and such levels may be non-diegetic according to film theory's definition of diegesis, and yet function as diegetic cues within a game's soundtrack. As another limitation of diegesis, I will argue in the last section of this chapter that it fails to recognize sounds outside the gameworld which may very much be part of the experience of play: the acoustic soundscape of group play, the arcade environment or online audio conferencing such as *Teamspeak*.

VERISIMILITUDE

If fidelity refers to the faithfulness of sound quality in computer games, verisimilitude concerns itself with the experience and nature of *truthfulness* and authenticity in a game context, as conveyed through the game soundscape. In the section above we used the notion of fidelity to trace the move from synthetic tones representing *real* actions to *realistic* sound effects attached to character movements that are called up interactively to combine into a unique and (at least in principle) seamless flow. Verisimilitude addresses precisely the nature of this acoustic ecology and its claim to represent a realistic experience in both temporal and spatial terms. In its traditional literary/theatrical definition, verisimilitude reflects the extent to which a work of fiction exhibits realism or authenticity, or otherwise conforms to our sense of reality. In film, the notion of verisimilitude signifies the relative success of cinematography at creating an immersive, engaging fictional world of hyper-realistic proportions both in terms of image and sound, but also of intensity of emotion and experience (Chion, 1994; Deutch, 2003; Figgis, 2003; Murch, 1995). The core idea in this section is the notion that game sound has developed historically to conform to our sense of reality while at the same time it has constructed a sense of reality, particular to games, that we now expect.

Role in Game Sound: Socio-Cultural History

Cinematic immersion works by presenting a hyper-real universe, a larger-than-life movie world with action and emotion wrought to an exaggeratedly high intensity. It both summons attention and diverts attention. Its visual and auditory elements both attract and construct an experience and work to divert the audience's attention from realizing that what they see isn't *real*. In games, this is even more the case-by definition games are interactive-their auditory and visual elements are driven by the player. So already, there is an implication that the *auditeur* is also a participant, hearing with the ears of the character. As Chion (2003) puts it (in relation to David Lynch's cinematographic style): "We listen to the characters listening to us listening to them" (p. 153). In FPS games, this relationship is even clearer as the soundscape design is very intentionally oriented towards an authentic experience of listening with the character's ears—the acoustic field shifting with the avatar's movement on screen, the reflections, sound coloration and directionality of sounds dynamically and responsively shifting along—a mode of listening that Grimshaw (2008) defines as *first-person audition* (p. 83).

Undoubtedly, one of the most important predecessors of game sound is sound in cinema. Expanding the context of significance to other media forms would include radio (the predecessor to film) as well as television and a particular genre of motion picture: cartoons (with their own predecessor, the paper comic). Unlike cinema, however, where sound's role is highly artistic and affective, or radio and television, where sound is part of a programming *flow* (Truax, 2001, p. 169) sound in games must aspire to both aesthetic, affective as well as informational and epistemic functions. Since games are an interactive medium, these functions often overlap and are interdependent. Verisimilitude as a feature of a designed or supporting soundscape can be traced back to the early days of radio particularly with radio drama (Truax, 2001, p. 170). In the absence of a visual reference in-house generated sound effects came to play a central role in creating a realistic environment to go along with the narrative, thus inadvertently giving birth to some of the most widespread conventions of cinema and game sound: notable examples being *fist-fight* sounds or *walking in snow* sounds, the former being generated as an artificial exaggeration of what a punch *would* sound like, and the latter is easily simulated by grinding a fist into a bag of rice or peppercorns. Foley art, which emerged as the mainstream film

sound craft in the earlier days of modern cinema, and which is experiencing a resurgence today, builds directly onto these conventions, generating an ever-increasing repertoire of techniques through which to simulate "real" sounds (typically by using other acoustic materials).

In his discussion of film sound Christian Metz (1985) uses the term *aural objects* to refer to film's tendency to solidify an arbitrary relationship between the viewer/listener's perception of real sounds and the reality of the actual sound sources. The resulting realism, as pointed out not only by him, but other film theorists such as Chion (1994), Deutsh (2003), Figgis (2003) and Murch (1995), to name a few, is that film *sound bites* become hyper-real: We associate them with certain events and interactions in place of their authentic acoustic counterparts. For example, if someone played back the actual sound of walking in snow and the sound of close-miked grinding into a bag of rice, most of us would perceive the latter as more real. Given such a set of conventions, and media's natural condition of being an inter-textual and self-perpetuating phenomenon, subsequent media forms and genres simply have to play on and incorporate said conventions. Or do they?

Aural Objects, Flow and Space

As mentioned already, the first RPGs utilized a small corpus of synthesized melodies to denote unique spaces, quintessential game moments and mood. Loosely based on music psychology conventions, these early game soundscapes used major tonality to signify an uplifting mood, minor tonality to signify danger or failure (as in *Zelda* or the *Final Fantasy* series), upward note-trill to denote jump and a downward note sequence to indicate death or end-game (as in all of the *Super Mario*-based and derivative series). The bigger picture in the early days consisted of having a continuously running soundtrack of synthesized music where many smaller elements, that are meaningful in themselves mix together to create a flow of gameplay experience (McDonald, 2009) but also a game *space*.

As with narrative support music in cinema, synthesized tunes in early games, specifically in the fantasy genre (titles such as *Final Fantasy*, *Zelda*, *Castlevania* and others), act as a *vector* (to use Chion's (1994) term) to the temporal flow of the interactive experience and take on iconic or referential meaning (Deutch, 2003). It is precisely this quality of game sound that illustrates perfectly the distinction between fidelity and verisimilitude - as technologies, storage capacities and processing speeds of game consoles have improved over time, some games have moved towards a more and more authentic depiction of the acoustic reality, while others continue to preserve the nostalgic qualities of what Murch (1995) calls *metaphoric sound*, only in better sound quality (see Figure 2). Metaphoric sound—one that does not represent the action seen on the screen *realistically,* is so ingrained in our cultural memory that it seems odd to even point it out. Popularized by early fantasy games and their predecessors—isomorphic cartoon sounds (Altman, 1992), it contributes to a type of verisimilitude that is very different from the one richer and more realistic game genres strive for (adventure, military or FPS games). In other words, *Super Mario*, *Zelda* or *Final Fantasy* just wouldn't be recognizable to their audience or, in our terms, possess verisimilitude, if it were not for their inter-textual references to iconic sounds of the past. Examples are ample - the theme sounds of their game universe or even individual sound effects such as the *1-up* sound, the brick-smashing sound or the jumping tune in *Super Mario*; the battle cries of *Zelda*'s Link and its iconic chest-opening sounds; or the epic combat rhythms during attacks and boss battles in *Final Fantasy,* among many others. Given this, sound designers for classic fantasy titles take great care to preserve these iconic sounds in each platform and each iteration of their titles. As Phillips (2009) mentions in his expose on film and game music,

fantasy game theme songs have long transgressed the computer game genre and, particularly in Japan, are frequently re-orchestrated and performed by choirs and symphonic orchestras. Composers of game music, while largely unknown in North America have star status in most of Asia.

There is another issue too: fantasy games deal with imaginary actions that no one has experienced in the real world, such as stepping on enemies' heads, eating a giant mushroom, catching a star (references from *Super Mario*) and, sonically, these actions do not have 'real' counterparts in the acoustic reality we are familiar with. Creating the infamous sound of the lightsaber in *Star Wars* (McDonald, 2008) is a classic story in the history of metaphoric sound using both musical conventions and pop-psychology. Likewise, this quote from a sound designer of *Torment* illustrates game verisimilitude challenges perfectly:

During Torment, I was processing some sword hits, and they were coming up very interesting. While they didn't work for the spell I was working on, I gave them a description like 'reverberant metal tones, good spell source.' Later, I was looking for something with those qualities, but had forgotten I made those sounds. When I searched my database for 'metal tones', I found them, and they were exactly what I needed! (Farmer, 2009)

A less discussed but highly important part of game verisimilitude is the temporal flow of the soundscape, as it is intimately linked to the tradition of sound effects and aural objects. While the *fantasy sound* of the past presents a highly melodic, musically semantic flow, the interactive-adaptive tradition results in a "loopy"-sounding score of slightly varied bank sound effects (i.e. there may be only one *footsteps* sound that is nevertheless used for all characters) organized around modules of game quests and activities but lacking an overall structure or temporal design (see Figure 3 below).

Another aspect of verisimilitude in game sound has to do with creating space, specifically in realistic, rich cinematic RPG/action games. I will begin with Murch's (1995) notion of *worldizing*—giving a certain space acoustic qualities that make the player get involved—and combine that with Ekman's (2005) discussion on diegetic versus non-diegetic sound as acoustic elements that do or do not belong to a gameworld. Historically, it is important to note again how early games (Collins, 2008; McDonald, 2008) instantiated the use of a melody to represent space—for example, in *Final Fantasy* towns have a certain melody representing the calm mood of a non-threatening environment while out-of-town wooded areas use a separate melody which is consistent everywhere in the game and represents mild danger: mission dungeons have their own musical melody and, within them, entering the space of a boss battle features a fast-paced tension music that is consistently the same throughout the game for each boss battle. Thus, these games established a situation where mood, space, and call-to-action are rolled into one and are all represented via one single melody/track. With the emergence of more powerful game consoles the notion of *space* becomes divorced from the conveyance of *mood* or a call for a particular action and becomes more representative and realistic aiming to immerse the player into a gameworld.

This connects the idea of diegesis with the notion of verisimilitude through the experience of immersion, as "immersion is a mental construct resulting from perception rather than sensation" (Grimshaw & Schott, 2007, p. 476). While the cinematic concept of *diegesis* simply refers to whether or not the sound source is in or outside the frame, both Jørgensen (2006) and Ekman (2005) use this term to address whether a sound belongs to a gameworld or not. There is an important distinction to be made in using diegesis in this way as it puts the emphasis on immersion into the *resounding space* (Grimshaw & Schott, 2007) of a game and carries an implication that the gameworld already *is* an acoustic reality that sounds either belong or not belong to. On the other hand, regarding diegesis only as a refer-

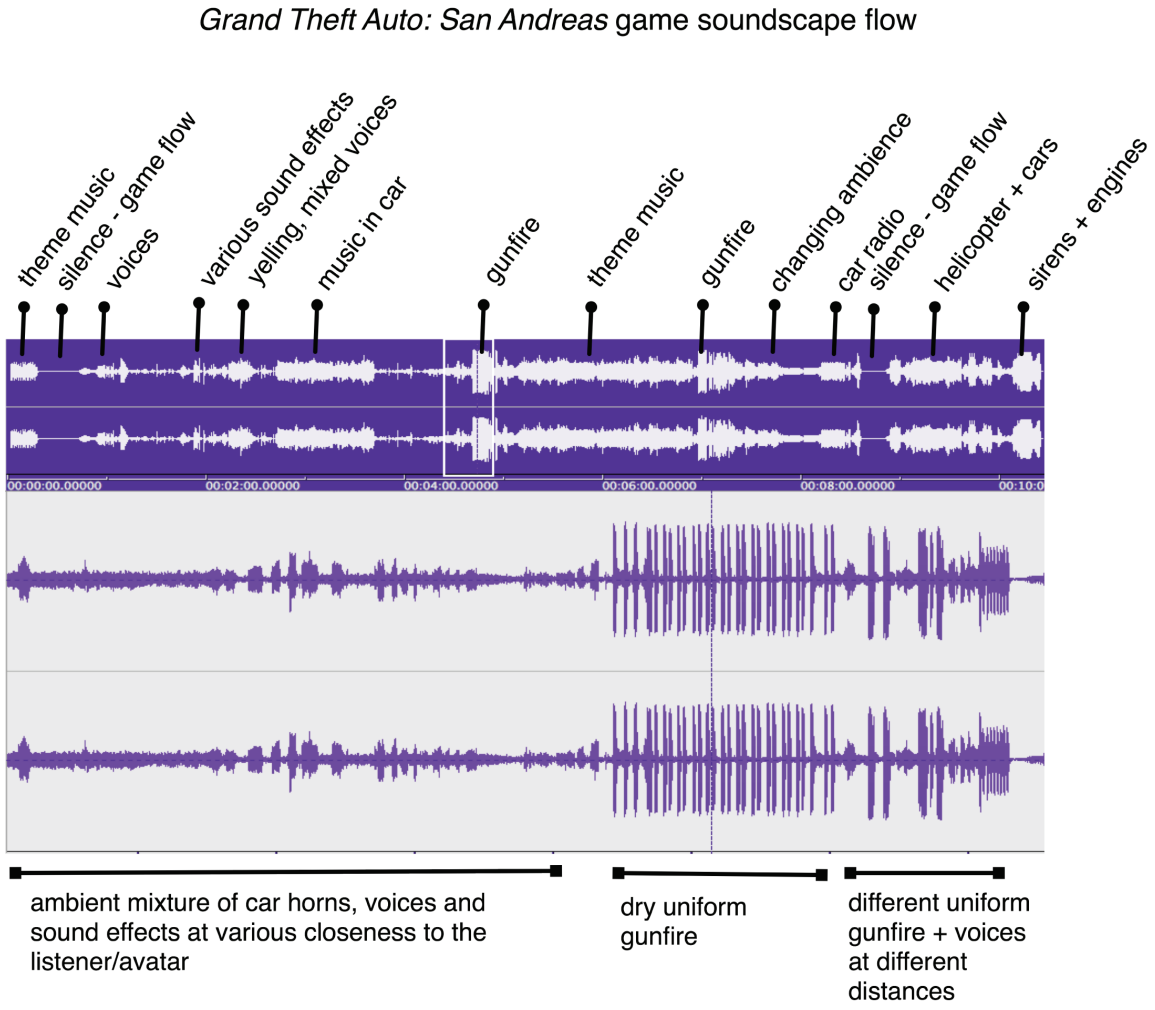
ence to in- or out-of frame sounds leaves the game soundscape intact as it assumes then that *all* sounds are part of the gameworld. Such an idea fits perfectly with Schafer and Truax's notion of an acoustic community (1977; 2001): a sonic locale or context that is formed over time through a dynamic exchange between sounds, soundscape and listeners, becoming an ecology of its own that can be threatened, altered or generally disturbed by the introduction of new, foreign sounds or the removal of familiar signals that local inhabitants (players) depend upon. The question is whether it is an ecology, where the listener is consumed by the soundscape in a spectator-based relationship (Westerkamp, 1990), or if the ecology includes the player in an (inter)active co-production. Again, we have to remind ourselves that immersion is a perception, not a sensation (Grimshaw, 2008, pp. 170-174). The answer is in the *ear of the listener* so to speak: While even realistic games represent only a small portion of the game environment sonically (see Figure 4), they do successfully create and maintain a sense of immersion, verisimilitude, and belonging to a gameworld, not to mention conveying information through sonic signals.

LISTENING TO GAME SOUND

It follows that the historic shifts of verisimilitude in game sound have affected the experience of listening as well. With the socio-cultural baggage of radio and film sound, listeners are already conditioned to accept *aural objects* (Metz, 1985), internalize them, and think of them as more real than the real sounds they represent. Further, listeners of game sound have adopted what Colin Ware (2004) refers to in visual studies as *naive physics of perception*—in the aural sense. That is, players accept and often ignore the clearly artificial behaviour of looped sound bites, their sometimes low or unrealistic quality, and their lack of diversity and complexity (see Figures 3 and 4). What Ware was trying to get to is that designers often reduce work and design complexity by counting on the fact that players don't need that much realism—only enough in order to be *hooked*. The idea being is, it is acceptable if a lot of things from the real world don't necessarily manifest themselves sonically in the gameworld. Given this, we can now expand the framework of listening positions from Table 1 to include a pattern of attention to sound that ignores the otherwise obvious "loopy"-ness of sound effects and as such, the predictability of game soundscapes as a whole. A listening of denial, or *naive listening* is perhaps a good term to use. It is not that players can't, when prompted, identify the artificial nature of many sonic elements in a game soundscape, it is that they conditionally and purposefully ignore it, while instead immersing themselves in the experience of gameplay. Ideals of game sound become less about fidelity of acoustic sources or of audio quality and more the verisimilitude of non-engaging engagement with a holistic, interactive environment.

From the discussion so far, there are a few other modes of listening that I would like to put forth, however before I introduce them, it is important to draw a link between the types of listening fostered by the *flow* of television and contemporary radio soundscapes, and those encouraged by the gameplay experience in general. The emergence of continuous media such as radio and TV created a brand new type of listening experience: one that Truax calls distracted or media listening (2001, p. 169). In order to accommodate viewers tuning in and out of the program and at the same time attract and keep their attention, TV sound flow uses a number of attention-management techniques such as dynamic shift changes and modular programming structure (Truax, 2001, p. 170). It essentially tells us how to listen. It trains us to increase or decrease our auditory attention by use of carefully crafted cues, until they become second nature. These gestalts of auditory perception, then, seamlessly integrate cinema and game sound, carrying the promise of total immersion, suspension of disbelief and verisimilitude. As a

Figure 4. A sonic excerpt from Grand Theft Auto: San Andreas gameplay. While richer and more varied in dynamic range (including periods of relative silence) the game flow still consists of a series of sound effects strung together, with some distance/amplitude rendering



result, we begin relying less on active, engaged, information-processing listening, and more on habitual background and media listening in all of our surroundings (Schafer, 1977; Truax, 2001). This is not to forget however, that games are interactive, and the player is, in Schafer's terms, a co-composer of her own game soundscape, at the same time that she listens to it. The listening positions that I'd like to add to in the interest of engaging with and critically understanding the experience of computer game sound are presented in Table 3.

ECOLOGY

Discussing game soundscapes as sites of local acoustic ecologies is not a novel idea (Grimshaw, 2008) and as Grimshaw and Schott (2007) point out, "the more immersive a game is the more appro-

Table 3. A set of listening modes emergent out of the current discussion on fidelity, verisimilitude and the ecology of game sound. These modes reflect and attempt to identify macro trends borne out of historical shifts in the qualities, techniques and functions of game sound over time

Imaginative Listening	A listening that supplies the perceptual conditions for immersion - building up a mental image of an environment from the little that is provided acoustically by the game's soundtrack, for example, the way a game like *Cooking Mama* is reminiscent of *Super Mario* games and evokes a fun, fantastical, care-free world.
Nostalgic Listening	An analytical, culturally-critical type of listening that has emerged over time in experienced players who look for iconic game music themes through platforms and generations of a particular game (some notable examples here being the *Final Fantasy*, *Super Mario*, *Zelda* and *Mega Man* series).
Disjunctive Listening	A listening position that describes the ability that gamers develop to very quickly and fluidly interchange listening attentions—one moment they may be immersed in the heat and tension of a battle and in the next they may pause to change their settings, entering a *user interface* type of soundscape (for instance, in the *Fallout 3* example in Figure 2, the player shifts constantly between the battlefield ambience/listening position and armour selection/target selection screens).
Naive Listening	A non-analytical, electroacoustic listening that allows the player to feel *immersed* into the game reality with the minimum amount of auditory complexity. In the absence of truly realistic soundscapes, players effortlessly ignore loops, repetitions and lack of sonic fidelity in order to become more immersed in the game. The name is inspired by Ware's (2004)*naive physics of perception* idea.
Conditioned Listening	The type of listening that Truax (2001) calls *media [flow] listening* (p. 169) where players listen with an underlying expectation of how the flow of the game's soundscape will unfold, tacitly familiar with the sonic elements of the games in general.
Inter-textual Listening	A result of cross-pollination of different media genres, this listening position addresses situations where game soundscapes contain radio, telephone, or TV sounds (most famously featured in *Grand Theft Auto*). Conversely, the popular events of *Video Game Concerts* are settings where game sounds live on outside gameworlds and are performed, listened to, and used for other purposes outside of games.

priate it is to discuss the game world in terms of an ecology and, therefore, the greater the immersive function of the game sounds'' (p. 479). Grimshaw, unlike Schafer, analogizes game soundscapes to an actual bio-ecology where various species (in our case, sounds) interact, co-exist and are co-dependent on each other. He also focuses on the ecology of first person shooter (FPS) game soundscapes as this genre lends itself particularly well to a discussion of ecology in terms of sound. Spatialization and 3D sound rendering are honed to an art form in FPS games and the player literally has to listen through the character's ears in order to play and succeed in the game. Sounds of shots, enemies in the background or out-of-the-frame (extra-diegetic) sounds are extremely important, as are user interface sounds including warnings and alarms that often require immediate attention and split-second decisions (trans-diegetic sounds, per Jørgensen, 2006). Schafer, however, would still look at ecology from the perspective of balance within an acoustic community where each sound has a meaning in the sonic context and a place within the spectral niche of the soundscape. This acoustic balance may or may not be in stasis: at certain times an element may mask and overpower other sonic elements. For example, in action scenes music often takes on a dominant sonic role overshadowing smaller environmental or game alert sounds (in Figure 4 it is clearly visible in the full sequence layout (top section) that music tracks have a significantly higher/broader dynamic range than all other sound effects). For Schafer, and especially for Truax whose work focuses more on electroacoustic sound, sound balance is not simply about *loudness* but also about value connotations. Music, for example, is not only a much stronger emotional, affective device than environmental sound within a given game environment, but it also carries a history of being used commercially, to condition consumers into spending time and money in certain settings

(Truax, 2001; Westerkamp, 1991). As Hildegard Westerkamp (1991) points out, the phenomenon of *background music* is responsible for sound becoming "associated in our memories with environments and products" (1991). In essence it becomes the ambience of the media environment, however, it does not result in endless diversity of spaces and sounds but, rather, in the emergence of archetypal surrogate environments (Westerkamp, 1991). In the context of games, ominous abstract tones analogous to the cinematic model of the *mood track* provide such a strong emotional sense, enforced and enriched by previous generations of media listening such as film, radio and TV, that the acoustic qualities of space, reverberation, distance, location and timbre, which are the more subtle yet vital cues of everyday listening, are often lost in the 'background'. Similarly, music in action and rhythm games often provides a promotion vehicle for indie bands whose sound is conceived as culturally related to the genre of the game itself thus perpetuating—not challenging—the status quo of popular culture and mass media. Essentially, music's overshadowing of other sonic elements has both a cultural and a political economic implication for games in addition to an acoustic one.

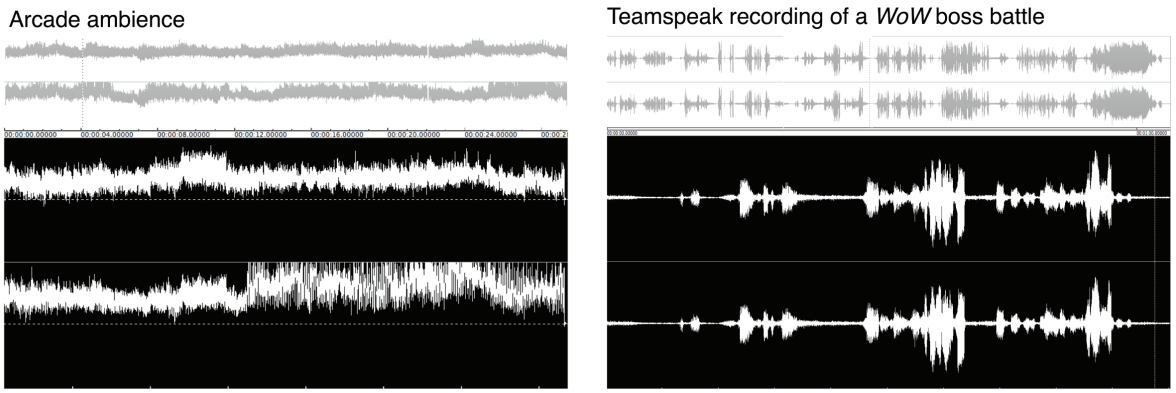
Ecology of Listening

While so far we have been discussing new listening patterns that emerge from the experience of game soundscapes and their socio-cultural and historical evolution, what about the listening that takes place inside game soundscapes? Does anybody listen within the game itself or is it a silent vacuum space where sound happens but no one can hear it? In other words, how would a game's acoustic ecology change if characters in it (maybe even all of them!) could listen to one another and to the player's character, or even to sounds outside the gameworld? In Truax's (2001) terms this would complete the holistic relationship of true acoustic communication, uniting a constant interplay between listeners, sounds and soundscape, where game characters and the player-driven avatar are all participants in the ecology. However, such algorithmic subtlety is far from reality to date and, partly due to economic reasons but also party due to notions of value, may never be a generally utilized phenomenon anyway. Even though sound in games has experienced tremendous growth and is now considered an important part of game design, development companies still invest in it considerably less than they do in visual graphics and animation. Sound designers in game development companies are typically pressured to stick with *tried and true* approaches to composition, design and functionality of audio, and are dissuaded from implementing "risky" new ways of using sound as part of the game mechanics. There are, of course, a few examples where sound is used in more participatory or ecological ways. For a while now *Nintendo DS* features a microphone input so games such as *Elektroplankton* and to a lesser degree titles such as *Yoshi's Island* or *Guitar Hero* involve user-generated vocal elements into the gameplay: mostly in the form of shouting, blowing or speaking into the mike. More complex platforms support a genre called *stealth games* where the avatar's own soundmaking in the game (primarily footsteps) is implied to be *heard* by the other non-player characters. *Metal Gear Solid* is the best known title, in addition to *Hitman*, *Assassin's Creed 2*, and even youth-themed games such as *Harry Potter and the Chamber of Secrets*, or *Zelda: The Phantom Hourglass*, where Link has to walk slowly in the Temple of Time in order not to alert the phantom knights. Even at a rudimentary implementation such as linking the player/character's speed to levels of "noise" in a given space, this approach taps into an aspect of acoustic ecology that has been largely overlooked: the character's experience of listening within the gameworld. Acoustic Community as a Feature of Game Sound

We have already discussed acoustic community in the context of game soundscapes as a conglomeration of different types of sound cues,

sound functions, foreground, midground and background sounds; a community that forms over time and evokes a coherent sense of *place* in the gameworld. In this section, I'd like to also bring up the idea of the acoustic soundscape that is located outside the gameworld but exists synchronously to it: the sounds that surround the player in her physical environment, sounds that may or may not be related to the gameplay, but are nevertheless part of the immediate acoustic community that the player or players are in. Without focusing too much on the minutiae of less significant sonic details such as household sounds, context does offer quite a distinct sense of acoustic community depending on whether a player is at home alone, with friends, at an arcade, at a LAN party, or on a headset with online co-players (see Figure 5). A *Rock Band* house party, for example, is a particular community where the soundmaking of multiple players and audience members supplies much of what makes this game's soundscape a great experience. It is precisely the exclamations of joy, frustration, encouragement—and not the *designed* game sound—that give this acoustic community both a sense of fidelity and verisimilitude. In contrast, many RPG, sports or puzzle games that are played at home, even with company, result in a much quieter soundscape with sporadic and minimal interaction. Using *Teamspeak* or other voice chat programs for Massively multi-player online role-playing games (MMORGs) or multi-player military strategy games results in yet another acoustic community where players' voices have to fit seamlessly within the spectral niche of the game's soundscape without masking or obliteration: every second counts and a lot of the *designed* sonic information is crucial to the gameplay (see Figure 5). Game expos, conventions and professional game championships are another quintessential acoustic community of gaming, filled with PAs (amplified public announcements), a constant arcade-like hum of game sounds: the shifting of chairs and mashing of buttons, whether players are wearing headphones or not, the murmur and exclamations of crowds. In fact the arcade environment, as Phillips (2009) points out, is responsible for some of the early choices in game sound as each game's *signature* soundtrack was designed to attract attention in a loud and noisy acoustic environment of competing

Figure 5. On the left we see a recording from an arcade ambience: a constant hum of competing, masking sounds, many of which are already distorted synthetic chiptunes (in the zoom-in section). On the right we have a Teamspeak-based recording of a World of Warcraft mission: the progression (upper section) clearly reflects more verbal excitement as the team finally defeats a difficult boss, culminating into celebratory exclamations.



game stations: hence gaming's early and ready acceptance of sonic masking. As games moved into the home and became more technologically sophisticated, game sound changed to provide a fuller, more subtle soundscape, often to be delivered through headphones. With the emergence of MMORGs, the popularity of game tournaments, expos, LAN parties and, most recently, *Guitar Hero* and *Rock Band* house party nights, gaming is once more returning to a social model of play where the sounds of the cultural context and setting are again significant and instrumental in forming that sense of acoustic community that unites designed game sound with the incidental (acoustic and electroacoustic) sound-making and sonic environment.

CONCLUSION AND FUTURE DIRECTIONS

This chapter explores the notions of fidelity and verisimilitude manifesting historically both as global cultural conventions of media and technology, as well as, more specifically, being design goals in the production of sound in games. By exploring these two perspectives of acoustic realism through the lens of the acoustic communication framework with its focus on patterns of listening over time, acoustic communities and ecology, I hope to offer a model for future theorizing and exploration of game sound and a lens for in-depth analysis of particular game titles. As well, it is my hope that placing some much needed emphasis on listening, ecology, and the holistic acoustic setting of the gaming experience will benefit not only sound designers and game theorists but will also continue the trajectory of deepening inquiries into game studies as a rich and unique form of interactive media deserving of its own theoretical attentions.

For example, before we go ahead and favour real-time audio synthesis and physical modeling for their realistic acoustic rendering (not an imminent event, I realize: science and programming still have a ways to go), we need to generate precisely the type of historical and socio-cultural analysis of game sound touched on in this chapter. We need to understand the importance of all the elements of a game soundscape, which, for better or for worse, have become important to audiences, or at the very least, we are now habituated to. There is a crucial epistemological relationship there—through inter-textual cross-pollination and transference of practices and artefacts, we have internalized many of these arbitrary meanings and a realistic physical modelling of a game soundscape might not mean much to us or even be conducive to gameplay. Designers, audio engineers and programmers need to know and think about these issues.

Further, I believe the focus on listening positions in this chapter is a key to understanding not only some of the cultural practices surrounding gameplay, but it can also tell us something about auditory perception that designers or scientists could potentially use. Listening to game sound is now every bit as *everyday* as everyday listening goes in our media and technology-saturated environment, so games offer new opportunities to science, given the fact that contextual listening has always evaded laboratory psychoacoustic studies. Clearly, my main concerns however, are with the opportunities for critical and media studies to engage with and treat game sound and the phenomenon of listening to game sound as another rich cultural artifact—a *text* if you will—that can add to the layers of theory and critique surrounding media, art, and cultural expression. While the use of *fidelity* and *verisimilitude* are only two relevant heuristics in the analysis of game sound, it is my hope that the field of media studies will identify others and conduct the same kind of rigorous examination of their historical and cultural roots in order to elucidate their role and importance not only in game sound but in our culture-at-large today.

Finally, my sense of the future directions in the field of game sound is that, as the game industry matures, as playing computer games starts to lose some of its negative notoriety, naturally there is more and more societal and media attention on games as well as on game elements such as sound. With that, increased popularity of gaming results in industry growth, expanding game genres, expanding the notions of what a game is, how it is played and how it is experienced. Sound plays a crucial role in experience and interactivity and there has been an increased design attention to it both from industry as well as from independent artists. With that comes a book like this one and my prediction is that there will be (hopefully) more to come from scholars, critics, media theorists, sociologists, scientists, and designers who would be now better equipped to continue this in-depth conversation about game sound and listening in a way that preserves the complex ecology of people's interactions with their (media/techno)-soundscapes while expanding the multidisciplinary nature of this maturing field. There has been a resurgence of concern over noise and the urban soundscape coming back into public attention in the context of environmentalism and sustainability and, well, it only takes one look at the history of game sound, inter-related with similar media forms and genres, to glean its influence on the way in which we listen, make sense of and experience our physical *offline* soundscape. More work in this area is not only needed, but is, I am confident, bound to come.

REFERENCES

Altman, R. (1992). *Sound theory sound practice*. London: Routledge.

Assassin's Creed 2. (2009). Ubisoft Montreal. Ubisoft.

Brandon, A. (2004). *Audio for games: Planning, process, and production*. Berkeley, CA: New Riders Games.

Castlevania. (1989). Konami Digital Entertainment.

Chion, M. (1994). *Audio-vision, sound on screen*. New York: Columbia University Press.

Chion, M. (1999). *The voice in cinema*. New York: Columbia University Press.

Chion, M. (2003). The silence of the loudspeaker or why with Dolby sound it is the film that listens to us . In Sider, L., Freeman, D., & Sider, J. (Eds.), *Soundscape: The School of Sound lectures 1998-2001* (pp. 150–154). London: Wallflower Press.

Collins, K. (2007). An introduction to the participatory and non-linear aspects of video game audio . In Hawkins, S., & Richardson, J. (Eds.), *Essays on sound and vision (pp. ##-##)*. Helsinki: Helsinki University Press.

Collins, K. (2008). *Game audio: An introduction to the history, theory, and practice of video game music and sound design*. Cambridge, MA: MIT Press.

Cook, P. (Ed.). (1999). *Music, cognition, and computerized sound: An introduction to psychoacoustics*. Cambridge, MA: MIT Press.

Cooking Mama. (2007). *OfficeCreate*. Majesco Publishing.

Deutch, S. (2003). Music for interactive moving pictures . In Sider, L., Freeman, D., & Sider, J. (Eds.), *Soundscape: The School of Sound lectures 1998-2001* (pp. 28–34). London: Wallflower Press.

Ekman, I. (2005). Understanding sound effects in computer games. In *Proceedings of the 6th Annual Digital Arts and Cultures Conference*, 2005, Copenhagen, Denmark: IT University Press.

Electroplankton. (2006). Nintendo America. Nintendo.

Fallout 3. (2008). Bethesda Softworks. Bethesda Game Studios.

Farmer, D. (2009). *The making of Torment audio*. Retrieved July 9, 2009, from http://www.film-sound.org/game-audio/audio.html.

Farnell, A. (2011). Behaviour, structure and causality in procedural audio . In Grimshaw, M. (Ed.), *Game Sound Technology and Player Interaction: Concepts and Developments*. Hershey, PA: IGI Global.

Figgis, M. (2003). Silence: The absence of sound . In Sider, L., Freeman, D., & Sider, J. (Eds.), *Soundscape: The School of Sound lectures 1998-2001* (pp. 1–14). London: Wallflower Press.

Final Fantasy 2. (1988). Squaresoft. Square ENIX.

Friberg, J., & Gärdenfors, D. (2004). Audio games: New perspectives on game audio. In *Proceedings of ACM SIGCHI International Conference on Advances in Computer Entertainment Technology* (pp. 148-154).

Gaver, W. (1994). Using and creating auditory icons. In G. Kramer (Ed.). *Auditory Display: Signification, Audification, and Auditory Interfaces* (Santa Fe Institute Studies in the Sciences of Complexity, Vol. 18, pp. 417-446). Reading, MA: Addison-Wesley.

God of War 2. (2007). SCE Studios Santa Monica. Sony Computer Entertainment.

Grand Theft Auto. (2004). *San Andreas*. Rockstar North. Rockstar Games.

Grimshaw, M. (2008). *The acoustic ecology of the first-person shooter: The player, sound and immersion in the first-person shooter computer game*. Saarbrücken, Country: VDM.

Grimshaw, M., & Schott, G. (2007). Situating gaming as a sonic experience: The acoustic ecology of first-person shooters. In *Proceedings of the Third Digital Games Research Association Conference* (pp. 474-481).

Guitar Hero. (2006). *Harmonix*. Rec Octane.

Harry Potter and the Chamber of Secrets. (2002). *Eurocom*. Electronic Arts.

Hitman. (2002). Io Interactive. Eidos Interactive.

Hug, D. (2011). New wine in new skins: sketching the future of game sound design . In Grimshaw, M. (Ed.), *Game Sound Technology and Player Interaction: Concepts and Developments*. Hershey, PA: IGI Global.

Huiberts, S., & van Tol, R. (2008). IEZA: A framework for game audio, *Gamasutra*, Retrieved April 4, 2009, from http://www.gamasutra.com/view/feature/3509/ieza_a_framework_for_game_audio.php?page=3.

Jørgensen, K. (2006). On the functional aspects of computer game audio. In *Proceedings of the first International AudioMostly Conference* (pp. 48-52).

Jørgensen, K. (2011). Time for new terminology? Diegetic and non-diegetic sounds in computer games revisited . In Grimshaw, M. (Ed.), *Game Sound Technology and Player Interaction: Concepts and Developments*. Hershey, PA: IGI Global.

Marks, A. (2009). *The complete guide to game audio: For composers, musicians, sound designers, game developers* (2nd ed.). Location: Elsevier Press.

McDonald, G. (2008). A brief timeline of video game music. Retrieved July 8, 2009, from http://www.gamespot.com/gamespot/features/video/vg_music/.

Mega Man. (1993). *Capcom*. Capcom Entertainment.

Metal Gear Solid. (1998). *Konami Japan*. Konami Computer Entertainment.

Metz, C. (1985). Aural objects . In Belton, E. W. J. (Ed.), *Film sound (pp. ##-##)*. New York: Columbia University Press.

Murch, W. (1995). Sound design: The dancing shadow . In Boorman, J., Luddy, T., Thomson, D., & Donohue, W. (Eds.), *Projections 4: Filmmakers on film-making* (pp. 237–251). London: Faber and Faber.

Phillips, N. (2009). From films to games, from analog to digital: Two revolutions in multi-media! Retrieved July 8, 2009, from http://www.film-sound.org/game-audio/film_game_parallels.htm.

Planescape: Torment. (2005). Black Island Studios. Interplay.

Rock Band. (2008). *Harmonix*. MTV Games.

Roeber, N., Deutschmann, E. C., & Masuch, M. (2006). Authoring of 3D virtual auditory environments. In *Proceedings of the First International AudioMostly Conference* (pp. 15-21).

Schafer, R. M. (1977). *The tuning of the world*. Toronto: McClelland and Stewart.

Spyro the Dragon. (2008). *Insomniac Games*. Sony Computer Entertainment.

Stockburger, A. (2007). Listen to the iceberg: On the impact of sound in digital games . In von Borries, F., Walz, S. P., & Böttger, M. (Eds.), *Space time play: Computer games, architecture and urbanism: The next level (pp. ##-##). Location: Birkhäuser Publishing*.

Super Mario Bros. NES (1985). Nintendo. Nintendo.

Truax, B. (2001). *Acoustic communication* (2nd ed.). Location: Ablex Publishing.

Tuuri, K., Mustonen, M., & Pirhonen, A. (2007). Same sound—different meanings: A novel scheme for modes of listening. In *Proceedings of the Second International AudioMostly Conference*, 2007, 13-18.

Ware, C. (2004). *Information visualization: Perception for design* (2nd ed.). Location: Morgan Kaufman Publishing.

Westerkamp, H. (1990). Listening and soundmaking: A study of music-as-environment . In Lander, D., & Lexier, M. (Eds.), *Sound by artists (pp. ##-##). Location: Art Metropole & Walter Phillips Gallery*.

Wilhelmsson, U., & Wallén, J. (2011). A combined model for the structuring of computer game audio . In Grimshaw, M. (Ed.), *Game Sound Technology and Player Interaction: Concepts and Developments*. Hershey, PA: IGI Global.

World of Warcraft. (2004). *Blizzard Entertainment*. Blizzard.

Yoshi's Island. (2007). *Nintendo Japan*. Nintendo.

Zelda: Phantom Hourglass. (2007). Nintendo. Nintendo.

KEY TERMS AND DEFINITIONS

Acoustic Community: A term emerging from Schafer and Truax's work with the WSP (World Soundscape Project) in the 1970s referring to stable sonic locales that include a set of sound which clearly belong there and characterize a community: For example, the sounds of coin machines, yelling, and synthesized music all belong to an arcade acoustic community.

Acoustic Ecology: A movement started by R.M. Schafer and continued through the World Forum for Acoustic Ecology (WFAE) and also a term denoting the sonic balance in a given soundscape through its signal-to-noise ratio.

Chiptunes: A term that has been now popularized by the arts community, referring to 8-bit synthesized melodies or single tones that were originally directly encoded onto a game's electronic chip memory, in early game development.

Diegesis: A term from film studies referring to what is in-the-frame of the screen as opposed to what isn't. In game sound studies, Chion is credited with popularizing it to refer to sounds that are in or out of frame from the player's perspective. It has also been used by others to refer to sounds that do or do not belong to the gameworld.

Fidelity: Literally means *faithfulness* and here, it refers to the audio quality of a sound reproduction relative to its original acoustic source.

Listening Positions: Developed by B. Truax as a term, it refers to types of listening attentions that have become patterns over time with exposure to certain types of sound environments, habits, or media, that is, background listening is a passive form of listening attention that we all engage in at different times.

Loopy: An adapted term I am using here to denote the quality of game sound flow in many RPG games where short looped sounds from an effects bank are triggered each time an action is performed, thereby often sounding cut-off, too-similar, or simply uniform.

Soundscape: A term coined by R.M. Schafer to describe the totality of sounds surrounding us at any given time/place: analogous to a landscape.

Verisimilitude: Literally means *similar to reality* and it is a theatrical term referring to the ability of an artwork to appear real, to foster a sense of realism in the audience. Here, it refers to the ability of game soundscapes to *sound real*.