

# Game Sound Technology and Player Interaction

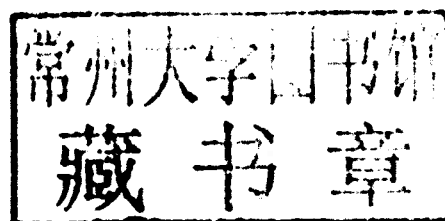
Concepts and Developments



MARK GRIMSHAW

# Game Sound Technology and Player Interaction: Concepts and Developments

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## Foreword

BANG! There, that got your attention. OK, so that's a fairly bad joke to illustrate just what sound can do for you... namely, GET YOUR ATTENTION! Actually, sound does so much more: it connects your visual input to a frame of reference, the audio-visual contract. So, when we create experiences, either in film, TV, live on stage, or in computer games, we use this cerebral connection between sound and vision to intensify your overall experience. Because, that's our goal in any of these mediums—to create an experience!

Sound takes up 50% of this experience (maybe not 50% of the budget, but that's another story). There's an old adage we audiophiles use when discussing budgets in the hope that a producer might actually listen to us once in a while. If you get a room full of people to watch great graphics with poor sound and then compare it to poor graphics with great sound, they will almost always perceive the latter as the best quality graphics.

Generally producers don't believe this story, but I have witnessed it in real life. A few years ago I was working on an AAA title—action adventure: cars, guns, gangsters... you get the idea. One evening, the sound designer reworked the “Whacking someone over the head with a pool cue” sound, improving its overall effectiveness with small, subtle, deep thuds, some crunching bone (actually carrots), and a deliciously realistic skin smacking sound (supermarket chicken being hit by a baseball bat). He added his new sound to the game database and went home. The following morning the game team rebuilt the whole game (including the new sound). Later that day many people congratulated the “Whacking someone over the head with a pool cue” animator on his new improved animation: he was somewhat bemused to say the least. He hadn't worked on that animation for several weeks. I'm sure you can work out what happened, people saw the same animation with the new improved sound and believed they were seeing a better animation. This is how we use the audio-visual contract to our benefit.

OK, so that's my practitioner's story in, but let's take a look at game sound and what you need to study if you are interested in this field... and what's in this book. There are several axes or dimensions to think about. Emotion is the obvious one: fear, anger, hatred and so on, these are all well represented in game sound, from survival horrors to gangster simulations. But what about humour, joy, happiness? Just play Mario Kart, Sonic the Hedgehog, Loco Roco and I guarantee you'll soon realise that the sound has a great deal to do with provoking laughter, smiles, and an enlightened mood.

So, I've now mentioned the breadth of experience our industry creates, but think too of another axis, the history of game sound. From tiny little beeps and bleeps (Pong) to the colossus soundscapes of today's blockbuster games. A story which starts with a few programmers/musicians/sound engineers trying to get “something” out of a paltry 8-bit chip after the graphics guys have already had their fill, through to my point at the beginning of this introduction—persuading a producer to give you some kind of

serious sound budget. A tale of one guy who does everything (including the voice over) to a small army of specialists from musicians, Foley artists, sound technicians, weapons specialists, vehicle specialists, atmosphere creators, the list goes on. Our game sound pioneers took this journey and, along the way, solved some tricky issues, like repetition—in music, in dialogue, in sound effects—memory management, automated in-game mixing and so on.

I am going to sum this section up by saying there are now many different aspects to game sound: music, diegetic sound, atmospheres, interactive music, development of emotional connection, realism, abstractism, super-realism. What I really like about this book's approach to game sound is the 5 core sections which give it a unique and very practical way of tying together all the axes I mentioned earlier, namely: Interactive Practice, Frameworks & Models, Emotion & Affect, Technology, and Current & Future Design. In conclusion, then, I hope that you, as a reader, enjoy the discussion and findings discussed here as much as I have.

*Dave Ranyard*

*Dave Ranyard is the Game Director/Executive Producer of Sony's hugely successful, 20+ million selling SingStar franchise. He has been in the games industry since the mid nineties, starting out as an AI programmer at Psygnosis, and later moving to Sony Computer Entertainment Europe's London Studio where he has held a number of roles over the past 10 years, ranging from audio manager to running the internal creative services group. He has worked on titles including Wip3out, The Getaway & The Getaway: Black Monday, The Eyetoy: Play series and, more recently, Singstar. Prior to the games industry he lectured in Artificial Intelligence at the University of Leeds where he also gained a PhD in the subject. In recent years, Dave has taken a keen interest in GDC and is currently on the advisory board. Dave is a keen musician and he has written and produced many records over the past 15 years.*



## Preface

A phrase often used when writing about the human ability to become immersed in fantasy is “the willing suspension of disbelief” which Samuel Taylor Coleridge first coined in the early 19th Century as an argument for the fantastical in prosody and poetry. What is a computer game? At base, it is nothing more than a cheap plastic disc encased within a cheaper plastic tray. And the system it is destined for? A box of electronics, lifeless in a corner. Put the two together, though, throw in the player's imagination and interaction and he or she is delivered of experiences that, to use Diderot's phrase, are “the strongest magic of art”. Disbelief is suspended willingly, sense and rationality recede, and the player becomes engaged with, engrossed in, and, given the appropriate game, immersed in a virtual world of flickering light and alluring sound where the fantastical becomes the norm and the mythic reality.

For the reader interested in that flickering light, there is a plethora of books and scholarly articles on the subject. For the reader interested in the ins and outs of music and sound software, how to rig a microphone to record sound, and how to transfer that sound to a game environment, there likewise is a wealth of handy resources. For the reader truly interested in understanding or harnessing the power of sound in that virtual world, in emulating reality or the creation of other realities, in engaging, engrossing and immersing the player through sound and emotion, there is this book.

This is a book that deals with computer game sound in a variety of forms and from a variety of viewpoints. Sound FX, rather than game music is the topic, other than where the music is interactive or otherwise intimately bound up with the playing of the game. Such sound FX may be used to emulate acoustic environments of the real world while others deliberately set out to create alternate realities, some are based upon the use of audio samples whilst others are starting to make use of procedural synthesis and audio processing, some sound works hand-in-hand with image and game action to immerse the game player in the gameworld while interactive music in other cases is the sole *raison d'être* of the game. From the simplest of puzzle games to the most detailed and convoluted of gameworlds, sound is the indicator par excellence of player engagement and interaction with the structures of the game and the rules of play.

Academic writing about game sound, its analytical and theoretical drivers, is a developing area and this is reflected by the diversity of theoretical methodologies and the variety of terminology in use. Far from being a weakness, this range points to the potential for the discipline and the wide appeal of its study because it is, at heart, multidisciplinary. The range of subject matter across the chapters reflects the complexity and potential of human interaction with sound in virtual worlds as much as it reflects the passions, backgrounds, and training of the book's contributors. Their contributions to the study of computer game sound bring in disciplines and theories from film studies, cultural studies, sound design, acoustic ecology, acoustics, systems design and computer programming and cognitive sciences and psy-

chology. The authors themselves have a diversity of experience: some are researchers and academics whilst others are sound practitioners in the games industry. All are experts in their chosen field yet all are students of game sound, forever exploring, forever questioning, forever seeking to drive the study and practice forward.

The readership of this book is intended to be similarly diverse in terms of both discipline and motivation. There is something for everyone here: the student for whom a knowledge of computer game sound leads to that important qualification, a game sound designer wishing to keep abreast of the latest thinking and developmental concepts, or an academic theoretician or researcher working to innovate game sound theory or technology. Furthermore, the appeal of the book is wider than computer games, reaching out to those working in virtual reality or with autism, for example. The reader will not find screeds of instructions for software or hardware, programming recipes or tips on how to break into the industry. Instead, contained within this book, will be found lucid essays on philosophical questions, theoretical analyses on aspects of computer game sound, models for conceptualizing sound, ideas for sound design, and provocative discussions about new sound technology and its future implications. All chapters raise further questions as to the fascinating relationship between player and sound.

Reflecting the disciplines the authors come from, some key terms (found at the back of each chapter) are provided with definitions that, *prima facie*, differ slightly to the definition provided for the same key term in another chapter. As with the authors' preferences for American or British English, this has been allowed to stand in order to illustrate both the diversity of approach to the topic throughout the book and the educational and professional backgrounds of each author. The study of computer game sound is yet young and the terminology and its application still in flux: the definition for each key term, where minor differences exist, pertains to the chapter the key term belongs to.

The term “computer game” has been chosen, in preference to a number of other possibilities, as referring to all forms of digital game, arcade machine, gaming console, PC game, or videogame and the reader may assume that, unless a chapter uses one of those specific forms, “computer game” references the general case. Quite deliberately, the term has been chosen in preference to videogame in order to fly the flag for sound: videogames are not just video but sound too and all chapters proselytize the importance of sound to the game experience even where they reference the relationship of sound to image. “Sound” has generally been chosen in preference to “audio” because the focus of the book is on the relationship between sound and player rather than techniques for creating and manipulating audio data. However, “audio” is the usual term in some disciplines and, here, authors have been given free reign to use whichever terminology they are comfortable with.

The book itself is organized into five sections. None is mutually exclusive in terms of its content. Indeed, the astute reader will pick up divers common threads meandering their way through the chapters: the debt game sound owes to film sound and the need to slough off that used skin, issues of presence and player immersion, realism, the unique, interactive nature of computer game sound, and the potential for the emotional manipulation of the player, for instance. All chapters, too, have an eye on the future and its possibilities and authors have been encouraged to speculate on that future.

An oft-overlooked area in computer gaming (and certainly not the first thing that comes to mind with the term “computer game”) is that of electronic gambling machines: one-armed bandits and their modern equivalents. Karen Collins and her co-authors open the first section on Interactive Practice by providing a fascinating glimpse into the sound of such machines and how music and sound FX provoke and toy with the user's emotions in an effort to part them from their money. They draw parallels to sound use in other, more typical computer games and suggest ways in which sound use in electronic gambling



machines might provide inspiration for the design and analysis of sound in computer games in general.

Mats Liljedahl's chapter is an attempt to redress the imbalance between visual and auditory modes in computer games. It does this by providing an overview of the use of sound in virtual environments and augmented realities, in particular, concentrating on the sound designer's required attention to emotion and flow. Using the concept of GameFlow, Liljedahl describes and explains two games he has been involved in the design of in which the sound modality is purposefully given priority over the visual. The chapter seeks to inspire and serves as an introduction to the art of computer game sound design: *Sound for Fantasy and Freedom*.

Linda O Keeffe takes a holistic view of computer game sound by treating it as a dynamic soundscape created anew at each playing. She draws upon soundscape and acoustic ecology theory to elucidate her stance and compares and contrasts game soundscapes to real-world soundscapes. Throughout, O Keeffe prompts questions as to the listener's perception of, and relationship to, soundscapes: what is noise, what roles do context and the player's culture and society play? Ultimately, how can (and why should) we design immersive soundscapes for the gameworld?

Next, Axel Berndt takes a close look at the occurrence of diegetic music in games, design principles for music games and issues of interactivity and algorithmic performance. A critique is presented of recent and current games as regards the performance of in-game music and advice and solutions are offered to improve what is currently a rather static state of affairs, merely scratching at the surface of possibility. Interactivity in music games is assessed through a critique of what is termed visualized music and Berndt proposes a framework of design that incorporates musical performance paradigms both as individual and as social, collaborative practice.

This leads to *Frameworks & Models* which is opened by Kristine Jørgensen and whose chapter is both an exhaustive survey of the use of diegetic terminology, with regard to game sound, and a proposal for a new conceptual model for such sound. The main thrust of her argument is that the concepts of diegetic sound and non-diegetic sound have been transposed from film theory to the study of computer games with frequently scant regard for the very different premises of the two media. The interactive, real-time nature of computer games and the immersive environments of many game genres requires a radical reappraisal of sound usage and sound design for games: games are not films and the use-value of game sound is greater than that of film sound.

This is followed by a chapter in which Ulf Wilhelmsson and Jacob Wallén propose a model for the analysis and design of computer game sound that combines two previous models—the IEZA Framework for game sound and Walter Murch's conceptual model for film sound—with affordance and cognition theories. The IEZA Framework accounts for the structural basis of game sound, the function of sound, while Murch's model describes sound as either embodied or encoded, a system that accounts for human perception and cognitive load limits. Combining the two systems, the authors assert, provides a powerful tool not only for analysis but also for the planning and design of computer game sound and this claim is demonstrated by a practical example.

Milena Droumeva, in her chapter, filters the computer game soundscape through the precepts of Schafer's and Truax's soundscape and acoustic communication theories. Different ways of listening to game sound are proposed with assessments of the role of sound in the perception of realism: Does sound provide fidelity to source or does it provide a sense of verisimilitude and what are the strengths of each approach as regards computer game sound design? Droumeva ultimately advocates a view comprising game soundscape and player together as an acoustic ecology and expands that ecology from the virtual world of the game to include concurrent sounds from the real world.

Ulrich Reiter's chapter on Perceived Quality in Game Audio explores the bi-modality and cross-modality of auditory and visual stimuli in gameworlds. It summarizes previous work in this area and proposes a high-level salience model for the design of audio in games that accounts for both interactivity and attention as the bases for the evaluation of audio quality. Issues of level of realism and verisimilitude are discussed while the validity, and use, of Reiter's proposed model is substantiated through experimental methods outlined towards the end of the chapter.

Paul Toprac and Ahmed Abdel-Meguid's chapter introduces the section dealing with Emotion & Affect. The authors present to the reader four relevant emotion theories then summarize fundamental research they conducted in order to test those properties of diegetic sound best suited to evoke sensations of fear, anxiety, and suspense. Their results, an early example of an empirical and statistical basis for sonic fear and anxiety, lead the authors to devise some rough heuristics for the design of such emotions into computer game sound and to point to directions for future research in the area.

The following chapter, by Guillaume Roux-Girard, also deals with the perception of fear in computer game sound being an in-depth analysis of sound usage in the survival horror game genre that focuses on sound's ability to instil fear and dread in the player. It proposes a model for sound, based upon film sound practice and existing models for computer game sound, that is user-centric—one based on the reception of sound rather than its production—and Roux-Girard provides several illustrative examples from recent horror games to validate the model.

In *Uncanny Speech*, Angela Tinwell, Mark Grimshaw, and Andrew Williams continue the horror theme with a look at Non-Player Character speech in horror games and its relationship to the 1970s' theory of the Uncanny Valley. The authors trace the development of theories of the uncanny from its beginnings in psychoanalysis over 100 years ago through to its practical application in robotics (as the Uncanny Valley theory) and its strong correlation to fear and anxiety in computer games. Recent empirical work by the authors is described and its implication for the design and production of Non-Player Character speech in computer games is discussed.

Stuart Cunningham, Vic Grout, and Richard Picking's chapter looks at Emotion, Content, and Context in Sound and Music. The chapter is an exploration of the interaction that is possible between player and computer game sound, in particular, music playlists used in conjunction with games. The authors provide an overview of emotion research in the context of computer games and consider the emotional and affective value of sound and music to the player. The experimental work that is summarized in the chapter includes the generation of musical playlists according to the environmental context of the player: that is, the environment outside the game. Not only does this raise the intriguing situation of sensory and perceptual overlap and interplay between real-world and virtual, but the authors also suggest further possibilities such as the playlists themselves being responsive to the changing psychology and physiology of the player during gameplay.

Concluding the section Emotion & Affect, Lennart Nacke and Mark Grimshaw's chapter is a study of computer games as affective activity. In this form of activity, sound has a large role to play and the chapter focuses on that role as it affects, indeed effects flow and, particularly, immersion: in the latter case, a preliminary mathematical equation is supplied for modelling immersion. The authors start with a review of psychological and physiological experiments and, combining these approaches, psychophysiological experiments on the effects of sound and image in virtual environments. Following a summary of a recent psychophysiological study on computer game sound conducted by the authors, the chapter concludes with a discussion on the advantages and disadvantages of such an empirical methodology before speculating on the implications of biofeedback for computer game sound with reference to player

interaction and immersion.

The section on Technology opens with a chapter on Spatial Sound for Computer Games and Virtual Reality by David Murphy and Flaithrí Neff. The authors guide the reader through the basics of human spatial sound processing and the propagation of sound in space while pointing out the problems faced in transferring and accurately replicating these phenomena within computer game systems. They conclude with a survey of existing spatial sound technologies for use in virtual worlds, their strengths and weaknesses, and look to the future possibilities for computer game sound posed by the ongoing development of the technology.

Andy Farnell's chapter comprises an in-depth critique of sample-based game audio followed by an analysis of the potential of procedural audio: the real-time design of sound. For Farnell, audio samples have proven to be too limiting, both for the purposes of creativity in game sound design and for the promise of realism: audio samples are predicated upon selection whereas procedural audio is design. A close discussion of procedural audio techniques, both as they have been used and how they might be used to the benefit of computer games, leads the author to the conclusion that it is both pointless and wasteful of computer resources to pursue precise sonic realism: procedural audio can instead be used to provide just the necessary level of realism, a perceptual realism, that is required for the player to comprehend source and source behaviour whilst saving scarce resources for more interesting and immersive tasks.

Eoin Mullan's chapter delves further into the promise of procedural audio by providing a detailed exploration of the potential of physical modelling, a branch of procedural audio. He traces the technique's development from the synthesis of musical instrument sounds to its current state where it stands poised to deliver a new level of behavioural realism to computer games. For Mullan, this will be achieved through the integration of the technology with game physics engines and through physical modelling's ability to provide unprecedented levels of player-sound interaction.

Current & Future Design is the subject of the next two chapters comprising the final section. First, Valter Alves and Licínio Roque present a lucid case for the importance of sound to the design and experience of computer games: attention should be paid to sound from the start of the design process the authors assert. Alves and Roque discuss concepts such as resonance and entrainment as means to engage and immerse players in the gameworld. They present 7 guidelines for game sound design and detail an illustrative example of the application of these heuristics.

Lastly, in this section, Daniel Hug's chapter is a clarion call for a new aesthetic of computer game sound. Through a discussion of two dominant paradigms in computer game sound discourse, pursuit of reality and cinematic aesthetics, it details the debt that game sound owes to cinema sound but then uses examples, in particular from many innovative game developers and from cinema's own subversive stream, to shrug off that mantle and argue for a new future for game sound design. Rich in ideas and provocative in its discourse, the chapter is full of practical suggestions for making computer game sound not only a different experience to cinematic sound but an engaging and rewarding one too.

Closing the chapters is an appendix which is a lightly edited transcript of an online discussion forum to which the book's contributors were invited to attempt to debate and answer the question: What will the player experience of computer game sound be in the future? This is, of course, an open-ended question and the unstructured, lively debate that ensues is indicative of the open-ended potential for the future of computer game sound.

Whatever your need in picking up the book, I hope you will find it met. At the very least, perhaps one of the contributions here will raise intriguing questions in your mind, an itch that will be scratched

by future investigation on your part. Perhaps the ideas contained within will inspire you to develop a new game sound design paradigm or to innovate the technology and push the frontiers of human-sound interaction? After all, the aim of this book is not just to contribute to the development of ever better computer games or more cogent analyses but it is also to cast an illuminating light on at least one part of humankind's relationship with sound as we step out of reality into virtuality.

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*Mark Grimshaw*  
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Section 1

# Interactive Practice



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