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Playing Music

Design, Theory, and Practice of Music-based Games

Dissertation

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ao.Univ.Prof. Dipl.Ing. Dr.techn. Peter Purgathofer
E187 - Institut für Gestaltung und Wirkungsforschung

eingereicht an der Technischen Universität Wien
Fakultät für Informatik

von
Dipl.Ing. Fares Kayali
9625201
Lenaugasse 7/15, 1080 Wien

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Abstrakt

Die Forschung zu Computer- und Videospielen ist eine junge akademische Disziplin. Aus diesem Grund ist eine der primären Herausforderungen das Formulieren grundlegender Modelle und Terminologien, die es ermöglichen digitale Spiele beschreiben, analysieren und gestalten zu können. Diese Arbeit beleuchtet Musik-basierte Spiele im Spannungsfeld zwischen digitalen Spielen, der Medienkunst und Musikinstrumenten. Um derartige Spiele analysieren zu können werden Design-Prinzipien für das Genre musik-basierter Spiele vorgestellt.

Eine qualitative Analyse repräsentativer Beispiele in Kombination mit experimenteller, prototypischer Gestaltung auf mehreren Plattformen, erlaubt die technischen Grundlagen interaktiver Musik darzustellen und exponiert die folgenden Design-Prinzipien: *Active Scores, Rhythmus-basiertes Spielen, Quantisierung, Synästhesie, Kinästhesie, Spiel als Performance, instrumentales Spielen, Audio Agenten und Gesten.* Diese Prinzipien werden definiert und in Kontext mit Interaktivität in Musik-basierten Spielen gesetzt. Daraus ergibt sich eine Grundlage für die Analyse von Interaktivität in Musik-basierten Spielen im Allgemeinen. Eine Differenzierung zwischen Simulationen und traditionellen Spielen erlaubt es ein Modell zu definieren, welches Design Entscheidungen als Zugeständnisse an das *Spielen* von Musik und an das *Spielen* von Spielen formuliert.

Abstract

Game Studies is a young scientific discipline. Therefore, one of its primary goals is the development of adequate models and terminologies for describing, analyzing, and designing digital games. This thesis looks at music-based games as interactive applications at the crossroads of digital games, media art, and instruments. To describe these games, a series of design principles for the genre will be presented.

A qualitative study of representative examples of music-based games in combination with experimental prototyping on multiple platforms has been conducted in order to outline the technical foundations for interactive music and to observe the following design aspects: *active scores, rhythm-based play, quantization, synaesthesia, kinaesthesia, play as performance, instrumental play, sound agents,* and *gestures.* These terms are defined and linked to interactivity in music-based games. This is the foundation for an analysis of interactivity in music-based games. The differentiation between simulation and traditional gameplay leads to a model that illustrates game design decisions as concessions between *playing* games and *playing* music.

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Introduction

The field of game studies is still relatively young and one of its primary goals is the development of adequate models and terminologies for describing, analyzing and designing games (Aarseth, 2003). While the field of game audio is no longer as neglected as it once was, much more research is still needed to fully explore its ramifications. Game audio is an important component of the gameplay experience and is also aesthetically significant (Järvinen, 2002). Current developments indicate that game audio is becoming a new means for digital music distribution. An example of this is the high numbers of songs sold by Harmonix via its game - or music platform, as they prefer it to be called (Edge, 2008a) - *Rock Band* (Harmonix Music Systems, 2007).

This work provides insights on the principles of design of music-based games. Music-based games are an old genre; early examples were produced during the eightie,s and musical environments in interactive media artworks have been around even longer. Yet in recent years, the genre has gained momentum due to the impact that games like *Guitar Hero* (Harmonix Music Systems, 2005) and *Rock Band* have had on casual gamers. The physical nature of the interface (a guitar or drum-kit) is combined with the performance aspect of gameplay to create a powerful immersive experience. Both games are engineered to enhance these aspects and draw the player into the illusion of playing a real instrument. This is just one of many examples of how the design of a gaming instrument impacts player involvement.

The work presented here describes various decisions made when designing music-based games and their consequences for the experience of the player. Drawing upon the established field of film audio and on current game audio research, deeper perspectives and terminologies for the use and reception of interactive music in games will be presented. This vocabulary is then used to describe the design traits of music-based games. Design is set into context with existing terminologies and research in the game studies field. The resulting observations are tested and refined in practical research, using prototyping across several platforms and interfaces to test the presented theory. The practical part of this thesis also outlines a light-weight technical means of implementing interactive music in digital games.

Summarized, the research goals for this thesis are:

- outline the light-weight technical foundations of interactive music applications
- research game audio terminology and refine it in the context of interactive music
- define principles for the use of interactive music through practical experiments and qualitative analysis
- explain differences in the design of music-based games and musical instruments by differentiating between simulation and gameplay

After giving a detailed account of my research methods, I will present an overview of the history of music-based games and music in games. Then, film and game audio terminology will be presented and applied to the context of music-based games. By applying this terminology and by presenting the qualitative examples and practical experiments conducted while researching for this thesis, I will describe a series of design principles of music-based games. Examining these principles, it becomes clear that a differentiation between simulation and gameplay is necessary. I will define how the terms *simulation* and *gameplay* apply to digital games and how they affect the previously described principles.

Methodology

This thesis uses an iterative methodology for analyzing music-based game design. The following chapter details the scientific background of the analysis methods used. First, qualitative examples are chosen by evaluating the history of music in games. This representative selection of games is based upon a close examination of the evolution of music in games and music-based games. The selected games are played analytically and the main design principles are pinpointed. These principles are defined using game, music and film terminology and then assessed by implementing several experimental prototypes across different interfaces, a step which leads to new and substantiated principles of interactivity. Together with the results of repeated qualitative analysis, the experience gained during the trials is traced back to the initially established theory, thereby either fortifying it or signaling the need for revision. Factors chosen for qualitative analysis may already reflect on insights that have been shaped by the first round of analysis and prototyping. Furthermore, the results analyzing the qualitative examples and experiments are presented together rather than iteratively presenting the results as proscribed by the methodology, i.e. results are not presented repeatedly. How terminology was refined is mentioned in each description. The revised principles are then correlated to game design and put in the context of simulation and gameplay, establishing an understanding of the use of game mechanics in music-based game design.

The following figure summarizes and puts into context the methods described in this chapter. It also illustrates the recursive analytical and design approach used to generate a refined theory based on the results. The fields in the chart below illustrate the steps taken in this thesis.

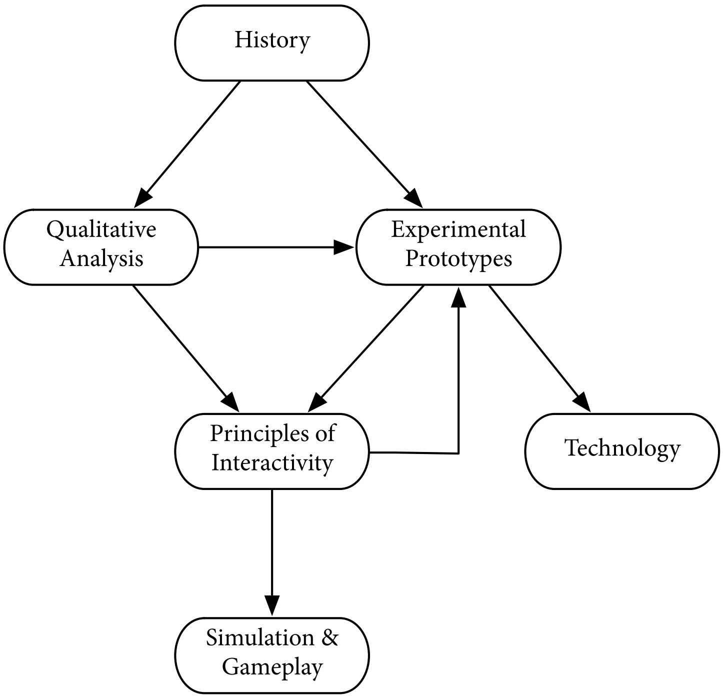

Fig. 1: An illustration of the work plan for this thesis.

Scientific Areas

Game Studies or Games Research is a young scientific discipline still striving for independence. Regular conferences like the DiGRA[1] (Digital Games Research Association) conference, online journals such as *Gamestudies.org*[2] (arguably the first peer-reviewed game studies journal), or the more recent *Eludamos Journal for Computer Game Culture*[3] have contributed greatly to building a foundation for the field. Still, game studies has close ties to other scientific fields such as literature (narratology), film studies, and musicology, to name just a few. The methods employed depend on the chosen area of research. When research focuses on the player, sociological and psychological methods are commonly used. If the focus is on the games themselves, research methods are often rooted in the humanities. In a recent article, Norwegian game studies pioneer Espen Aarseth describes the rift between the methods of humanists and social scientists when studying digital games, the latter focusing on the player (player studies) and the former concentrating on the games themselves.

1 http://www.digra.org/ [Accessed 12/05/08]

2 http://gamestudies.org/ [Accessed 12/05/08]

3 http://www.eludamos.org/ [Accessed 12/05/08]

> “These two camps, one focused on understanding games through playing them, and one focused on observing actual players, represent two quite separate paradigms in terms of player perspective, two that are not always living happily side by side.”
> (Aarseth, 2007)

Ways of avoiding this rift are detailed in an interesting paper by Dmitri Williams (2005) entitled “Bridging the Methodological Divide in Game Research”.

Aarseth also lays out an overview of the scientific fields of interest to game studies. He argues that on some levels, games as a new medium elude the traditional approaches derived from film studies, narratology, etc. He divides games into three areas, each of which can be studied from distinct scientific perspectives (Aarseth, 2003). The following table gives a summary of those areas and perspectives:

Studied area	Research interest	Scientific fields
Gameplay	Player actions, strategies, and motives	Sociology, ethnology, psychology
Game structure	Game rules, including simulation rules	Game design, business, law, computer science, AI
Game world	Fictional content, topology/ level design, texture, etc.	Art, aesthetics, history, cultural/media studies, economics

Fig. 2: A summary of areas for study in games and their corresponding sciences.

Qualitative Analysis

The first step for a qualitative analysis is making a representative selection of games. In a qualitative analysis, a relatively small number of examples is used to deduct insights on music-based games as a whole. At this point, it is necessary to clarify that the results of this study do not claim to be a complete language for describing all facets of music-based games. Good quantitative methods for creating a unified game description vocabulary have been established. Björk, Lundgren and Holopainen describe the deduction of game design patterns in a paper presented at the Level-Up conference in Utrecht (Björk et. al., 2003). Such a quantitative method leads to detailed results but would contradict the qualitative and explorative nature of this thesis. The iterative methodology used here portrays how results fluctuate and are constantly being refined and expanded by new games - in fact, this paper charts how the games industry, and the field of game studies, constantly reinvent themselves. The examination is representative. To substantiate that the selected games are characteristic, a concise overview of the history of music-based games is provided. The history is presented in a non-linear way, meaning that instead of a chronological history, significant events, relevant people, and games are presented in a thematically connected fashion. This approach is inspired by a method developed by German professor of mediology and technoculture Siegfried Zielinski for the examination of significant moments in media history. Media Archeology is a practice that helps analyze media history by illustrating its influence and repercussions on present and future media. This technique is usually applied when uncovering old or lost stories in media history (Zielinski, 2002). The history researched for this thesis is much more recent and thus not really a subject for media archaeology. A quote from German philosopher Ludwig Wittgenstein's work *Tractatus logico-philosopicus* is one point of origin for Zielinski's practice of media archeology, "Philosophy is not a doctrine it is an activity. [...] The results of philosophy are not 'philosophical sentences' but the clarification of sentences" (Wittgenstein, 1984). Zielinski wrote in an article on media archeology:

> "I shall now launch a few probes into the strata of stories that we can conceive of as the history of the media in order to pick up signals from the butterfly effect, in a few localities at least, regarding both: the hardware and the software of the audio-visual. I name this approach media archaeology, which in a pragmatic perspective means to dig out secret paths in history, which might help us to find our way into the future. Media archaeology is my form of activity/Tatigkeit."
> (Zielinski, 1996)

Inspired by this method, I have developed a non-linear timeline of the history of music-based games. It is based upon individual stories and areas that eventually highlight key events, people, and games in the history of music-based games rather than lining events up year by year. This thesis will not provide an in-depth historical examination of the subject. The media archeology method introduced above is a description of the inspiration behind structuring the historical analysis thematically rather than chronologically.

The subject examined in this thesis, music-based games, is a relatively narrow game genre and boundaries will be expanded during the course of the paper. Firstly, the genre broadens when topics like music and sound usage in general are discussed. Secondly, the influence of media art and especially game art is a great factor in the shaping of how music-based video games are constituted. Therefore, the examination of games must also take these areas into account. By using the media archeology approach, the history of music-based games is described in a qualitative way, thus laying the foundation for a representative selection of qualitative examples.

The qualitative analysis is conducted using the methods of playing research and participant observation, which will be described in the following section. Adhering to the research goals, each analysis deals with the following factors and areas:

- The Interface
- The Player
- Sound and Music Usage
- Visual Representation
- Cultural Embedding
- Instrumental Attributes
- Gameplay

Playing Research

For the qualitative examination of game design, the following Playing Research methodology proved to be adequate and useful. Playing research has been established by Espen Aarseth as a valid methodology in his paper "Playing Research: Methodological approaches to game analysis":

> "Firstly, we can study the design, rules and mechanics of the game, insofar as these are available to us, e.g. by talking to the developers of the game. Secondly, we can observe others play, or read their reports and reviews, and hope that their knowledge is representative and their play competent. Thirdly, we can play the game ourselves. While all methods are valid, the third way is clearly the best, especially if combined or reinforced by the other two."
> (Aarseth, 2003)

This concept proves to be a very natural way of studying games and is appropriate for gaining insight of the inner workings and mechanics. In fact, aspects of all three of the above-mentioned approaches have been drawn upon, although no personal interviews were conducted during the course of writing this thesis. However, in-depth interviews with game designers in computer and video game magazines answered many questions. Also, by designing the games described later in this thesis, I became a developer myself and reflect on games from that point of view. Studying game-specific mainstream literature is also a well-founded access point for garnering hard-to-access facts about games and enriching one's knowledge of a specific game by understanding its context within the gaming culture. Computer and video game magazines have significant differences in their approach to games, which must to be taken into account when researching. For example, the UK-based print magazine *Edge*[4] addresses game developers and people striving to work in the industry and thus regards games from a very different perspective than big online portals like *Gamespot*[5] and *IGN*[6], which supply news and reviews to a more general public. All have merits, the latter two providing almost complete review archives and *Edge*'s in-depth articles giving a unique understanding of a small sample of games. These sources in combination with the observation of other researchers, friends, and dedicated fans of the respective games (a lot of hardcore gaming can be watched on *youtube*) reduces the subjectiveness of playing by yourself and allows for a qualitative analysis.

Sybille Lammes (2007) refines Aarseth's methodology in her paper "Approaching game-studies: towards a reflexive methodology of games as situated cultures". Although the study of music-based games culture is not an integral part of this thesis, the following concepts help comprehend and assess the role and the involvement of the researcher. Lammes argues that the player is part of a cultural sphere that must be considered when researching games with the playing research and participant observation methods. In his article "A Ludicrous Discipline? Ethnography and Game Studies", Tom Boellstorff (2006) calls for anthropological research methods for cultural game studies; the participative study of games always involves "a form of ethical yet critical engagement that blurs the line between researcher and researched, even when the researcher is clearly not a member of the community being studied" (Boellstorff, 2006). Consequently, Lammes calls for situatedness and reflexivity to be taken into account:

> "I will claim that the researcher needs the combined tools of reflexivity and situatedness because both situatedness (intertwining agent and environment) and reflexivity (distance/proximity) take into account the involvement of the researcher/player with its material and view this as a cultural praxis. Situatedness allows for game-research that shows the physical locality of playing whilst still relating play to a more global or national context. Reflexivity

4 http://www.edge-online.com/ [Accessed 12/05/08]

5 http://www.gamespot.com/ [Accessed 12/05/08]

6 http://www.ign.com/ [Accessed 12/05/08]

permits us to show how the researcher is culturally and locally involved in her quasi-object of study through play."
(Lammes, 2007)

When conducting a qualitative analysis by playing research and participant observation, this means that the views derived of each game are reflexively put into perspective by considering the researcher's cultural embedding and gaming experiences as well as the immediate surroundings and geographical location of play.

Literature and Archive Research

Part of the literature research for this thesis takes part within specific scientific fields, primarily game studies. Literature in this field can easily be explored in various journals and conferences, including those mentioned above. For researching works on game audio, two comprehensive archives were found: *gamesound.org*[7] focuses on industry relevant technical articles and is maintained by Kenneth Young, audio designer for Media Molecule; and *gamessound.com*[8], an academic archive maintained by Karen Collins, a video game researcher at the Canadian Centre of Arts and Technology, University of Waterloo, Ontario.

As mentioned above, the basis for researching music-based games' history lies in the availability of pertinent literature. When assembling a selection of representative games, the sources of information are often not scientific papers and articles but instead reviews and interviews found in online and printed magazines and archives like *Gamerankings*[9] and *Metacritic*[10]. Of course, such information is often fragmented and incomplete but still suitable as secondary information for putting the actual playing of the game into context. Gathering the actual games is unproblematic for newer titles. When no longer available new, they can usually be bought used. For older games, the situation is more complicated:

"If games are art, then surely they are the most self-destructive and frustrating form of it. No other medium actively erases its past and makes classic works so inaccessible. Technological advancement, the relative youth of the games industry and standard market forces all play a part in relegating prior works to the sidelines of public discourse; but whatever the reason,

7 http://www.gamesound.org/ [Accessed 12/05/08]

8 http://www.gamessound.com/ [Accessed 12/05/08]

9 http://www.gamerankings.com/ [Accessed 12/05/08]

10 http://www.metacritic.com/games/ [Accessed 12/05/08]

> this phenomenon is bad for gaming and disastrous for gamers. For games to be considered a worthwhile craft, classic works need to be kept alive as reference points for developers and audiences. Currently, classic games are the ones you are least likely to be able to play."
> (Zacny, 2008)

The following two examples show how the research for this thesis was affected by this problem; my copy of the Commodore 64 game *To Be On Top* (Factor 5, 1987) had been damaged and copies were no longer available for purchase. The game is one of the first music-based games and features an excellent interactive synthesizer soundtrack by German musician Chris Hülsbeck, who will be featured later on. The ROM of the game still can be downloaded but unfortunately does not work on any available emulator. The situation is different for another important game, Toshio Iwai's *Otocky* (Sedic, 1987). Regarded as a classic, the game can still be imported and used with the Famicom Disk System. The Famicom Disk System is a sideline of Famicom (known as Nintendo Entertainment System in the U.S. and Europe) and was only released in Japan. The game can also be played using the *Nestopia*[11] emulator. Thus, the lack of thorough archiving excluded one game, lesser regarded by the community, while another game from the same era is still accessible.

Personal Preconditions

At this point, I would like to describe my own preconditions as a participant observer, musician, and game player. Since this is relevant to the methodology employed, I have included it in this chapter instead of in the preface.

My personal experience of working with music and musicians dates back many years, from stints as a bassist, to producing a rap ensemble, to VJ-ing[12] in clubs and concert venues. For my master's thesis (Kayali, 2004), I created the playful audiovisual live performance software, *Sonic~Image,* which makes it possible to use a wireless gamepad to perform realtime audiovisual compositions. I later used *Sonic~Image* in several concerts, teamed up with Viennese hardcore/punk/sludge combo Phal[13]. I accompanied Phal, a guitarist and a vocalist, with audiovisual loops and samples from my laptop.

11 http://www.bannister.org/software/nestopia.htm [Accessed 12/05/08]

12 VJ-ing (analogical to the term DJ-ing) refers to the live performance technique of supporting the music of a DJ or a band with compositions of visual media (usually short video clips, pictures, or 3D-animations). The term VJ stands for Video Jockey and is also used to denote moderators of the music TV channel MTV. To distance themselves from this profession, live video artists went on to call themselves "Visualists".

13 http://www.med-user.net/phal/ [Accessed 12/05/08]

Fig. 3: Phal on stage.

My gaming adventures started during the late eighties on a Commodore 64 and over the years spread to include as many (stationary and portable) gaming devices as I could get my hands on. My fascination for music-based games began in the early nineties when I discovered Chris Hülsbeck's game *To Be On Top* and flamed up again in 2001 with Harmonix' rhythm game *FreQuency* (Harmonix Music Systems, 2001), which I particularly liked for its extremely challenging difficulty at higher levels and excellent soundtrack ranging from rap to electronic music and electropop. Additionally, I have always been an ardent fan of sports video games and am quite addicted to Konami's *Pro Evolution Soccer* series (Konami Computer Entertainment Tokyo, 2001-2008) and to the basketball simulation *NBA 2K8* (Visual Concepts, 2007). This affiliation with sports video games fed the interest in simulation that I will later incorporate into the analysis of music-based games.

According to Aarseth and Lammes, my situatedness in music and software production and as an experienced gamer (and even a game designer during the course of this thesis) allows me to justify my viewpoint as a qualified observer of music-based games. Of course, it is necessary to objectively step back from this experience to relativize the results of the qualitative analysis.

Experimental Design and Prototyping

> "Why are experiments (and simulation) in the physical world superior to models and simulations in the head? The reason is that you want to find out both what you can figure out and what you can't figure out, i.e. what you cannot simulate mentally. That is, you want to know also about the effects of your actions that you cannot predict or foresee."
> (Gedenryd 1998, p. 129)

Gedenryd explains in his Ph.D. thesis, "How Designers Work", that experiments are a good way to validate or negate assumptions made during designing. Quick methods for illustrating and testing a given aspect of a product or concept are an absolute necessity in many industrial and scientific branches. In an industrial context, rapid prototyping is often used to preview products. Specialized machinery like laser cutters and industrial robots is used to create a model that, depending on its purpose, may consist of wholly different materials than the planned product. For example, a prototype of a car that shows all the visual and aerodynamic attributes but contains no engine and is thus not able to drive. Conducting experiments is also common practice in the natural sciences, like physics or chemistry. The results are then used to bolster or negate a given theory. In the field of informatics, prototypes are usually more bloated than a typical experiment and are often considered to be a preliminary stage of the finished software or hardware product. In this thesis, a few finished works are presented and analyzed. Other than those, this thesis is concerned with using lightweight methods to test specific concepts. As in the example of the car prototype, these experimental prototypes will not show a finished game but instead focus on specific aspects. It must also be noted that game prototypes do not necessarily have to be pieces of software. In some cases, board games or paper can also be used to try out the various rules of a game. Another good example is using Lego bricks to show level design. Experiments of this kind usually do not lead directly to finished products but instead assist in reaching conclusions on the isolated matter at hand. Ian Bogost[14], a video game researcher from Georgia Tech University and a game designer with Persuasive Games, recognizes the importance of creating experimental prototypes when designing video games:

> "In order to develop the potential of video games, any work in this area needs an experimental part that sidesteps the limitations of commercial game development. We cannot limit ourselves to the analysis of existing game spaces, but instead have to encourage the creation of new possibilities in this area."
> (Bogost et al. 2005)

14 http://www.bogost.com/ [Accessed 12/05/08]

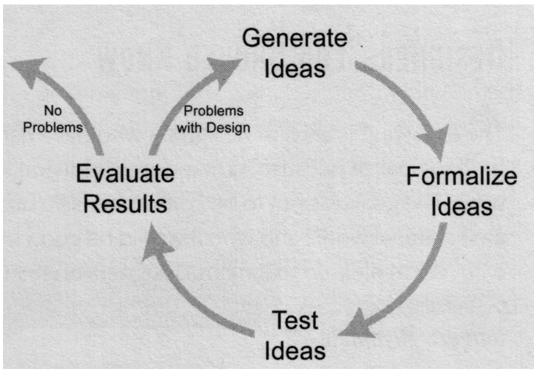

Fig. 4: Iterative testing of ideas (Fullerton, Swain & Hoffmann (2004)

Creating lightweight prototypes is a common practice in game design. There is good literature available on game design prototyping methods, first and foremost of which is the excellent book *Game Design Workshop: Designing, Prototyping, and Playtesting Games* by Fullerton, Swain and Hoffman (2004). Besides detailing the prototyping process, they also sketch an iterative process of generating and testing ideas. This approach is similar to the iterative methodology used for this thesis, where theoretical concepts are tested and iteratively refined. Fullerton, Swain and Hoffman define software prototypes as follows:

> "Software prototypes are analogous to physical prototypes, except that they are made using programming tools. Like physical prototypes, they include only the elements needed to make the system functional; they are void of polished art and sound; and they serve as the conceptual blueprint for creating the final electronic game."
> (Fullerton, Swain & Hoffmann, 2004)

This definition of a software prototype has much in common with the way prototypes are understood in computer science. Yet, it states that the prototype serves just as a blueprint for the final system, implying that the code could be discarded before the final software is programmed from scratch. This is in stark contrast to the way prototypes are used in computer science, where too often the final product is based directly on the prototype. The definition makes clear that a prototype is not intended to be the first build of game. Instead, a software prototype serves to expose specific functional aspects of the software, which, in the case of games, have much to do with gameplay and interactivity.

These functional aspects can be broken down even further. Chaim Gingold[15], a former game designer on the team that created the Will Wright game *Spore* (Maxis, 2008), published an article titled "What WarioWare can teach us about Game Design" on gamestudies.org (Gingold, 2005). *WarioWare* (Nintendo R&D1, 2003-2006) is a series of games that originated on the Gameboy Advanced and has incarnations on the Nintendo DS and Wii. All WarioWare games consist of a series of mini-games, each focused solely on one interactive principle. Gingold goes on to call

15 http://www.slackworks.com/~cog/ [Accessed 12/05/08]

these games “micro-games”. Their focus on a single principle exposes the essence of the corresponding interactive principle very well. This very reduced version of a game can also be used to inspire prototypes that follow the rule of implementing only one interactive principle. Aside from being cheap and communicative tools for game companies (Gingold in LaBounta et al., 2007), this form of micro-prototyping is also useful for some of the practical experiments in the context of this thesis. Gingold & Hecker listed several key characteristics of game prototypes during a lecture to the Montreal International Game Summit; “cheapness, agility, lightness, falsifiability, testability, relevance to the game at hand, generalizability, and surprisingness.” (Ruberg, 2006).

The forms of experimental prototypes presented go along with the views of prototyping in current HCI (Human Computer Interaction) research and design theory. Bill Buxton (2007) stresses the importance of fast and lightweight sketching of user interaction to try out as many concepts as possible. Anne Burdick talks about the concept of design as research in a chapter of Brenda Laurel’s book *Design Research: Methods and Perspectives* (Laurel, 2003). For research questions with a more practical orientation she states:

> “Such research questions are qualitatively different from those of user testing and human-centered research. The most significant difference is that the experiments developed in response to or in tandem with these questions use the act and material of design as the means of investigation. It is through making (rather than observing or interviewing) that these contributors generate new information.”
> (Burdick, 2003)

Andrew Stapleton has a similar view of design and research in game studies and defines a reflexive method called RADDAR (Research As Design - Design As Research): “(constructivist) research is a design process and (game) design is a research process” (Stapleton, 2005). These two quotes indicate that experimental design is a formal method for generating and testing theoretical research. As stated above, this thesis uses design as an iterative methodology (much in the way that Stapleton describes design and research reflexively). The purpose of this section is to shed light on the practice of experimental prototypes and design as research from various scientific perspectives. Prototyping in informatics, experimental prototypes and micro-games in game studies, and design as a method of HCI research all justify the chosen methodology, each from a different perspective.

Summary

From the media archeological approach to games history and the analysis of representative games to the explorative design methodology, this thesis focuses on a qualitative approach to music-based game design. The following list gives an overview of the scientific fields involved in the research for the thesis:

Qualitative Examples	Terminology	Aesthetics and effect on the player	Prototyping
Art, Game Studies, Media History	Game Studies, Film Studies, Musicology, Computer Science	Art, Media Studies, Psychology	Game Studies, Computer Science, HCI, Design Theory

Fig. 5: Scientific fields

An in-depth view of the history of music-based games will be provided. The inspiration taken from media archeological practices results in a qualitative review of the history of music-based games and music in games. The information on the games and involved people has been gleaned by combing through games, reviews, interviews, and archives, resulting in a representative, qualitative selection of games and an overview of the development and influence of game audio technology. The selected examples have been analyzed qualitatively using the playing research and participant observation methods. The analysis has been supported by reading corresponding reviews and interviews. This phase results in a loose definition of genres and in a set of interactivity principles for music-based games that is connected to literature research on terminologies for audio and music usage in game and film studies. Thereby, a terminology describing music-based games is provided.

Through analyzing music-based art pieces by the author and by experimental design and prototyping across different interfaces, the different design approaches are tried out practically. This method allows the refinement of the previously established principles of interactivity. The technological possibilities for independently designing music-based games are also outlined.

The information collected through analysis and design is structured and put into context, situating the terminologies within game design. A model of how to design music-based games between the poles of simulating instruments and establishing gameplay is given.

Several sections of this thesis have previously been published at conferences and in scientific journals[16]. This illustrates well the motivation for writing this thesis, furthering the understanding of games and, ideally, also advancing the creation of music-based games.

16 An overview of the author's publications in the context of this thesis is given in the Appendix: "Related Publications".

A Brief History of Music and Games

This chapter provides a historical overview of the use of sound and music in games, including several perspectives on the evolution of audio and music in digital games. From chiptunes music to the first use of sampled sounds, the underlying technologies shaping game audio aesthetics will be examined. The progression from accompanying music to adaptive audio to interactive music puts a focus on the development of interactivity. This chapter also looks at the influences and interplay of games, digital art, and game art. Spotlighting specific regions, key designers, and composers sheds light on the various approaches to designing music-based games. This chapter clarifies the basis for the subsequent selection of qualitative examples. A strong understanding of music-based games from a historical, technological, and artistic standpoint makes it possible to choose a viable selection of games.

Machines, Coin-Ops and the Beginnings of Game Audio

The sound collage that can be heard when wandering through one of the many multi-story arcades in Tokyo's *Akihabara* district is inspiring. Each floor is dedicated to a single genre of games. When entering, one is surrounded by a fusion of sound composed of distinct button smashes and game sounds. The collage changes noticeably when switching, for example, from the high-speed, techno-like sounds of millions of bullets that permeate the shooting games floor to the drum-like rhythms produced by players sitting at beat 'em up game machines.

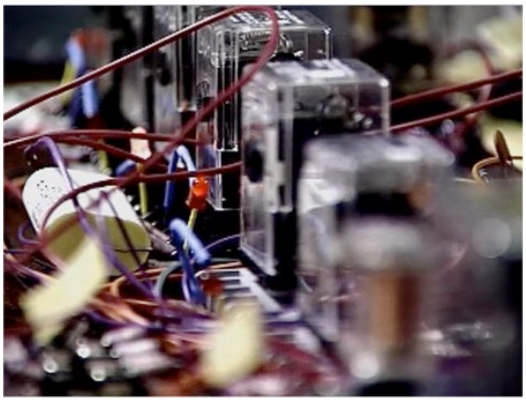

Fig. 6: The clanking relays of William Higinbotham's Tennis for Two

Computer and video games have always been an audiovisual medium. Even though one of the first games ever, *Tennis for Two*[17] (Higinbotham, 1958), did not have audio output, the mechanical sounds that were made by the switching relays gave the game a strong acoustic presence[18]. These mechanical noises are a distinctive characteristic accompanying all electro-mechanical games, especially early pinball machines[19].

17 http://www.bnl.gov/bnlweb/history/higinbotham.asp [Accessed 12/05/08]

18 For a short clip see http://www.youtube.com/watch?v=6PG2mdU_i8k [Accessed 12/05/08]

19 The art piece *bagatelle concrète*, by Martin Pichlmair and myself, exploits this distinct sound impression and will be presented in a later chapter.

It was not until 1972 that video games added real sound output. In this year, Atari co-founder Nolan Bushnell released Allan Alcorn's famous arcade game *Pong* (Alcorn, 1972). Pong was the first game ever to feature game audio, a short sound effect played when the ball is struck by a paddle (McDonald, 2004). The first home console to provide audio output was also created by Atari. Released in 1977, the *Atari VCS* provided two programmable audio channels. The first game to make use of the VCS' audio capabilities was released a year later. *Space Invaders* (Taito Corporation, 1978) emanates a pulsing sound that increases in speed as the player progresses through the game. The *Space Invaders* soundtrack is considered to be the first occurrence of adaptive game audio (Pidkameny, 2002).

Fig. 7: Atari's handheld "Touch Me" and the "Simon" game by Ralph Baer and Howard Morrison

The first audio-based game was Atari's *Touch Me* (Atari, 1974-1978) followed by the more popular *Simon* (Baer & Morrison, 1978). Both games are handheld gadgets featuring four lights each coupled with a distinct sound. The player mimics audiovisual sequences of increasing difficulty.

The role of Atari in the dawn of home consoles and consequently game audio was crucial. Atari not only released the first commercially successful video games, *Pong* and *Space Invaders*, they also brought games from the arcades to home television sets. Atari developed the first sound effects played in video games, the game that had the first adaptive soundtrack, and released the first audio-based game.

Chiptunes - The Characteristic Sound of the 8-Bit Era

> "One of the good things about the older 8- and 16- bit was because of the limited resources that [..] we had to work with - we had to be very creative, and we couldn't rely on a wide range of music, or a wide range of orchestration to create the melody. We had to create this core melody, and play it with these limited resources."
> (Legendary video game music composer Koji Kondo in an interview for Kikizo, 2007)

A history of digital games is always, to some degree, a history of technology. Technological advances in memory, storage capacity, and audio hardware have enabled the high-fidelity soundtracks of today's games. Before the nineties, there were no means of storing and replaying digitized music for game consoles. Sounds were generated by dedicated sound chips, the characteristics of which greatly influenced game sound from that particular era. Audio was produced by a combination of a noise generator (sound selection), frequency (pitch modulation), and volume. Sound hardware evolved over time and the release of the Commodore 64 home computer in 1982 also introduced the *MOS Technology 6581 Sound Interface Device (SID)* (Kuphaldt, 2007).

> "The SID Sound is absolutely unique and can't be accurately produced by any other Synthesizer that I know. Specially the pulse-with modulation is the holy grail of its power."
> (German video game composer Chris Hülsbeck in an interview with Neil Carr for remix64.com, 2001)

The SID chip has oscillators that generate triangular, square, and saw-toothed waves as well as white noise. Sounds are modifiable by an ADSR-function enabling envelopes for attack, decay, sustain, and release. The sound chip is considered one of the best of its time and its distinct style is still popular today. Before the prevalence of CD-ROM drives enabled the use of digitized samples and songs (Weske, 2000), synthesized sound chip music (also called *chiptunes*) characterized the distinct style of video game sound and music.

Fig. 8: The title screen of Chris Hülsbeck's game "To be on Top"

Two of the first music-based games emerged at the dawn of the chiptune era: Toshio Iwai's *Otocky* (Sedic, 1987) for the Famicom Disk System was produced in Japan, and Factor 5's German-produced *To Be On Top* (1987) for the Commodore 64 features music by Chris Hülsbeck. *To be on Top* fully exploits the C64's sound hardware, putting the player in the role of an aspiring pop star. In various mini-games, the player collects synthesizer tunes, samples, and drum loops and then puts them together with the goal of producing a chart-breaking song.

In their paper "Video Game Music: chiptunes byte back?", Mitchell and Clarke (2007) argue that chiptune music still has an active following today. Carlsson (2008) credits file sharing as one of the reasons for the increase in popularity of "retro" chip music. The vintage song files are typically distributed in editable files that give access to the played notes and channels (e.g. *.sid* and *.mod* file formats). The distinct style of the musical elements created by sound chip hardware influences many musicians. Bands revolving entirely around vintage game hardware have even arisen. The Austrian group *GameBoy Music Club*[20] uses the homebrew software *Nanoloop*[21], a real-time sound editor and sequencer for the GameBoy, for regular performances in Austrian clubs and abroad.

Chiptunes or chip music was the first and most distinct form of video game sound. Shaped by hardware constraints, the sound of games from the chiptune era is characterized by a unique style that remains popular today. Although video games have mainly moved on to using digitized sound, the advances made during the chiptune era continue to have repercussions on game sound today.

20 http://www.gameboymusicclub.org/ [Accessed 12/05/08]

21 http://www.nanoloop.de/ [Accessed 12/05/08]

Orchestral Scores - From *Dragon Quest* and *Zelda* to Video Game Music Concerts

Fig. 9: A poster for a concert of Koichi Sugiyama - Dragon Quest Suites 1 & 2 at Suntory Hall, Tokyo, 1987

The earliest information on orchestral and symphonic interpretations of video game music found while researching this text dates back to 1986 and comes from Japan. Koichi Sugiyama[22] is an established Japanese video game music composer, who composed the music of the highly popular *Dragon Quest* series (Square Enix, 1986 - 2004). In 1986, he recorded the music of *Dragon Quest I* with the London Philharmonic Orchestra and released the album *Dragon Quest I Symphonic Suite* (Sugiyama, 1986). The music of *Dragon Quest* was subsequently performed live during the *Family Classic Concert* in 1987 (see the figure to the left), possibly the first video game music concert ever. The Family Music Concerts, all conducted by Koichi Sugiyama himself, have become an annual series of orchestral performances still continuing today[23].

Another highly acclaimed Japanese composer is Koji Kondo, whose most important works include the music of the *Zelda* (Nintendo, 1986 - 2007) and *Super Mario* (Nintendo, 1985 - 2007) series. Kondo's influence on video game music cannot be overvalued. *The Legend of Zelda: Ocarina Of Time* (Nintendo EAD, 1998) introduced musical instruments as game mechanics. In order to progress in the game, the player must perform certain passages on an ocarina. This mechanic was later picked up by Zelda games and was also used by the early Lucasfilm Games adventure *Loom* (Lucasfilm Games, 1990), which uses a loom played like a harp as an interface for

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22 http://sugimania.com/ [Accessed 12/05/08]

23 http://sugimania.com/family/index.html [Accessed 12/05/08]

the game's magical spells. Kondo's music has been released on a vast number of albums. An impressive list of his releases can be found on *Wikipedia*[24].

In Japan, it is common practice to release the soundtrack of a video game. When browsing video game stores in Tokyo, one can find several shelves filled with game soundtrack albums from all genres. This is in contrast to Europe and the U.S., where games increasingly tie in to popular music (more later in this chapter), but soundtracks are not usually released separately (this may be connected to licensing and copyright issues). Of course, there are exceptions, such as the multi-faceted soundtrack of the latest incarnation of *Grand Theft Auto* (Rockstar North, 2008), which was released exclusively to journalists as a promotion.

Vintage video game music is not just popular in Japan. The music of Chris Hülsbeck was formative for synthesized video game music in the eighties and early nineties and is still popular today. In August 2008, an orchestral concert of his greatest hits was performed by the WDR Rundfunkorchester. The concert, *Symphonic Shades*[25], was broadcast live on the German radio station *WDR4*. WDR claims this to be the first video game concert ever broadcast live on radio. Simultaneously, an album of the same name (Hülsbeck & Böcker, 2008) was released containing symphonic versions of his video game music hits. Chris Hülsbeck may be the only video game music composer outside of Japan to successfully release several albums of their work. A full discography can be found on his website[26].

Video game music has attracted many fans of its own. Because of its different style and the attachment some fans have to games, also involving the soundtrack, video game concerts have found their own niche. For this reason, the works of renowned video game music composers are performed in orchestral setups and albums of video game music can be bought separately from the games.

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24 http://en.wikipedia.org/wiki/Koji_Kondo#Albums [Accessed 12/05/08]

25 http://www.symphonicshades.com/ [Accessed 12/05/08]

26 http://www.huelsbeck.com/ [Accessed 12/05/08]

Japanese Game Designers

The Works of Toshio Iwai, Tetsuya Mizuguchi and Masaya Matsuura

The creative influence of these three Japanese game designers and artists must not be undervalued. It might have something to do with the high regard, and therefore creative freedom, which individual famous designers receive from their respective Japanese publishers. Konami's Hideo Kojima, renowned for the highly popular *Metal Gear Solid* series (Konami, 1998-2008), Tecmo's "bad boy" Tomonobu Itagaki (*Ninja Gaiden*, Team Ninja, 2004), and of course Nintendo's heart and soul Shigeru Miyamoto, the creator of Mario, can also be mentioned in this context. The designers Iwai, Mizuguchi and Matsuura seem less bound by economic factors than Western developers generally are, and their games are often characterized by spirited non-traditional ideas putting many of their games at the crossroads of game, art, and instrument.

Toshio Iwai

Fig. 10: Toshio Iwai in

Toshio Iwai is an acclaimed media artist and game designer. He was born in 1962 in Kira (Aichi prefecture), Japan. After matriculating in 1981 at the Fine Arts Department of Tsukuba University, Iwai became primarily involved with experimental animation (ICC, 2006). What he calls "his oldest work", made at the age of 12, is the *Flipbook in the Textbook*. It is a character animation drawn in his junior high school textbook. He regards it as very meaningful to his later career, "I think it was my first experience interacting with moving images that I created myself. And it was also the beginning of being triggered by the image media" (Iwai, 1993). Iwai went on to create several media installations while still a student. The most acclaimed was *Time Stratum*, which won the *High Technology Art Exhibition Gold* prize in 1985 (ICC, 2006). It is inspired by his affection for early animation movies. Over 100 paper figures are placed on a rotary disc and illuminated by a strobe light, making them appear to be living, moving people. In 1987, Iwai graduated from the Plastic Art and Mixed Media master's course at Tsukuba University. The same year, he also created his first video game, *Otocky*. It is a musical shooter in which the player shoots enemies using an equipped weapon that releases projectiles called music balls. *Otocky* is credited in the online Game Innovation Database[27] as being the first media art video game.

27 http://www.gameinnovation.org [Accessed 12/05/08]

In a lecture at the Futuresonic festival, Iwai explained his initial interest for music. He initially had friends compose the music he needed for his works, but this contradicted his desire to create all aspects himself (Iwai, 2006b). “So once again he turned to a retro toy: the hand-cranked antique music box that uses paper punched cards. Iwai found this device interesting, it made the music ‘visual’ and thus better understandable to him.” (Debatty, 2006).

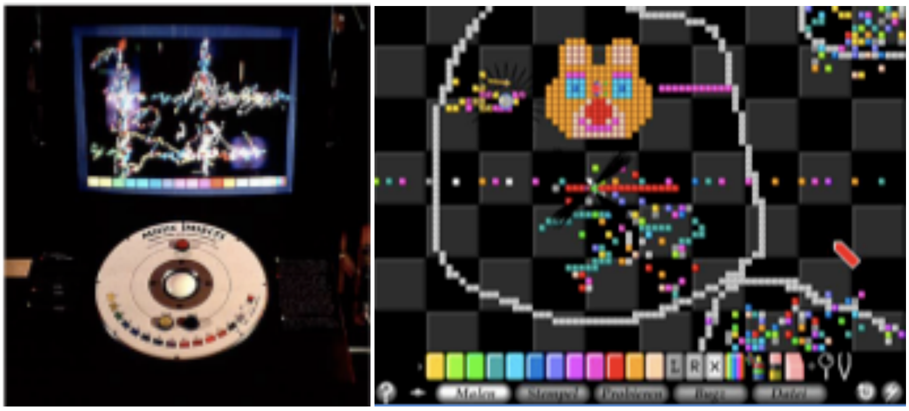

Fig. 11: Toshio Iwai’s Music Insects installed at the San Francisco Exploratorium (left) and a screenshot of the PC game Sim Tunes (right)

The punch cards inspired his installation *Music Insects*[28], permanently exhibited at the Exploratorium in San Francisco. In this installation, insects wander across a grid that can be painted with colors. When an insect touches a colored square, it emits a light and sound depending on the color. *Music Insects* was remade for the Super NES in 1993 under the name *Sound Fantasy* but for unknown reasons was never released by Nintendo. *Music Insects* is also the precursor for the computer game *Sim Tunes* (Maxis Software, 1996). Iwai explains his motivation behind the conversion of some of his art pieces into video games, “I decided to make this advanced version of *Music Insects* […], because I wanted to show this work all over the world” (Iwai, 1993).

28 http://www.exploratorium.edu/xref/exhibits/musical_insects.html [Accessed 12/05/08]

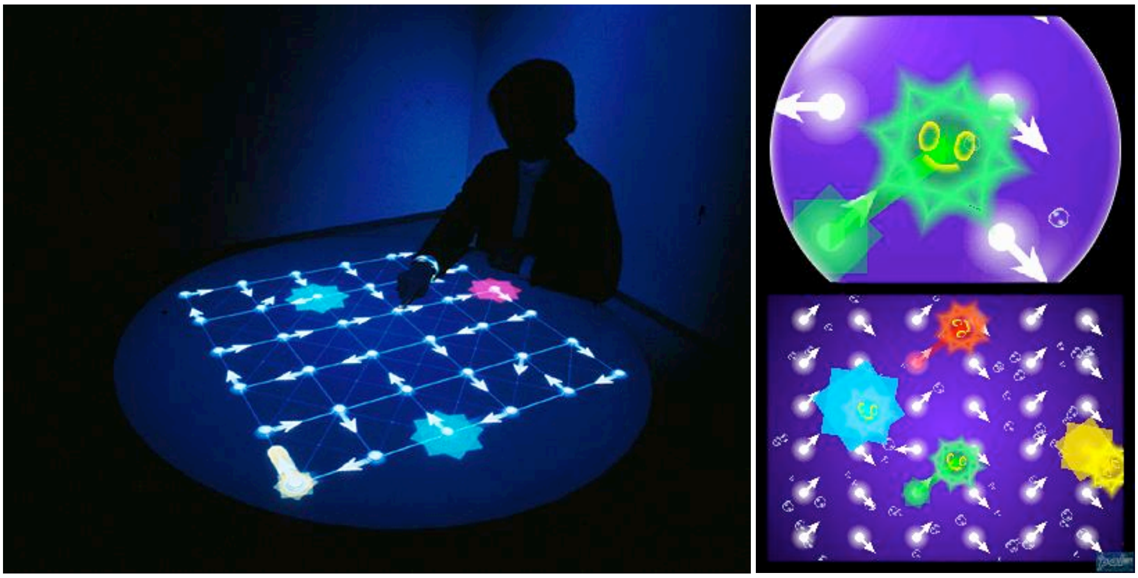

Fig. 12: The interactive media installation "Composition on a table" (left) and a screenshot of the Luminaria mini game in Electroplankton for the Nintendo DS.

In the same way that *Music Insects* is a precursor for *Sim Tunes*, a series of table installations became the basis for some of the mini-games within the later released Nintendo DS game *Electroplankton* (Indies Zero, 2005). *Composition on a table*[29], pictured above, is a series of four table installations that allow the visitor to playfully interact with music through physical interfaces like knobs and turntables. The haptics of these physical interfaces were later successfully transferred to the Nintendo DS' touchscreen.

Venturing even further into the realm of music, Toshio Iwai teamed up with Japanese pianist Ryuichi Sakamoto to create the concert *Music Plays Images x Images Play Music*. In this concert, a tight symbiosis between music and image is achieved as Iwai visualizes the music from Sakamoto's piano, who in turn snatches up visual influences to incorporate them into the music. The performance won a Golden Nica at the *Fleshfactor - Ars Electronica Festival* in 1997 (Iwai & Sakamoto, 1997). The concert recalled an earlier art piece, *Piano - as image media* (Iwai, 2001), the first real audiovisual instrument that Toshio Iwai created. "Here the user, seated at the piano, triggers a flow of images that depress the piano's keys; a consequence to this action releases yet another flight of images. The resulting interactive installation synthesizes two different aesthetics: sounds (simple melodies), images and a mechanical object (the piano) with digital media" (Williams, 2000).

29 http://www2.kah-bonn.de/1/34/0e.htm [Accessed 12/05/08]

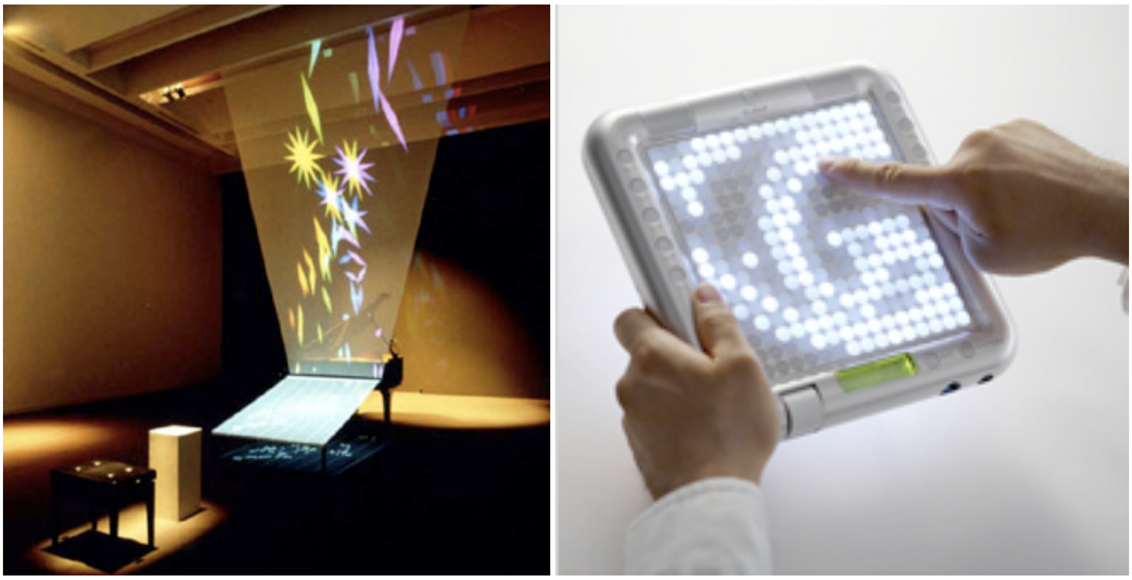

Fig. 13: The interactive audiovisual installation "Piano - as image media" (left) and the musical instrument Tenori-On (right).

In 2007, Iwai released his first commercial instrument, the *Tenori-On*[30], built in cooperation with Yamaha. The *Tenori-On* is a screen-based instrument, consisting of an LED grid held with one hand and played with the other. It has a number of playing modes, which each interpret the patterns drawn across the screen differently.

Toshio Iwai is a unique and multi-faceted artist. His works, of which only a few were mentioned here, include animations and video art, interactive media installations, audiovisual performances, musical instruments, and video games. Iwai's artistic background has greatly influenced the design of his music-based video games and two of the games mentioned here even originated from an art piece. His initial affiliation with image media and his later engagement in music and musical instruments has resulted in works incorporating an artful symbiosis of sound and vision. Toshio Iwai's music-based video games are located in the borderland between interactive media art, instruments, and games.

30 http://www.global.yamaha.com/design/tenori-on/ [Accessed 12/05/08]

Tetsuya Mizuguchi

Fig. 14: Tetsuya Mizuguchi holding a presentation at Art Futura in 2005.

"As a child I didn't have any aspirations to become a games producer. The first game I played was when I was 7 and I played Pong at a friends house. I played some video games as a child but I also played baseball. I majored in media aesthetics at University which looked at how we would make media in the future. It was at this time that I wanted to join the games industry. I then started at Sega in 1990."
(Mizuguchi on playstation.com, 2004)

Tetsuya Mizuguchi is one of the most outspoken Japanese developers. For that reason, this section is enhanced by many quotes illustrating his ambitions in game design. Tetsuya Mizuguchi was born in 1965 in Otaru, Hokkaidō, Japan. After he graduated from the Nihon University School of Art, Mizuguchi joined Sega in 1990. He started out in Sega's AM5 division, mainly creating arcade games. There, he designed the excellent racing game *Sega Rally Championship* (Sega AM5, 1995). After transferring to United Game Artists, also a division of Sega, his interest shifted to music-based games. In 1999, he created *Space Channel 5* (United Game Artists, 1999). The game centers around a female character, *Ulala*, who beats enemies with her dancing moves, triggered by rhythmically mimicking the opponents' attacks. The rhythmical patterns blend seamlessly with the background dance music of the game. A tangent to *Space Channel 5* is about an early convergence to popular music, when Michael Jackson asked to be in the game and was included as a late opponent called *Space Michael*, who featured a signature dance. Mizuguchi recalls this moment in an interview with the games magazine *Electronic Gaming Monthly*:

> "We were in the middle of production of Space Channel 5, in 1998 or 1999. I got a call from the U.S. from my partner - the executive producer of Space Channel 5 - and he said, 'Oh, Michael wants to act in Space Channel 5.' I said, 'Who's Michael?' 'Who is Michael Jackson?' he said, 'The Michael Jackson - the real Michael Jackson'"
> (Mizuguchi in EGM, 2007).

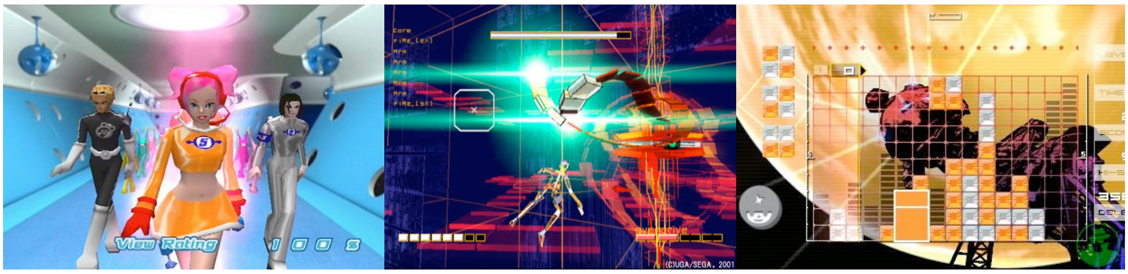

Fig. 15: Screenshots of Space Channel 5 (left), Rez (middle) and Lumines (right).

Still with United Game Artists, Mizuguchi designed the seminal *Rez* (United Game Artists, 2001). Originally released for the Sega Dreamcast and later transferred to the Playstation 2 and XBox Live Arcade (re-released as *Rez HD*, Q Entertainment. 2008), *Rez* is an on-rails shooter inspired by the synaesthetic paintings of Vassily Kandinsky and featuring an avatar that flies through the inner workings of a computer system. The game is visualized by psychedelic vector graphics accompanied by a pounding techno and trance soundtrack.

In 2003, Mizuguchi left Sega to found his own company, Q Entertainment[31]. In 2004, he released *Lumines* (Q Entertainment, 2004), a Tetris-like puzzle game whose gameplay is partially synced to techno music tracks. The development of *Lumines* and *Rez* shows Mizuguchi's interest in working with musicians to incorporate the soundtrack of his games into the gameplay experience. For both games, he worked with renowned musicians and DJs like Underworld, Ken Ishii, and Adam Freeland. The later released *Lumines II* (Q Entertainment, 2006a) also incorporated music videos by popular artists like The Chemical Brothers, Beck and Gwen Stefani. The latest music-based games designed by Tetsuya Mizuguchi are *Every Extend Extra* (Q Entertainment, 2006b) for the PSP and *Every Extend Extra Extreme* (Q Entertainment, 2007) for the XBox 360. The games are successors to the freeware PC game *Every Extend* (Omega, 2004), which challenged the player to trigger chain reactions by exploding his or her own vessel. Mizuguchi also added the element of music to the game; e.g. by increasing the pace of the music and the gameplay by collecting *quicken* items. Once again, the games are accompanied mostly by techno and trance music that blends beautifully with the game's abstract graphics.

> "The inspiration I had when I came up with the REZ idea has stayed in my head, and Lumines is the result of a chemical reaction between the initial inspiration and PSP's new style. I wanted to create a puzzle game that unites gameplay and music that could satisfy psychological feelings through rich graphics and sound."
> (Mizuguchi, 2005 in the press release for Lumines)

31 http://www.qentertainment.com/english/english.html [Accessed 12/05/08]

Mizuguchi is a great fan of the concept of synaesthesia. He thinks of it as a way for media to evolve into a sensation that encompasses all senses. Mizuguchi has always had a penchant for trying out new approaches to media. His shift from designing racing games to music-based games illustrates this fact, as does his more recent project, the Genki Rockets:

> "One of the most virtual of pop groups, Genki Rockets isn't really a group at all. It's the brainchild of Tetsuya Mizuguchi, who heads up Q-Entertainment; the company created Genki Rockets exclusively for the video games Lumines II and Lumines Live, fashioning the vocals by sampling and then mixing together several female singers. Glamoove Inc., one of Japan's premier visual artists, designed the video for their single, 'Heavenly Star,' which is a tribute to a-ha's video for 'Take on Me.'"
> (A self-definition of the Genki Rockets on their Windows Live Space. [32])

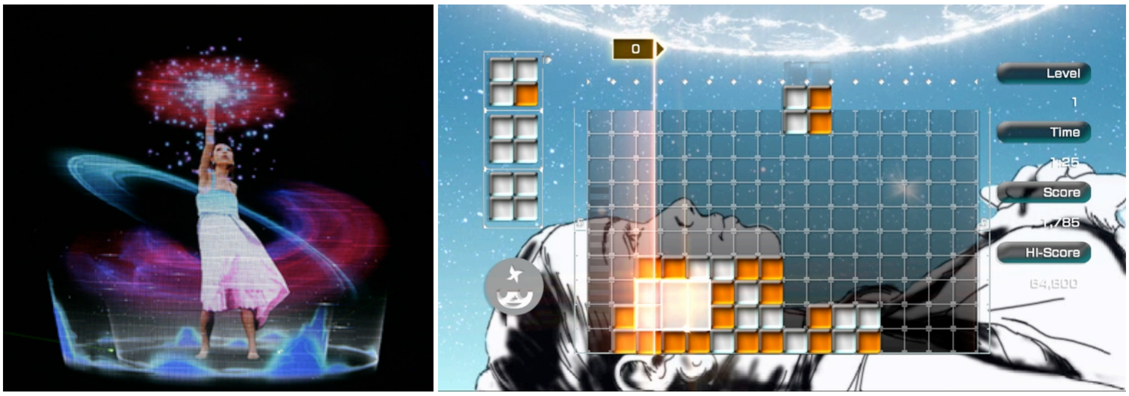

Fig. 16: The virtual singer Lumi of the Genki Rockets (left) and the music video "Heavenly Star" embedded in the background of the game Lumines II (right)

Mizuguchi not only directed the production of *Heavenly Star* but also wrote the lyrics. The music video was used as a track for *Lumines II* (see the above figure) and also featured in the opening of the 2007 Live Earth concert in Tokyo, Japan. After a spectacular laser show performance, the video's character Lumi introduced a holographic version of Al Gore, who gave a short opening speech to the concert. (Sato, 2007).

32 http://genkirockets.spaces.live.com/ [Accessed 12/05/08]

“We're on the starting line right now for interactive media. It's like everything is melting, everything is going to fuse together. What we need is to build the logic of that interaction. The first step was something like MTV, combining music and visuals, but the next step is to explore how we turn that into an interactive experience. How do we make the good feeling you get from media into a better feeling? What's the new sensory involvement, the new "wow!" feeling?”
(Testuya Mizuguchi in an interview with Fahey, 2008 of eurogamer.net)

Mizuguchi calls for the inclusion of interaction as the next step in music. He envisions an emerging genre he calls “music interactives” (Fahey, 2008). Music interactives can serve as an umbrella term including music-based games and also stretching to media art and, in Mizuguchi’s case, audiovisual live performances. Mizuguchi’s work is characterized by the urge to advance and combine different media. From the sensory overload of *Rez* and *Every Extend Extra* to the convergence of popular music, live performance, and video games of the Genki Rockets, his ambition to advance the use of music in new areas and media stands out in his work.

Masaya Matsuura

Fig. 17: Masaya Matsuura

“An encounter with an Apple II Computer software Kaleidoscope at age nineteen changed his life dramatically. The images were mesmerizing, but he felt something was missing. He added music to it, his very first experience as a producer of computer entertainment.”
(Translation[33] of the Japanese version of Matsuura’s biography on the Nanaon-Sha website[34])

Masaya Matsuura was born 1961 in Osaka, Japan. After graduating from Ritsumeikan University with a major in Industrial Sociology[35], he began composing music. Together with the female

33 http://gaming.wikia.com/wiki/Masaya_Matsuura [Accessed 12/05/08]

34 http://www.nanaon-sha.com/ [Accessed 12/05/08]

35 for a short biography of Masaya Matsuura see: http://www.mobygames.com/developer/sheet/view/developerId,97765/ [Accessed 12/05/08]

Japanese singer Mami Yasunori, a.k.a Chaka, he formed *PSY•S* in 1983. The group was very successful in Japan but hardly known beyond. In 1993, Matsuura blended music and multimedia to release the CD-ROM *The Seven Colors*, which won the Multimedia Grand-Prix that same year. PSY•S disbanded in 1996 and Masaya Matsuura founded the independent game company *Nanaon-Sha.*

> "In Japanese, NanaOn-Sha means seven notes or tones, but on the other hand, I wanted to make the company name easy to recognize or memorize for the worldwide people."
> (Masaya Matsuura in an interview with Klepek, 2007)

Shaped by Matsuura's background as a composer and versatile musician, Nanaon-Sha is a company focusing on the creation of music-based games. In its first year, Nanaon-Sha released *Parappa the Rapper* (Nanaon-Sha, 1996) for the Sony Playstation. The game is credited as being the first rhythm action game. It features a dog that mimics rap sequences when buttons are rhythmically pressed in the correct order. Rodney Alan Greenblat, an American cartoon artist and painter whose is especially popular in Japan, drew the graphics. *Parappa the Rapper* has two sequels: *UmJammer Lammy* (Nanaon-Sha, 1999a), which transferred gameplay from hip-hop to the rock genre, and *Parappa the Rapper 2* (Nanaon-Sha, 2001).

Fig. 18: A screenshot of gameplay in Parappa the Rapper (left), a canvas made of wire depicting Vibri, the lead character in Vib Ribbon, that hangs in Matsuura's office (middle), and a shot of Musika for the Apple iPod (right).

Nanaon-Sha's second important game series revolves around the character Vibri. Vibri is a wireframe 2D character that runs along a line with obstacles dynamically shaped to the background music. To evade the obstacles the player must hit button combinations that are assigned to each shape. The game, *Vib-Ribbon* (Nanaon-Sha, 1999b), features music composed by Masaya Matsuura but also allows players to insert a music CD of their own choice. *Vib-Ribbon* has two sequels that were released exclusively in Japan: *Mojib-Ribbon* (Nanaon-Sha, 2003), based upon Japanese Kanji characters, and *Vib-Ripple* (Nanaon-Sha, 2004), which generates its levels from user-contributed images. The concept of user-selected music was also used in the game *Musika* (Nanaon-Sha, 2007) for the Apple iPod. In this game, the player listens to mp3 music on the iPod while catching letters of the current song's title as they fly by on the screen.

> "Currently we are focusing on making the prototypes rather than an actual production line. Of course, we have the production seasons for the product, but focusing on making the unique prototypes helps our business be much more reliable. [..] basically, this kind of 'jam session' style for the development of ideas, came from my music career. [..] The development, making the prototype, is a very important mission for us. After the prototype is done, it's easy to find a certain production team [to complete the game]."
> (Masaya Matsuura on prototyping, in an interview with Sheffield, 2008)

The above quote illustrates the importance of prototyping for small game companies. Matsuura also points out the similarities between "jamming" in music and small-scale prototyping as an explorative method of game design. Masaysa Matsuura's games all show his experience as a musician. He is a pioneer of rhythm-based gameplay and has experimented extensively with custom, user-selected music in music-based games.

Summary

These three Japanese game designers have created games that are formative for the genre of music-based games. Their biographies disclose that music-based games are often a fusion of music, art, and video games. Each of the three featured designers has a unique and distinct approach to music-based games design. Toshio Iwai's works are strongly coined by his experience as a media artist, Masaya Matsuura's games reveal his background as a composer and musician, and Tetsuya Mizuguchi is a game designer who approaches music-based games as the next generation of music.

Modding for Music

> "Abstraction may be discovered or produced, may be material or immaterial, but abstraction is what every hack produces and affirms. To abstract is to construct a plane upon which otherwise different and unrelated matters may be brought into many possible relations. It is through the abstract that the virtual is identified, produced and released. The virtual is not just the potential latent in matters, it is the potential of potential. To hack is to produce or apply the abstract to information and express the possibility of new worlds."
> (McKenzie, 2004)

Open game engines like those of *Unreal Tournament* and *Quake* have always been a platform for user-generated content. Both games have enjoyed a flurry of user contributions ranging from avatars and maps to entire movies produced within the game (called *Machinima).* Artists have also drawn upon both engines as a basis for media art installations and environments. One critically acclaimed project is Jahrmann & Moswitzer's *nybble-engine-toolZ,* a "radical meta-art system shooter" that received an award at the *Prix Ars Electronica 2003.* Based on the *Unreal* engine, the nybble-engine-toolZ sets the player into a transformed environment:

> "[..] the rules of the game engine are turned round: the Unreal tournament becomes a situationist détournement, an inversion. Attack is collaboration, shoot is communication, and playing becomes the editing of code! "
> (Jahrmann & Moswitzer, 2003).

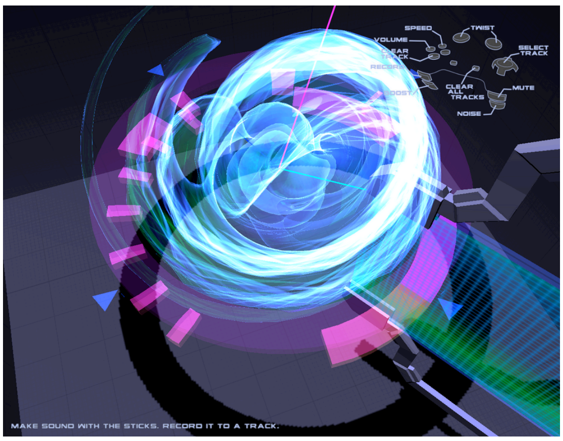

Fig. 19: A screenshot of Julian Oliver's Fijuu 2

In a similar way, the projects of New Zealand born artist Julian Oliver[36] transform game engines into musical environments. Both *Qtoth* (quilted thought organ), based on the *Half-Life* (Valve Software, 1998) engine, and *q3apd* that uses *Quake III* (id Software, 1999) as a music-making system, place the player within the familiar perspective of a first-person-shooter. However, instead of shooting enemies, the respective game worlds are artfully transformed to enable the player to trigger sounds and musical fragments, establishing a musical performance en-

36 http://julianoliver.com/ [Accessed 12/05/08]. This site details the artworks that are presented in following.

vironment with the familiar setting and controls of a first-person-shooter game. The latest of Julian Oliver's performance environments, *Fijuu* and its successor *Fijuu2*[37], are audiovisual installations playfully controlled with a gamepad. *Fijuu 2* is made with the open-source engine *Ogre*[38], which is generally used for game development.

Fig. 20: The Beastie Boys featured in NBA Street V3 (EA Canada, 2005) on MTV2's Video Mods show

Another way of modding games is to use them to create video films. The term *machinima*, derived from the words machine and cinema, denotes video films that are staged in a game world or use game characters. The most popular series of machinima is *Red vs. Blue* (Rooster Teeth Productions[39]), a series of military action episodes staged in the game worlds of the *Halo* series (Bungie Studios, 2001-2007). Many machinima feature a connection to music and videos with dancing game characters are a regularity. MTV2 picked up on this trend, with their show *Video Mods*[40] featuring popular music artists performing one of their songs as 3D characters in the world of a video game. Both the artists and the game publisher profit from this type of cross marketing.

The modding of games is a fast and easy way to produce new media. The convergence between games, music, and television on the MTV2 show *Video Mods,* and the playful instrumental interactivity of Julian Oliver's artwork illustrate two possible directions of modding games for music.

37 http://www.fijuu.com/ [Accessed 12/05/08]

38 http://www.ogre3d.org/ [Accessed 12/05/08]

39 http://www.roosterteeth.com/ [Accessed 12/05/08]

40 http://www.mtv2.com/#series/13696 [Accessed 12/05/08]

Independent Development

Quite recently, several small-scale independent games with strong musical ties have gathered some attention. As repeatedly noted in this chapter, music-based games have strong ties to art. Their focus on music also makes them easier and cheaper for small or independent companies to produce. As much of the gameplay is based on sound and music, sophisticated and thus expensive graphics can take a back seat to the acoustic component of the game. The structure of short levels corresponding to the length of a song allows for slimmer games. Through the emergence of downloadable games on the *Playstation Network*, *XBox Live Arcade,* and *Steam,* the format of smaller music-based games has recently picked up momentum. Here are some brief examples of independent music-based games.

One of the first games to draw attention to the Playstation Network is *flOw* (thatgamecompany, 2007). Based upon a flash game, flOw was published by Sony for the PSN. flOw is not strictly a music-based game. It features a worm that is guided by the player through the motion-sensing capabilities of the Sixaxis PS3 controller. By feeding on other animals, the worm grows larger and able to dive into deeper sections of the sea. The game is very meditative and features no time limits or game over conditions. All movements and actions of the player blend smoothly into the ambient background music of the game. flOw illustrates that tightly synchronized music-based gameplay features can also be used to supplement a game that does not revolve around music. The more recent *Pixeljunk Eden* (Q-Games, 2008) works similarly. Actions of the player's avatar, a small animal that collects pollen in a garden, blend into the background tech-house music of the game, without music being a core gameplay feature of the game. Distinctive about *Pixeljunk Eden* is that both graphics and music were created by one artist, Tomohisa Kuramitsu (a.k.a. Baiyon), allowing image and sound to mutually inspire each other (Jeriaska, 2008).

The game *Space Giraffe,* controversial for its excessive use of colors and psychedelic graphics (Llamasoft, 2007) employs a similar concept. By visually and acoustically enriching the gameplay of the classic arcade game *Tempest* (Atari, 1980), Space Giraffe draws the player into a synaesthetic experience.

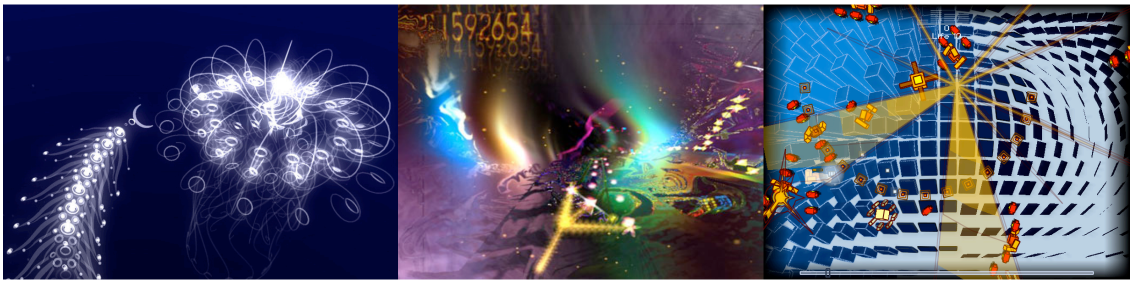

Fig. 21: Screenshots of flOw (left), Space Giraffe (middle) and Everyday Shooter (right).

Also based on a simple vector graphics style, Jonathan Mak's *Everyday Shooter* (Queasy Games, 2007), was released as a downloadable game for the PS3. *Everyday Shooter* is a strictly music-based shooter inspired by the works of Tetsuya Mizuguchi, which quantizes all gameplay events to the game's alternative rock soundtrack:

> "Everyday Shooter is an album of games exploring the expressive power of abstract shooters. Dissolute sounds of destruction are replaced with guitar riffs harmonizing over an all-guitar soundtrack, while modulating shapes celebrate the flowing beauty of geometry."
> (Jonathan Mak's description of Everyday Shooter on the Queasy Games website[41])

The last two independent games presented in this section are *Audiosurf* (Dylan Fitterer, 2008) and *Synesthete* (Aikman, Tkach et al., 2008). Both are rhythm action games that let the player fly on rails through a vector graphics based world, where they must react rhythmically to survive. *Audiosurf*, in the spirit of *Vib Ribbon*, allows for the use of custom music to dynamically generate new racing tracks. *Audiosurf* won multiple awards at the 2008 Independent Games Festival[42] and is currently distributed on Valve's steam platform. *Synesthete* was awarded the *Best Student Game* prize at the same festival.

Fig. 22: Screenshots of Audiosurf (left) and Synesthete (right).

41 http://www.queasygames.com/ [Accessed 12/05/08]

42 http://www.igf.com/ [Accessed 12/05/08]

To summarize, all the games presented in this section illustrate the fittingness of music-based games for independent game design. The popularity of small music-based games is underlined by the success and critical acclaim of *flOw* and *Everyday Shooter* on the Playstation Network and by the awards won by two music-based games at the 2008 Independent Games Festival. All of the games feature simple vector graphics and draw their distinctive style from the use of music.

Bemani, Harmonix and the Evolution of the Rhythm Game

Since 1997, the publisher Konami has contributed enormously to the worldwide success of rhythm games. Their brand name *Bemani* is also the name of its music video game division, originally named *Games & Music Division*. The first game they released was the arcade machine *Beatmania* (Okamoto, 1997), which provides the player with a DJ interface. Using several keys and a turntable, the player must rhythmically match visual patterns that tumble down the screen. The chosen song determines the speed and difficulty of the patterns. The *Beatmania* series (Konami, 1997-2002) was very popular and spawned a large number of arcade sequels and console conversions.

Fig. 23: The arcade cabinets of Beatmania (left), Dance Dance Revolution (middle) and Guitar Freaks (right)

In 1998, Konami invented an even more successful series of rhythm games; the *Dance Dance Revolution* (short *DDR*) series (Konami, 1998-2008). Not unlike *Beatmania*, the player's task is to rhythmically hit items falling down the screen, but the interface is quite different. Instead of pressing buttons, the player has to use his or her feet to hit squares on the floor. At higher levels the dancing moves become very complex and worldwide DDR tournaments are held regularly[43], grading either the style or the perfection of dancing. A year later, Konami pioneered the genre of

43 for an overview on DDR tournaments in the United States see: http://www.ddrfreak.com/phpBB2/viewforum.php?f=5 [Accessed 12/05/08]

guitar and drum based music games with the release of the arcade game series *Guitar Freaks* (Konami, 1999-2008) and *Drum Mania* (Konami, 1999-2008).

When Harmonix released *freQuency* (Harmonix Music Systems, 2001), they added a very important element to the Bemani brand of music-based rhythm games. Firstly, they transformed the player's perspective by traversing the music score along tracks going into the depth of the screen. Secondly, and more importantly, they added control of the music to the game. As the player rhythmically collects items along the rails, he or she activates parts of the song being played. The better the game is played, the better the music sounds. If notes are missed, short awkward sounds are emitted and failure over a longer stretch makes the music stop playing. The same concept is used by *freQuency*'s successor, *Amplitude* (Harmonix Music Systems, 2003). Both *freQuency* and *Amplitude* use licensed electronica, rap and pop music songs. The series concluded with the game *Phase* (Harmonix Music Systems, 2007) for the Apple iPod. *Phase* implements the same concept as *freQuency* and *Amplitude* but uses an iTunes plug-in to create levels of custom music selected by the player.

> "RedOctane had been talking to Harmonix for a while. It was a rental company and then they made dance mats for DDR [Dance Dance Revolution]. It ended up selling a bundle of these dance mats and wanted to progress that side of its business. The company was interested in making a guitar game as they'd seen Guitar Freaks, which Konami had done. So they came to Harmonix with the request, 'will you make us a great guitar game for our new piece of guitar hardware?' "
> (Harmonix' lead designer of Guitar Hero, Rob Kay, in an interview with Simons, 2007)

Obviously inspired by the above-mentioned *Guitar Freaks* games, Harmonix released the original *Guitar Hero* (Harmonix Music Systems, 2005) for the Playstation 2. Just like *freQuency* and *Amplitude*, *Guitar Hero* added an audible progression of the song to the concept of Konami's Bemani games, packaged a guitar peripheral into the game, and included many popular licensed rock songs to attract a broader public.

Overall, rhythm games have changed very little over time. The only changes Harmonix made to the much older Konami games concerned perspective and direct control of the underlying soundtrack. Distinction between rhythm games revolves mostly around the different input devices. From floor mats in *DDR*, to turntables or guitars, a variety of interfaces have found their way into the homes of rhythm game fans.

Tangible Sound - Physical Interfaces to Music

Traditional instruments have physical interfaces. Be it the strings of a guitar, drumsticks, or the buttons of a trumpet, instruments have a haptic quality. Recreating the tangible nature of instruments is a challenge taken on by various media art works and video games. Touch interfaces for music have a longer history in media art than they have in video games. The absence of touch screens for gaming platforms came to an end with the release of the Nintendo DS in 2004; and then with mobile phones, like the Apple iPhone, featuring touch screen interfaces. This section presents two art works that playfully utilize touch interfaces for music, and then a short overview of the various physical interfaces triggered by music-based games.

> "The reacTable* is a state-of-the-art music instrument, which seeks to be collaborative (local and remote), intuitive (zero manual, zero instructions), sonically challenging and interesting, learnable and masterable, and suitable for Instrument peripherals"
> (Jordà, Kaltenbrunner, et al., 2005)

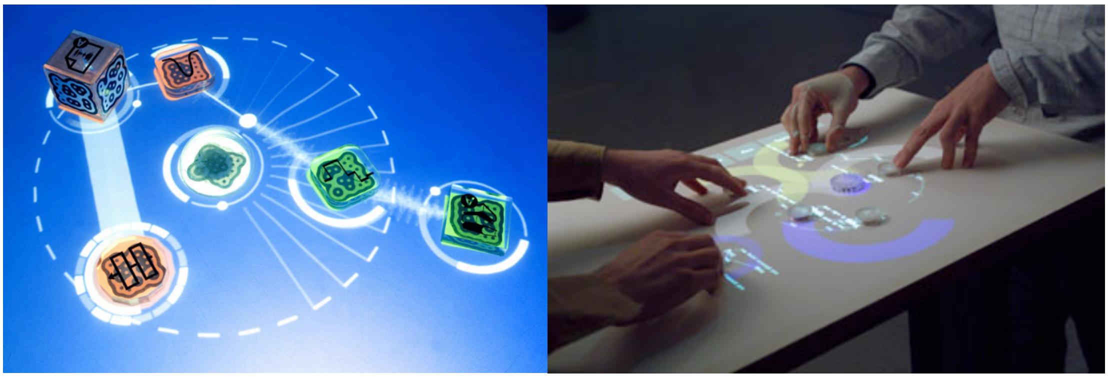

Fig. 24: The reacTable (left) and the Audiopad (right).

The *reacTable*[44] is a table installation. Objects including generators, filters, controllers, and a mixer are placed on the surface and tracked by a camera. The relative placement of the objects determines their interplay. (Kaltenbrunner, Geiger, et al., 2004). The *reacTable* is designed to be a music interface that is easily accessible while still providing depth and expression. This requirement holds true for other playful musical environments and games as well.

Very similar to the *reacTable*, the *Audiopad*[45] provides a fun setting for musical performances with a similar method of placing objects on a table. Instead of generating sounds like the *reacTa-*

44 http://reactable.iua.upf.edu/ [Accessed 12/05/08]

45 http://www.jamespatten.com/audiopad/ [Accessed 12/05/08]

ble, the *Audiopad* revolves more around sample playback and manipulation. Masaki Fujihata's installation *Small Fish* (Fujihata et al., 2000) provides an even more playful approach to a musical table installation; by manipulating a pond of fish, the player indirectly influences the installation's musical score.

Since video games began exploring music-based interaction, a vast array of specialized instrument peripherals has arisen, surpassed in number only by flight sticks and racing wheels. Some interfaces (dance mats, guitars and drum kits) were described in previous sections. Rudimentary guitar controllers were first introduced as early as 1994 with *Born to Rock* (Virtual Music, 1994) and its sequel, the Aerosmith based game *Quest for Fame* (Virtual Music, 1995). The *VPick* is a guitar pick that connects to the PC's printer port and sends a signal when moved. The game's manual recommends using the *VPick* with a tennis racket for optimal experience. Some other instruments that have been refurbished as game controllers include Maracas (*Samba de Amigo*, Sonic Team, 1999) and Bongos (*Donkey Conga*, Namco, 2003).

Fig. 25: Virtual Music's VPick (left), The bongos for Donkey Conga (middle) and the Maracas used in Samba de Amigo (right).

Music-based games try to implement facets of real instruments. Some games use abstract plastic versions of the real instrument as an input device, other devices such as the *reacTable* provide a depth of expression similar to an instrument by implementing new interfaces for making music.

Singing and Swinging in Style

Singstar and Rock Band as Social Gaming Platforms

In recent years, many games have surfaced that enable gamers and non-gamers to play together. The rise of Nintendo's DS and Wii consoles have brought gaming to a more casual public and in addition to games like *Wii Sports* (Nintendo EAD, 2006) and the *Buzz!* series (Relentless Software, 2005-2008) of quiz games, music-based games have become a big factor in casual and social gaming. Karaoke games also enjoy great success among music-based games. Games like Sony's *Singstar* series (Sony London Studio, 2004-2008) or the *Karaoke Revolution* series (Harmonix Music Systems, 2004-2008) published on the Konami Bemani label, provide gamers with the experience of performance familiar from Karaoke bars and DVDs.

Fig. 26: The Rock Band setup of instruments

Taking off from *Guitar Hero, Guitar Freaks,* and *Drum Mania*, an array of nearly identical rock music video games with multiple peripherals has recently flooded the market. The *Rock Band* series (Harmonix Music Systems, 2007-2008), *Guitar Hero: World Tour* (Neversoft, 2008) and *Rock Revolution* (Konami, 2008) all provide an instrument set for home performance. An ideal setup has two microphones, two guitars, and a drum-kit.

These music-based games make music accessible, which attracts a broader audience than other video game genres. The music-based games presented in this section allow for collaborative musical performances in the middle of the living room.

Audio Games and Accessibility

Fig. 27: The audio installation Sonic Pong[46] by Andrew Milmoe

Audiogames are games that lack a visual component, only having sound and interface. Their purpose is to make gaming accessible to the visually impaired. Among the first audiogames were text adventures, teamed up with text-to-speech software. The biggest portal for audiogames is *audiogames.net*[47], which features a large and comprehensive archive of games.

In 1997, Fumito Ueda, the designer of the critically acclaimed *Ico* (Team Ico, 2001), designed *Real Sound: Kaze no Regret* (Warp, 1997) for the Sega Saturn. The screen is blank while playing the game, an adventure that involves the player in a love story. Additionally, plant seeds and Braille cards are packaged with the game. Audiogames have also attracted the attention of regular game designers and artists. One artistic interpretation of an audiogame is the acoustic version of the game *Pong*. The interactive installation *Sonic Pong (*depicted above) gives away the position of the ball through a circle of cups surrounding the player that are struck when the ball approaches.

Research on audiogames has yielded insights and terminologies for the use of audio in games that are interesting to game design in general[48]. Two frameworks for audiogames have recently been released as research projects; TiM (Tactile interactive Multimedia framework) is an authoring environment that enables the creation of audiogames and the adaptation of regular games (Archambault et al. 2000 and Friberg et al., 2004). *The Audio Game Maker* is a "free application which enables visually impaired people to make their own sound-based computer games"[49].

46 http://www.milmoe.com/artprojects/sonicpong/sonicpong.htm [Accessed 12/05/08]

47 http://www.audiogames.net/ [Accessed 12/05/08]

48 Terms learned from research on audiogames are presented in the next chapter.

49 http://www.audiogamemaker.com/ [Accessed 12/05/08]

50 Cent and 1$ per Track

The Convergences between the Game and Music Industries

> "We see Rock Band as a music platform. We want to make that platform a reality, so when people are just listening to music, they're not experiencing everything in it any more. We want people to get inside music on a different level. [..] One day all the bands in the world will be able to get their music in the game without us having to be the bottleneck."
>
> (Harmonix' design director Rob Kay in an interview with games magazine Edge, 2008a)

Music-based games offer new ways to experience music. The added interactivity gives players an enriched musical experience they may not get from listening alone. Through increasing possibilities for downloadable content, music-based games also act as distribution platforms for music. In a mere two months after their Christmas release in 2007, *Rock Band* and *Guitar Hero* each sold a massive amount (2.5 and 5 million, respectively) of extra downloadable tracks, priced between one and two dollars apiece (Bruno, 2008).

> "With such a low installation base, we didn't think that there'd be 2 million songs sold in eight weeks. [..] We live in a rough time around music where our audience struggles to pay $20 for a CD but don't hesitate to pay $50 for a game. The notion to pay 99 cents or $1.99 to have a song and repeatedly play with it apparently isn't a big hurdle."
>
> (MTVN Music Group/Logo/Films division president Van Toffler cited in Bruno, 2008)

It is evident that music-based games provide new chances for the music industry to promote and sell content. Not limited to promotional convergences like the appearance of Michael Jackson in *Space Channel 5* or the MTV2 show *Video Mods,* there are even entire games featuring a popular artist as the main protagonist (e.g. U.S. Rapper 50 Cent in the action game *50 Cent: Bulletproof,* Genuine Games, 2005).

Electronic Arts started to feature many popular music artists in their sports and racing games in 2002 under the label EA Trax[50]. Blink 182's most successful single, *Feeling This,* was first released as part of the soundtrack of the Electronic Arts game *John Madden Football 2004.* According to Kusek & Leonhard (2005) the number of times a song is played in *Madden* during the first six months is about 700 million. This count by far exceeds the number of times a number one hit is played on American radio stations. Both the video game and the music industries benefit from this form of cross marketing (Tessler, 2008). Steve Schnur, worldwide executive of music and

50 http://www.ea.com/eatrax/ [Accessed 12/05/08]

marketing for Electronic Arts, gives a series of examples where a band was pushed by being featured on a video game soundtrack:

> "Avril Lavigne was first introduced to European audiences through FIFA 2003. Fabolous was first introduced in America via NBA Live, and went on to sell over 2 million albums here. JET got their American iPod commercial based on exposure in Madden 2004. [..] Our FIFA 2005 soundtrack featured the earliest appearances of Franz Ferdinand, Marcelo D2, and Scissor Sisters. Sony Records credits Madden 2005 as being instrumental in the breaking of Franz Ferdinand in North America. Ozomatli, a band that has existed for years with minimal sales and exposure, got an iPod commercial, a career-changing sales jump, and a Grammy nomination based on their exposure in Madden 2005. Def Jam Vendetta single-handedly created a new global market for hip-hop."
> (Schnur, 2008)

The number of songs sold as downloadable content and the wide possibilities of cross-marketing create a tight connection between the games and music industries. Games provide the framework to sell and promote content while enabling players to interactively experience popular artists and songs.

Summary

This chapter provided an overview of video games and music. In the beginning, only mechanical noises gave games an acoustic presence. Music in games is a continually evolving medium. Video game music has developed from being composed exclusively for a single platform (due to proprietary sound hardware) into the strong convergence with popular music common nowadays. This is a view shared by Japanese designer Tetsuya Mizuguchi and other designers, who push towards evolving music into an interactive experience and advance the genre from a specific perspective. Other influences treat music-based games as instruments, an approach that is beautifully illustrated by the works of Toshio Iwai and that is incorporated into a multitude of media artworks. The aesthetics and reception of music-based games varies regionally. The works of Japanese composers are regularly performed as symphonic concerts, European game music has strong ties to early synthesizer and techno culture, and U.S. American games increasingly feature tie-ins with popular music and mainstream culture. Of course, the history of music-based games is also a history of technology as sound hardware, storage media, peripherals and distribution platforms have changed the way music in games is used and composed. From small independent companies and artists producing downloadable games to the large-scale *Rock Band* platform, the music-based games genre is very diverse. Music-based interaction encompasses the long line of rhythm-based games originating in Japanese arcades, instrumental toys, media artworks, and party games. Music-based interaction is also used to enrich regular gaming experiences, such as when Koji Kondo first introduced music as a game mechanic in the *Zelda* series. The use of music in game mechanics is especially important for audiogames, a purely acoustic type of game easily accessible to the visually impaired.

As made clear by Tetsuya Mizuguchi's evolution of music to a more immersive genre called "music interactives" and by Toshio Iwai's wide range of artwork, instruments, and games, music-based games are a genre that stretches out into the realms of popular music, art, and instrument design. The borders between these areas are blurry, but are a great help in furthering the understanding of music-based games, which constitute themselves not only as games but also as art, evolving music into an interactive experience not limited to musicians alone.

Game Sound and Music Terminology

> "Music cannot be boiled down to a well-defined language, nor can it thus be coded merely by usage. Music is always in the making, groping its way through some frail and mysterious passage - and a very strange one it is - between nature and culture."
> (French composer and researcher Pierre Schaeffer in the introduction to "Solfège de l'Objet Sonore" (musical theory of the sound object), 1966)

The above quote is a disclaimer, not a contradiction, and intentionally poses a contrast to the seeming goal of a terminology. Attempts to condense music into a graspable form have always been made, and will continue to do so. This includes searching for a formula for successful rock and pop music, or devising software to automatically categorize music. Current research on music information retrieval[51] is very valuable, and nonetheless it seems that music has many qualities that somehow elude such methodical approaches. Therefore, this chapter does not attempt to define music itself but instead compares and condenses terminologies for the *use* of music in games. Starting with common definitions from film studies, a more specific vocabulary for the use of music and sound in games is then laid out

Sound in Film Studies

In film studies, audio is generally classified as diegetic or non-diegetic (Chion, 1994). The term *diegetic* originates from the ancient Greek word *diegesis* used to describe the telling of a story by a narrator (as opposed to *mimesis,* which denotes the imitation or representation of a story rather than the telling of one - e.g. in a theater play) (Aristotle, 335 BC).

In film, sounds that occur within the narrative context of a scene are called diegetic. Sounds that have no cause in what is shown on the screen are called non-diegetic. For example, if the movie's protagonists are sitting in a café and a song is played on the radio, it is called diegetic. If the same song is played in the background (and if it is apparent that the protagonists don't hear the song), it is called non-diegetic. Directly applied to games, this means sounds that "can be heard" by the player's avatar are diegetic and sounds that occur outside the gameworld are non-diegetic (e.g. background music or sounds and alerts related to the graphical user interface).

51 see Fingerhut (2004) for an introduction. Further information can be obtained via the *Virtual home of music information retrieval research* http://www.music-ir.org/ [Accessed 12/05/08] and the homepage of the *ISMIR (The International Conferences on Music Information Retrieval and Related Activities)* http://www.ismir.net/ [Accessed 12/05/08].

Space in Games

In order to understand sound and music as presented in the current chapter, an understanding of *space* must first be established. The arts, architecture, music, and game studies each define space in a slightly different context. In his analysis, *"Modalities of Space in Video and Computer Games",* Axel Stockburger (2006) makes a distinction between the *game space*, which includes all sounds originating from the game; and the *user space,* which encompasses the physical location and surroundings of the player. Game space is subdivided into *narrative space* (a game's story and setting and the player's progression within that space), *rule space* (the rules of play a game is based on), *audiovisual representation space* (the appearance of a game) and *kinaesthetic space* (the mapping of interaction). Sounds can originate in each of these spaces. Kinaesthetic space is connected to sounds arising in the user space; sounds triggered in the narrative, audiovisual representation, and rule space are all within the game space.

Sound in Games

This section provides an overview of current research on the use of sound in games. Karen Collins (2007) argues that games demand a finer granulation of terms since player interaction is expanding the possible uses of sound. According to Fay et al. (2004) and Whitmore (2003), game audio can either be *interactive*, *adaptive* (both signified by the term *dynamic*) or *non-dynamic* (linear). Interactive audio refers to sounds that are directly manipulated or triggered by the player (such as footsteps or location-based music changes). Adaptive audio denotes sounds that are changed through gameplay (e.g. the acceleration of the background music when a time limits runs out). Non-dynamic sounds characterize all of the rest (background music, narrators, etc.). Combining these terms with the concept of diegetic and non-diegetic sounds results in a diverse terminology:

- *interactive diegetic audio:* denotes sounds that are triggered by the player and are situated in the game's narrative space.
- *interactive non-diegetic audio:* denotes sounds that are triggered by the player but occur outside the game's narrative space.
- *adaptive diegetic audio:* denotes sounds that are not influenced by the player but are triggered by gameplay and situated in the game's narrative space.
- *adaptive non-diegetic audio:* denotes sounds that are not influenced by the player but triggered by gameplay and occur outside the game's narrative space.

- *non-dynamic diegetic audio:* denotes linear sounds that are situated in the game's narrative space.
- *non-dynamic non-diegetic audio:* denotes linear sounds that happen outside the game's narrative space.

Mark Grimshaw (2007a; 2007b) and Grimshaw & Schott (2007; 2008) proposes a similarly refined terminology for the analysis of first-person-shooter audio. Diegetic audio is broken down further into *ideodiegetic audio* (immediate sounds heard by the player) and *telediegetic audio* (sounds triggered by other players that have a subsequent consequence on the player). Ideodiegetic sounds are divided into *kinediegetic* (triggered by the player) and *exodiegetic* (triggered by gameplay), a distinction roughly equivalent to that of adaptive and interactive audio. As such, the only addition to the above terminology list is the inclusion of telediegetic sounds, which are player-induced acoustic elements that have a delayed effect on the player.

In her thesis, "Computer Game Audio and Player Action", Kristine Jørgensen (2007) softens the distinction between diegetic and non-diegetic audio by introducing the term *transdiegetic* audio. Transdiegetic audio designates sounds that transcend the border between the virtual game space and a game's interface.

The distinction of game audio categories is relevant for videogame design and also from a technical perspective. The implementation of frameworks for game audio is greatly facilitated when relying on distinct game audio uses (for examples see the *IEZA framework*, described by Sander Huiberts and Richard van Tol (2008) and the industry perspective on game audio given in *Edge* magazine (2008b).

Composition

When composing music for games there are several strategies aside from linear playback. Karen Collins (2007) defines *dynamic audio* as audio dependent on player actions. There are two types of dynamic audio: *interactive audio* (Bajakian et al., 2003) is directly influenced by the player and is the type of game audio prevalent in most music-based games; *adaptive audio* is not directly controlled by the player yet reacts to the player's actions (Whitmore, 2003) and status. Fay et al. state, "The difference is that instead of responding to feedback from the listener/player, the audio changes according to changes occurring within the game or playback environment" (2004).

Douglas Wilson (2008) gives a very good analysis of adaptive audio in an article on the strategy game *Civilization 4* (Firaxis Games, 2005), highlighting the immersive quality of the game's soundtrack. The soundtrack enhances the drama of the game by changing its tune according to gameplay (such as an attack or the immediate destruction of a unit) while adhering to the style of the historical epoch the game is currently played in.

A more flexible approach to dynamic, adaptive game music is generative music. Music is composed dynamically using algorithmic composition[52] . Parameters of the composition are set according to the state of the game and in response to player interaction. An excellent example is the soundtrack of *Spore* (Maxis, 2008), composed by ambient music pioneer Brian Eno.

L'objet sonore

To functionally describe game audio, sounds can be treated as objects (or icons) with an attached meaning. In Axel Stockburger's (2006) treatise of game space, sound objects are defined according to French musician Pierre Schaeffer, who is regarded as the originator of *musique concrète*[53]. Schaeffer first introduced the notion of the *objet sonore* (the sound object) in 1966:

> "[w]hen we listen to sound objects whose instrumental sources are hidden, we are led to forget the latter and to get interested in the objects themselves. Here, the dissociation between seeing and hearing is favoring a specific way of hearing: the hearing of sound forms, without any other purpose than to get a better understanding, and, finally to be able to describe and analyse the content of our perceptions".
> Schaeffer (1966)

Schaeffer's approach to sound objects is later reflected upon in Michel Chion's *"Guide des Objets Sonores: Pierre Schaeffer et la recherche musicale"* (1995). Sound objects in games are also referred to as auditory icons. They are of great importance to *audio games*[54] (games for the visually impaired without visual components). To understand the diagram below, which situates sounds according to three different listening modes, it is necessary to describe Michel Chion's distinction of human listening. In his book *Audio-Vision: Sound on Screen* (Chion, 1994), he describes

52 The paper "An introduction to procedural audio and its application in computer games" (Farnell, 2007) gives a technical overview on algorithmic composition and procedural audio.

53 For a description of *musique concrète,* see the later section on the modified pinball machine *bagatelle concrète,* whose musical output is shaped according to the rules of this musical style.

54 Audio games only exist acoustically and therefore implement mechanisms and concepts that are basic to the design of music-based games. For more information on the design of audiogames, see (Röber & Masuch, 2004 and 2005).

casual listening as the attempt to locate the source and cause of a sound. *Semantic listening* denotes the process of decoding auditory codes, and *reduced listening* refers to specifically listening to one quality of music (such as pitch or rhythm).

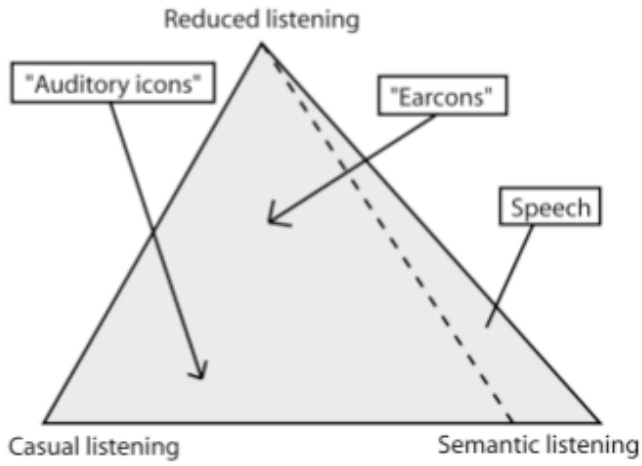

Fig. 28: Triangular sonic vocabulary (Friberg & Gädenfors, 2004)

The shape of the above figure is strongly related to Scott McCloud's triangular vocabulary[55] for visual cartoons in his book *"Understanding Comics"*, where he separates reality, meaning, and the picture pane (McCloud, 1993). Johnny Friberg and Dan Gädenfors use this graphical notation to designate auditory icons as authentic, recognizable sounds, while seeing *earcons* as musical phrases that convey information[56].

Summary

Since music is not completely graspable by a specific methodology, the process of formalizing music for music-based game design also depends upon its more abstract attributes. Kungel's (2004) distinct audio parameters for movies includes dynamics, harmony, sound, melody, pause, rhythm, beat, and tempo. It provides game designers a list of parameters that can be accessed through player interaction or be changed as feedback to players.

Understanding how sound and music are used in film helps analyze their meaning for videogames. This approach can also yield techniques that can be transferred from movies to games. For example, the technique of *Mickey Mousing* (described by Schneider, 1990; and in relation to

55 A similar graphical representation has been used in Kayali and Purgathofer (2008) to describe deviations from realism in the design of sports simulations.

56 For more information on how games convey information through audio interfaces, see "Approaches to Auditory Interface Design - Lessons from Computer Games" (Coleman et al., 2005) and "Designing Sound for a Pervasive Mobile Game" (Ekman et al., 2005).

iconic sounds by Curtis, 1992) refers to the tight synchronization of image and sound, i.e. when a movie soundtrack mimics the movements of on-screen characters or objects. This technique is used extensively in Disney movies (thus the name) or in Charlie Chaplin and Jackie Chan movies. It can also be applied to videogames, causing player interaction to get very direct and immediate feedback from the soundtrack (Whalen, 2004a, b).

This chapter presented terminology for music and sound in games and ascertained that music-based games rely strongly on the use of diegetic sounds. Since the creation and modification of music is a core quality of these games, most sounds originate directly within the on-screen action. In this sense, audio in music-based games can be safely classified as interactive. Music can also be based on generative and adaptive composition techniques, depending on the type of musical interaction that is at the core of the gameplay.

Qualitative Examples

Otocky

Toshio Iwai / Sedic (1987), Famicom Disk System

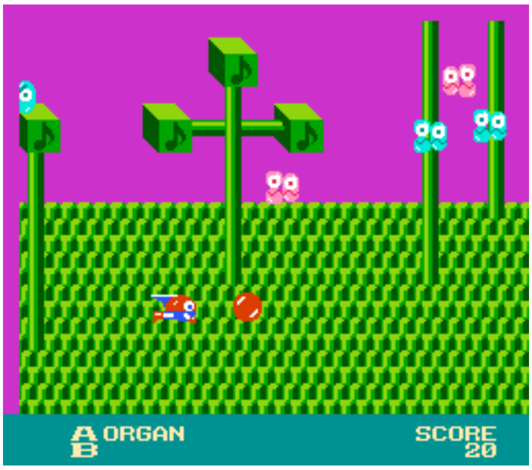

Fig. 29: The side-scrolling gameplay of Otocky

"To define the nature of Otocky, I would have to say, in utter paradoxical fashion, that it's hard to define. The game merges the appeal of making music with a typical, side-scrolling space shooter, where the player is the quick-reflexed conductor of the exceedingly cute, bulbous-bodied musical instrument."
(Spencer of Siliconera.com, 2005)

Toshio Iwai created *Otocky* in 1987 for the Famicom Disk System. Released the same year as Chris Hülsbeck's game *To Be On Top*, it is one of the first music-based games. *Otocky* is a side-scrolling shooter in which the player controls a small spaceship that fires music balls. All gameplay events are quantized to the beat of the game's soundtrack, meaning that gameplay acoustically blends with the background music. When the player picks up a new weapon, it changes not only the shape and effect of the music ball, but also its tune. Starting with a simple organ, the player goes on to acquire a violin, an electric guitar, and many more instruments. *Otocky* also has an editor, made available once the game is completed for the first time. In the editor, the player can simultaneously create new levels, author gameplay, and devise a musical score.

Parappa the Rapper

Masaya Matsuura / NanaOn-Sha (1996), Playstation

> "I've been into music since 1997, when my first game Parappa the Rapper was released on the original Playstation[57]. My game was one of the first to let gamers play along with a tune by pressing buttons along with the beat. [..] Me and my friends sang a bunch of catchy songs and the whole thing was animated with a cool cartoon style totally different from anything else out there."
>
> The "About Me" section on the website to Parappa the Rapper[58]

Parappa the Rapper is the first game created by Masaya Matsuura's company NanaOn-Sha. Its gameplay builds upon mechanics first used by the *Simon* and *Touch Me* handhelds. Series of rhythmic events of increasing complexity must be reproduced by pressing buttons and thus playing along with the game's rap music soundtrack. Aside from being credited as the first rhythm-based game, *Parappa the Rapper* is also famous for its distinct visual style, shaped by American cartoon artist Rodney Alan Greenblatt, who became especially popular in Japan.

Sim Tunes

Toshio Iwai / Maxis Software (1996), PC

> "You can see four small Insects walking on the screen. These Insects have their own sound. They are kind of walking musical instruments. Using the mouse, you can choose a colour from this palette, you can draw something like a paint software. If a insect crosses a colour dot, the insect makes a sound and light pattern. Each colour means musical scale, like do, re, mi, fa... If you paint randomly, these insects make random sound. But there are some techniques to make this sounds like real music."
>
> (Iwai, 1993)

Sim Tunes is the PC version of Toshio Iwai's *Music Insects* installation. It is a game without set goals. The interface is painterly and allows the player to color a grid and place arrows and obstacles. By placing different insects, each corresponding to a musical instrument, the player activates the painted score. As the insects walk across the grid, they trigger music according to the colors.

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57 The Japanese version of Parappa the Rapper was released in 1996.

58 http://www.us.playstation.com/parappatherapper/ [Accesssed]

Vib Ribbon

Masaya Matsuura / NanaOnSha (1999), Playstation

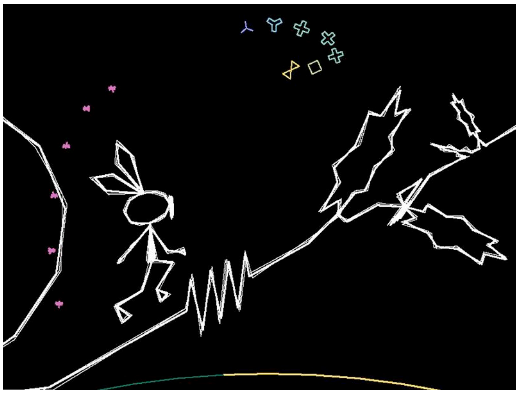


Fig. 30: A generated level of Vib Ribbon

"vib-ribbon can be played with any music CD. [..] Sony Music artist DJ Cam - the 'Parisian master of hip-hop blunts' - is an avid gamer and is into vib-ribbon. He has already played the game to his new album. His music [..] demonstrates the music interaction feature of the game, especially the hypnotic twists and turns of higher levels." (a text from the official Vib Ribbon website[59])

Also created by NanaOnSha, *Vib Ribbon* explores a new way of musical interaction. Instead of providing pre-set levels and difficulty degrees, *Vib Ribbon* prompts the player to browse her music collection to generate gameplay. The game analyzes the music and translates it into a visual representation. The player then traverses the generated levels, rhythmically reacting to the obstacles shaped by the chosen song. The player controls a female rabbit, Vibri, who runs through the level by button press combinations corresponding to the shapes of the arising obstacles.

FreQuency

Greg LoPiccolo / Harmonix Music Systems (2001), Playstation 2

Fig. 31: The gameplay of freQuency

"I had a half-baked idea from my Looking Glass days about a cyberspace world with a musical component where you would zoom through and interact with data. We looked at the beat-matching gameplay in games like Parappa and thought: 'How can we turn this into an immersive 3D experience and make the gameplay a little deeper?' " (Harmonix vice president of product development Greg LoPiccolo in an interview with Edge magazine's Randy Smith, 2008)

59 http://www.vib-ribbon.com/vibhtml/english/music/djcam_1.html [Accessed 12/05/08]

> “Ten years ago, when PaRappa was big news, developers from Harmonix visited Japan and showed me some interactive music software that they were working on. I strongly advised them that rather than interactive music software, it had to be a game.“
> (Masaya Matsuura, designer of Parappa the Rapper, 2008)

In *freQuency,* the player travels along a tunnel with different tracks that represent the layers of a song. By switching tracks and following their rhythmic sequences by collecting tokens with rhythmically accurate button presses, the player re-assembles an original song. Too many misses lead to an inevitable game-over and when a song is completed the player is rewarded with a hit-percentage. Free-form scratching sections occasionally break the linear structure of the game as a reward for good playing. As Greg LoPiccolo admits himself, *freQuency* is not the first rhythm-based game. Still, it set the scene for highly popular games like *Rock Band* and *Guitar Hero* to be released several years later.

Rez

Tetsuya Mizuguchi / United Game Artists (2001), Dreamcast, Playstation 2

> “As you move through a tunnel-like space, with pounding house beats in your ears, various potential targets swim and swish by, or take a swipe at you — or rather at your character. You hold the trigger down to lock on to them as targets, and then release it and watch as fiery lines radiate toward the moving targets. One’s missiles seem more balletic than ballistic.”
> (McKenzie, 2007)

Rez was created by Japanese game designer Tetsuya Mizuguchi. It explicitly marks his effort to make music an immersive and interactive experience. Drawing on the visual style of Wassily Kandinsky’s paintings, the player flies through a psychedelic world that pulsates to the beat of the game’s techno and trance soundtrack. Basically, *Rez* is an on-rails shooter. As the player flies through the levels, he or she marks up to eight enemies with a cross-hair, which then explode with the next beat of the background music. All acoustic events blend with the rhythm of the game’s soundtrack, as does the force-feedback feature of the controller, making Rez an immersive, multi-sensory experience.

Guitar Hero

Rob Kay / Harmonix Music Systems (2005), Playstation 2

Fig. 32: The gameplay of Guitar Hero

“Why are you playing Madden when you could go outside and throw a real football?" A lot of similar reasons apply — in Madden you have a whole team (GH: band), you can be someone else (GH: a rocker), everything is authentic like team and player names (GH: real songs). [..] playing Guitar Hero makes you feel more like a rock star than playing tabs does.”

(Tommy Gun in his article “Why we play Guitar Hero instead of ‘the real thing’”, 2006)

In this quote, Tommy Gun refers to the desire of players to act out their fantasies in games. With *Guitar Hero*, Harmonix has successfully revived the vibe of rock’ n’ roll. With its mix of nostalgic rock classics and current hits, *Guitar Hero* has reached players worldwide and, in contrast to Harmonix’ earlier music-based games *freQuency* and *Amplitude*, it has become a huge commercial hit. The core gameplay of *Guitar Hero* is a direct take-off on *freQuency*. By sight-reading symbols, the player rhythmically interacts with the game. One hand translates the game’s notation to button presses on the packaged guitar peripheral while the other hand strums.

Electroplankton

Toshio Iwai / Indies Zero (2005), Nintendo DS

> “I don't think that is a music-based game. That is a kind of in-between, something between a music-based game and media art.”
> (Japanese game designer Masaya Matsuura about Electroplankton in an interview with Klepek, 2007)

Electroplankton is a series of ten small musical toys created by Japanese media artist Toshio Iwai. Some of the games are derived from previous table installations and all of them are musical playgrounds, focusing on playful exploration rather than setting goals for the player. Each mini-game provides a different control scheme for the player to interact with the tiny planktons, the means for musical creation. Touching, sliding, colliding, rotating, and manipulating the planktons produces harmonious sounds and music.

Elite Beat Agents

Keiichi Yano / iNis (2006), Nintendo DS

Fig. 33: The gameplay of Elite Beat Agents

Elite Beat Agents is the western version of the Japanese game *Osu! Tatakae! Ouendan!* (iNis, 2005). To appeal to Western audiences, the three main protagonists were changed from male cheerleaders to slick agents and the J-Pop music was replaced by rock and pop classics. Individual songs are played through by rhythmically following patterns on the DS' touch screen. The patterns are numbered and must be activated sequentially by tapping on one-shots and tracing longer passages (in the above picture, beat 1 has to be followed while 3 through 6 have to be tapped). In *Elite Beat Agents*, the player does not create music but merely follows the beat and is rewarded by short cartoon cut scenes separating individual passages of the song.

Experimental Prototypes

Introduction

In order to substantiate and refine the principles of design presented later in this paper, several practical experiments were conducted during the course of this research. The examples introduced here illustrate several important aspects of music-based game design. The research platforms employ various interfaces, ensuring that music-based interaction is tested using touchscreens, gamepads, video tracking, microphones, motion sensors, and an arcade machine interface. Some terms regarding principles of design are used early in this chapter, yet defined later. This is a consequence of the recursive method of defining and verifying different principles of design.

Gestural interaction on the Nintendo DS

Four experimental prototypes were implemented on the Nintendo DS. Their purpose is to explore the use of gestures when using a touch screen interface. Three of the prototypes were presented at the Mobile Music Workshop 2008 (Kayali et al. 2008)[60].

GuitarDS

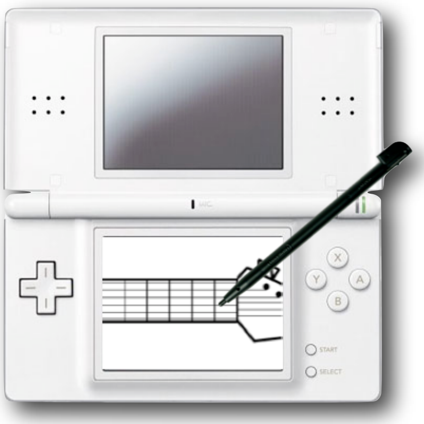


Fig. 34: GuitarDS instrument

The first prototype, *Guitar DS*, is a radically simplified guitar. As a guitar simulator, it has been greatly surpassed by a later DS game, *Jam Sessions* (Plato, 2007). In *GuitarDS*, the player strums the individual frets of the guitar with a stylus, triggering pre-recorded chords. In this reduced guitar interface, strumming and grabbing chords are abstracted to a single gesture. This gesture is closely related to the gesture of strumming a real guitar, especially if the DS is held appropriately.

60 Some of the descriptions given in this section follow the cited paper "Mobile Tangible Interfaces as Gestural Instruments" (Kayali et al., 2008).

PetroriOn

Fig. 35: The PetroriOn instrument

PetroriOn, primarily developed by Petr Kotik (documented in Kayali et al., 2008), is a synthesizer instrument that is played almost solely with the stylus (buttons are used only as modifiers and for settings). The name *PetroriOn* is a reference to Toshio Iwai's *Tenori-On* (see the chapter on music-based games' history). The touch screen is used as playing field, while the upper screen serves as an information display. The notes of a pentatonic scale are mapped on the screen along an invisible grid. The scale serves as a safety net; notes that are mapped across a pentatonic scale can be played arbitrarily yet will always result in a harmonic output. The pitch increases from left to right, the vertical location determines the duty cycle (changing the frequency of an oscillator modifies its tone color), and a modifier button triggers a noise generator. The instrument is played either by tapping the screen for single notes or by sweeping across it to produce continuous sounds. By holding a second modifier, notes are played back repeatedly in rapid succession. The repeated playback and the continuous playback when sweeping the screen are rhythmically aligned to a predefined tempo. By using the face buttons of the Nintendo DS, several drum loops can be added to the background of the player's composition. The background loops combined with the rhythmical and harmonic alignment of notes strongly ensures euphonic compositions. The player is a composer in this game, although a very restricted one.

Thumbtack

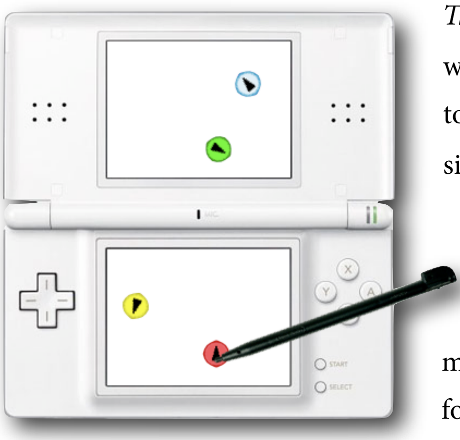
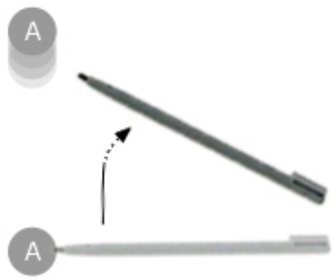
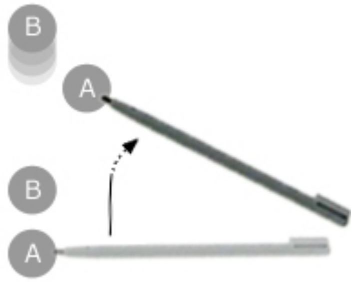


Fig. 36: The Thumbtack prototype

Thumbtack is a playful musical environment. Four moving widgets (the thumbtacks) can be played by using the stylus to hold, drag, or throw them around. The widgets obey simple physical rules. Each one has a unique sonic characteristic. Every collision of the widgets or with the border of the playing field triggers a distinct sound. This entices the player into playfully creating ongoing rhythmical patterns on the screen that serve as an active score for music. A list of gestures from the Thumbtack experiment can be seen below. This list is meant to illustrate the extraction of gestures as a means to better understand gameplay, and the visualization of gestures as a useful tool for designing games. This list is not a gesture reference. For detailed listings of 2d gestures, see the *Interactive Gestures Pattern Library*[61] or Apple's patent application for a multi-touch gesture dictionary (Elias, 2007).

Gesture	Description	Effect
	*Throw* Widget A is picked up and thrown with the stylus. The velocity and direction of movement are transferred to the widget.	The widget becomes an active part of the game. Reflections with other widgets and with the edge of the screen result in acoustic feedback.
	*Push* Widget A is picked up with the stylus. Widget B is pushed away by dragging Widget A. Velocity and direction of movement are transferred to widget B.	The crash between widget A and B results in a unique sound. Additionally, widget B becomes active and can produce further sounds.
	*Hold / Drag and Drop* Widget A is held with the stylus. A held widget can be dragged to another location with a slow movement and then be deposited.	Widget A becomes passive. It then only produces sound when hit by another widget.
	*Preserve / Stick* Widget A is pushed under the edge of the screen. In contrast to the drag and drop gesture, the widget can be stopped like this with a fast movement as well.	Widget A becomes passive. The position under the edge of the screen reduces the probability of being hit and activated by another widget.

61 http://www.interactivegestures.com/ [Accessed 12/05/08]

Gesture	Description	Effect
	*Confine* Widget A is picked up with the stylus. With a precise movement, widget B is pushed in a way that makes it reflect between widget A and the edge of the screen in an infinite loop.	The auditive feedback is an alternating loop of the sound of widget B hitting the screen's edge and the sound for the collision between widgets A and B. The distance between widget A and the edge of the screen controls the tempo of the loop.

Fig. 37: A list of gestures extracted from the Thumbtack prototype.

MicPlay

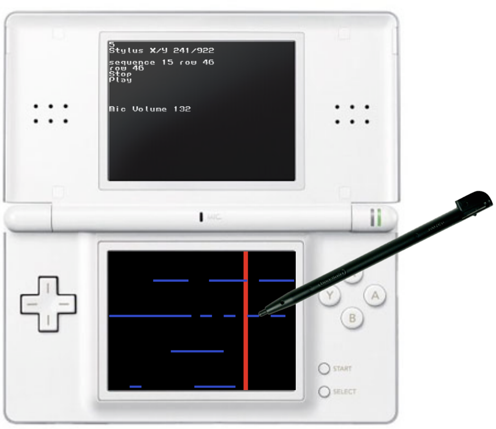


Fig. 38: The MicPlay sequencer

MicPlay is an ad-hoc sequencer for recorded samples. Four samples can be recorded with the Nintendo DS' built-in microphone. A playback head (the red vertical line) loops across the screen from left to right. By drawing on the screen, snippets or longer portions of the samples can be played back, depending on the length of the lines drawn and when the playback head crosses them.

Technical Background

These prototypes were created using the unofficial open-source C libraries *NDSlib*[62], a framework similar to the DS' hardware that provides direct access to the Nintendo DS' digital sound processor, and the higher level *PALib*[63] that builds on NDSlib. Both libraries originated in the homebrew development scene and have lively communities. The *DS-Xtreme*[64] was used to back fluid testing during development. The DS-Xtreme is a memory cartridge for the Nintendo DS

62 http://sourceforge.net/projects/ndslib/ [Accessed 12/05/08]

63 http://www.palib.info/ [Accessed 12/05/08]

64 http://www.ds-x.com/ [Accessed 12/05/08]

game slot that can be simultaneously connected to a computer with an USB cable. *DeSmuME*[65] was found to be the best emulator because, unlike many other emulators, it accurately simulates sound output.

Summary

These four prototypes supplement the understanding of *gestures* in musical interaction. The *PetroriOn* also provides insights into instrumental play. *Thumbtack*, initially meant only to implement a throwing gesture, yielded an unexpectedly long list of gestures and facilitated the definition of a *sound agent*. *GuitarDS* had a high degree of abstraction from a real guitar and thus helped to comprehend this method in terms of game design. *MicPlay* provided a very simple painterly interface (active score) and is the only example (besides Electroplankton's *RecRec* minigame) that processes audio input.

Radiolaris

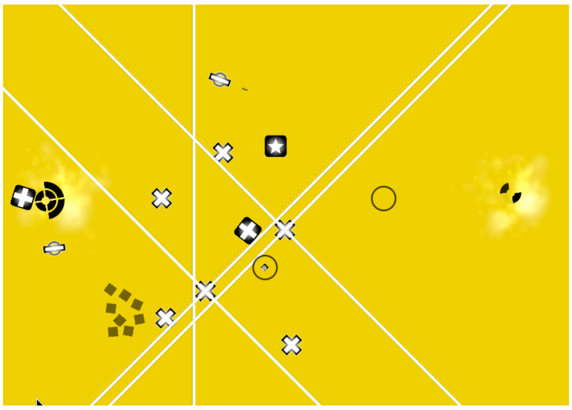


Fig. 39: Radiolaris

Radiolaris is an umbrella term for several experiments[66] that combine non-linear rhythmic interaction with a quantized musical environment. The game falls into the category of a shooter, yet gameplay resembles a real-time strategy game. The player chains rhythmic commands together, building units to protect the base at the left from enemy waves spawning on the right side of the screen. A vertical "radar" line sweeps across the playing field, triggering gameplay actions and audio samples and turning the player into the author of a dynamic audio composition.

65 http://desmume.org/ [Accessed 12/05/08]

66 The *Radiolaris* experiments were part of the "Playful Interfaces" research project conducted in 2007 in collaboration with Martin Pichlmair.

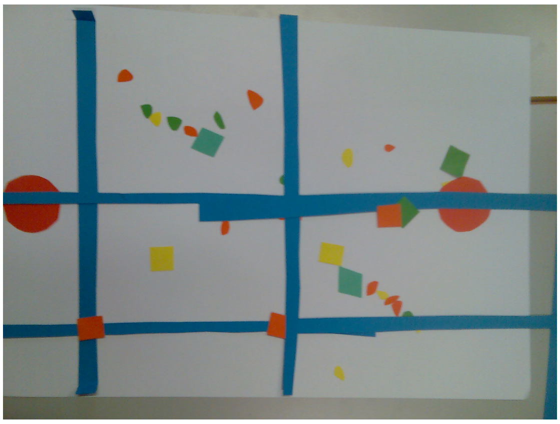


Fig. 40: Paper prototype for the previously depicted stage of Radiolaris.

During some stages of the development of *Radiolaris,* paper prototypes were used as a tool for testing different rules. For this purpose, the game was simplified into a turn-based model. Some of the rules devised from this process were later integrated into the software prototype. According to Fullerton, Swain, and Hoffmann, the process of mapping continuous gameplay in a turn-based physical prototype is a helpful tool during early design stages:

> "People not used to physical prototyping may argue that this method doesn't accurately represent the player experience on a computer. They may think a pen and paper prototype might work for a turn-based game, but not for an action based shooter because gameplay is integrally tied to the 3D environment and the ability of the payers to act in real-time. We are not arguing that physical prototyping replaces those things. What we are saying is the overall gaming system can benefit tremendously in its early stages by building a physical prototype."
> (Fullerton et. al., 2004)

Radiolaris provided much insight into the design and development process of music-based games. Since gameplay combines aspects of shooters, rhythm action games, and real-time strategy games, *Radiolaris* required various design methods and experiments. It functioned as a constantly evolving software prototype and different designs were regularly tried out using paper and other physical prototypes. From a programmer's perspective, *Radiolaris* showed the usefullness of dispensing with code in the early design stages in order to escape the confinements of technical ramifications. More importantly, it also led to the development of a sophisticated audio and rhythm framework. The engine was not only capable of using digital audio filters and maintaining the rhythm of constantly changing samples, it was also able to execute code and trigger animations to the beat of the game.

Technical Background

Radiolaris is built with the platform independent game-engine Torque Game Builder[67] in combination with the FMODex[68] sound engine. Both the FMODex sound engine and gamepad support were integrated into the Torque Engine by Marc Marschner. This integration is covered in detail in his master's thesis, "Foundations for Music-Based Games" (Marschner, 2008).

bagatelle concrète

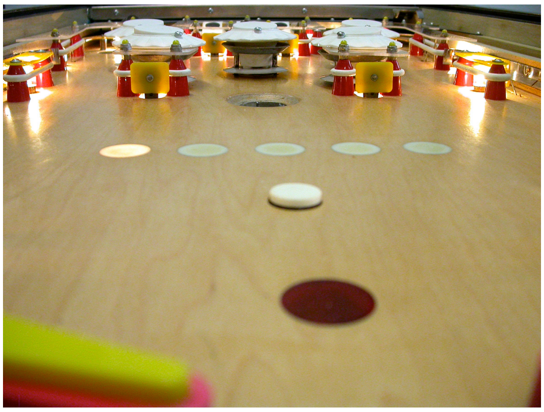


Fig. 41: bagatelle concréte

bagatelle concrète[69] is an electro-mechanical pinball machine from the early seventies that was turned into a "musique concrète" game. Instead of playing to get a high score, the player plays to make music. bagatelle concrète is an interactive media installation recently displayed at the *Homo Ludens Ludens* exhibition[70] at the *Laboral Centro del Arte y Creación Industrial* in Gijon, Spain. The name of the modified pinball machine is a reference to *musique concrète* (founded by Pierre Schaeffer, mentioned above). This musical style is based upon three principles: sampling, sample manipulation, and playfulness. The first part of the name, *bagatelle*, is connected to the history of pinball machines, a *bagatelle* being an early ancestor of the modern pinball machine created for King Louis XVI and Queen Marie Antoinette of France.

67 http://www.garagegames.com/products/torque/tgb/ [Accessed 12/05/08]

68 http://www.fmod.org/index.php/products/fmodex [Accessed 12/05/08]

69 http://bagatelleconcrete.attacksyour.net/ [Accessed 12/05/08]

70 http://www.laboralcentrodearte.org/exhibitions/show/64 [Accessed 12/05/08]

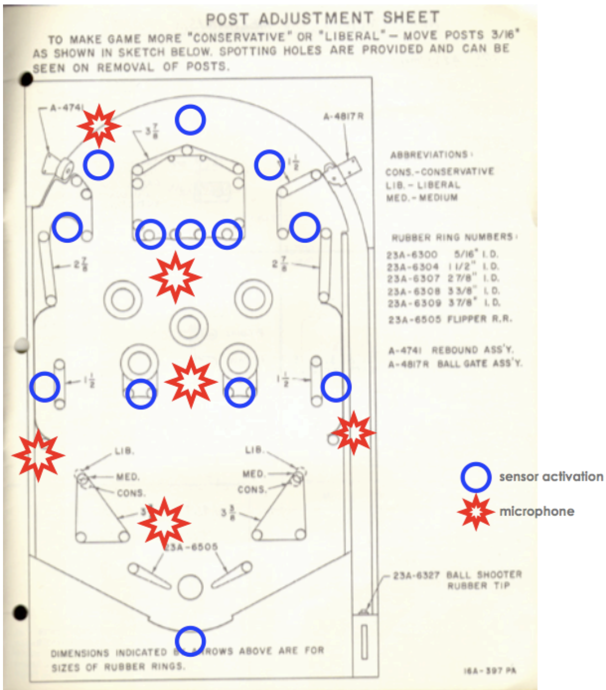


Fig. 42: Sensor and microphone placement

Inside the pinball machine, microphones record samples and sensors analyze the gameplay in real time. These samples are then played back, looped, and manipulated according to the style of play and rules of *musique concrète*. Playing *bagatelle concrète* feels like playing an instrument - a pinball machine instrument that rewards the player with music instead of points. For the scope of this thesis, *bagatelle concrète* explores musical interaction in media arts and serves as an experiment in instrumental play.

Technical Background

bagatelle concrète uses an Apple Mac mini-computer to collect sensor and microphone data using an *Arduino Interface*[71] board and an external sound card that are built into the pinball machine. The musical in- and output is handled using the open-source real-time audio software *Pure Data*[72] (Puckette, 1996). To restore and modify the pinball machine, a website called *Marvins Marvelous Mechanical Museum*[73] was heavily consulted. It is an extensive archive on the workings and restoration of pinball machines.

71 http://www.arduino.cc/ [Accessed 12/05/08]

72 http://crca.ucsd.edu/~msp/software.html [Accessed 12/05/08]

73 http://www.marvin3m.com/ [Accessed 12/05/08]

POSE

Fig. 43: POSE

POSE[74] is an interactive audiovisual playground created together with Wilfried Reinthaler and exhibited in 2005 at the *Echo* exhibition at the Ragnahof[75] in Vienna. It invites participants to playfully interact with different compositions of audio and video. Pose has multiple faces, each with a distinct appearance expressed by visual and audio content and also specific means of feasible interaction. POSE has a voice, a sound loop that is audible most of the time and functions as connecting element between the various faces. Each face provides basic action/reaction based interaction and the changing states follow more complex models. POSE is an example of combining performance aspects and gestural interaction within a synaesthetic environment. Interaction is provided by tracking the movement of observers within the scope of a camera mounted above the installation.

Technical Background

POSE consists of two pieces of software connected with Midi. Apple's *Quartz Composer*[76], a patcher language for image processing, is used for video output. *MAX/MSP*[77], a commercial audio framework very similar to Pure Data, is used for audio processing and video tracking.

74 http://www.point-of-infinity.net/pose [Accessed 12/05/08]

75 http://www.ragnarhof.at/echoexhibition.htm [Accessed 12/05/08]

76 http://developer.apple.com/graphicsimaging/quartz/quartzcomposer.html [Accessed 12/05/08]

77 http://www.cycling74.com/products/max5 [Accessed 12/05/08]

beat'em up

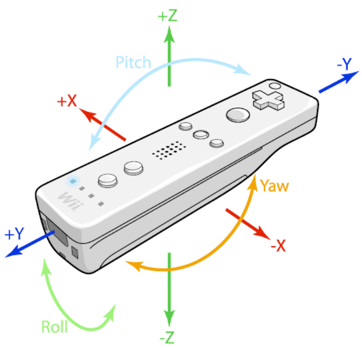


Fig. 44: an illustration of the Wii remote's degrees of freedom

beat'em up is an experiment using the accelerometers of the Nintendo Wii remote as an interface. By tilting and shaking the remote in rhythm to an underlying musical structure, the player triggers punches and kicks of an on-screen avatar. Physical performance plays a role due to the haptic nature of the interface.

Technical Background

The experiments were conducted using the prototyping language *Processing*[78] for gameplay and graphics and *Pure Data* for audio output. The sensor data of the Wii remote controller was accessed through a C++ framework, *DarwiinRemote*[79], bridged to Processing via *OSC* (Open Sound Control).

Technical summary

As explained in the methodology chapter, interactivity must be tested when designing a game. In this chapter, several experimental prototypes and two art pieces have been described. The two art pieces are relevant for this research as most of their inner workings were devised in experimental settings. An overview of the technical development background can be seen below, intended for choosing an appropriate environment for experiments with music-based interaction. References to the respective software packages are given as footnotes in the technical background for each example. The following table summarizes the development environments:

78 http://processing.org/ [Accessed 12/05/08]

79 http://sourceforge.net/projects/darwiin-remote/ [Accessed 12/05/08]

Prototype	Platform	Software	Availability	Interface	Audio
gestural interaction	Nintendo DS	NDSlib, PAlib	open source	touchscreen, microphone	samples, generative audio using 8-bit DSP
Radiolaris	Mac / PC	Torque Game Builder, FMODex sound engine	Torque: $250 for open source version for independent development, FMODex: free for non-commercial use	gamepad	quantized and processed samples, adaptive music
bagatelle concrète	Mac, electro-mechanical pinball machine	Pure Data	open source	flipper bats, microphones	recorded and processed samples
POSE	Mac, interactive media installation	Quartz Composer, Max/Msp	Quartz: free, Max/Msp: $495	body and hands, video tracking	samples and adaptive music
beat'em up	Mac	Processing, Pure Data, Darwiin Remote	open source	Wii Remote (accelerometers)	quantized samples and adaptive music

Fig. 45: A summary of the technical backgrounds of the experimental prototypes

Principles of Design

This chapter[80] provides an in-depth look at various concepts used in the design of music-based games. Based upon the qualitative examples and experimental prototypes, a terminology for music-based games design will be presented.

In his extensive thesis on the theories and methods of game studies and design, Aki Järvinen (2008) portrays gameplay as a series of dynamics emerging from the feedback between smaller game mechanics employed by the player and the game. Concurring with Robin Hunicke et al. (2004), he writes, "This is the 'run-time behavior' of game dynamics, i.e. sequences of game mechanics as realized in the feedback loop between the players and the game" (Järvinen, 2008).

Game mechanics are derived from a *core mechanic* that shapes the theme of the game. It is a superset of various game mechanics that employ a distinct interactive principle. An overview of "The Principles of Interactivity in Music Video Games" can be found in Pichlmair & Kayali (2007). This initial description of factors for music-based game design will from now on be designated as *principles of design*. This term denotes the most important factors of music-based game design, encompassing interactivity, game dynamics, and core mechanics.

Music-based games pose a complex challenge to designers, who must satisfy the requirements of games and of interactive music media. When regarding music-based games from this cross-medial point of view, it becomes possible to distinguish the principles that shape their design. The principles presented in this chapter are not meant to be a sharp categorization; the borderlines between some of the described principles are fuzzy and many principles are cross-referential to each other.

This chapter begins with two tables presenting the principles of design derived from the qualitative analysis and experimental design. The principles are then described in detail and examined in reference to their role in the analyzed games. To conclude this chapter, dependencies, references, and exclusions amongst the described principles are presented.

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80 This chapter builds on the foundations laid out in "Levels of Sound: On the Principles of Interactivity in Music Video Games" (Pichlmair & Kayali, 2007). The principles detailed in that paper are expanded, deepened, and applied to practical experiments. The core of this and the next chapter were published in "Playing Music, Playing Games - Simulation vs. Gameplay in Music-based Games" (Kayali & Pichlmair, 2008).

Principles of Design in the Qualitative Examples

	Rez	Otocky	Sim Tunes	Electroplankton	Vib Ribbon	Parappa the Rapper	Elite Beat Agents	Guitar Hero	FreQuency
Synaesthe-sia	X	.	.	X	X	.	.	.	.
Kinaesthetic Play	X	.	.	.	.	.	.	X	.
Gestures	.	.	.	X	.	.	X	X	.
Instrumental Play	.	X	X	X	.	.	.	.	X
Rhythm Ac-tion	.	.	.	.	X	X	X	X	X
Quantization	X	X	X	X	.	.	.	.	.
Audio Input	.	.	.	X	X	.	.	.	.
Play as per-formance	X	.	.	X	X	.	.	X	.
Sound Agents	X	X	X	X	.	.	.	.	.
Active Score	.	X	X	X	.	.	.	.	.

Fig. 46: The principles of design derived from qualitative analysis

Principles of Design in the Practical Experiments

	GuitarDS	PetroriOn	Thumbtack	MicPlay	Radiolaris	bagatelle concrète	POSE	beat 'em up
Synaesthesia	.	.	.	.	.	.	X	.
Kinaesthetic Play	X	.	.	.	.	X	X	X
Gestures	X	X	X	.	.	.	X	X
Instrumental Play	X	X	X	X	.	X	.	.
Rhythm Action	.	.	.	.	X	.	.	X
Quantization	.	X	X	X	X	X	.	.
Audio Input	.	.	.	X	.	X	.	.
Play as performance	X	X	.	X	.	X	X	.
Sound Agents	.	.	X	.	X	.	.	.
Active Score	.	.	X	X	X	X	.	.

Fig. 47: The principles of design derived from practical experiments

Instrumental Play

The *Encyclopaedia Britannica* defines musical instruments as "any device for producing a musical sound"[81]. This definition can be refined by instrument classifications such as the Sachs-Hornbostel system (Sachs & Hornbostel, 1914), which makes distinctions based on the means of sound generation. Instruments are divided into idiophones, membranophones, chordophones, aerophones, and the later-added *electrophones*.
Following this system of classification, music-based games can be defined as electrophones. Comparing electronic instruments with traditional ones, Kurtz writes:

> "A violin is less restrictive than the piano because it has no fixed keyboard; the violin can play many more notes than a piano. Yet, both piano and violin are more restrictive than a synthesizer, because they each have a distinctive sound, while the synthesizer can produce the sounds of most traditional instruments and many non-traditional ones, like sirens or wind effects. The synthesizer, more than an instrument, is a "sound processor." The synthesizer player has control over an enormous palette of sound sources, in addition to the infinite range of combinations."
> (Kurtz 1998)

This quote illustrates that a musical instrument's potential is shaped by two aspects. The interface and the instrument's acoustic range define the area of possible musical expression. Music-based games have the acoustic potential of a synthesizer. Their interfaces are diverse, ranging from gamepads to multi-touch screens and instrument peripherals. The following graph shows the relation between a generative music system and a participant (or player):

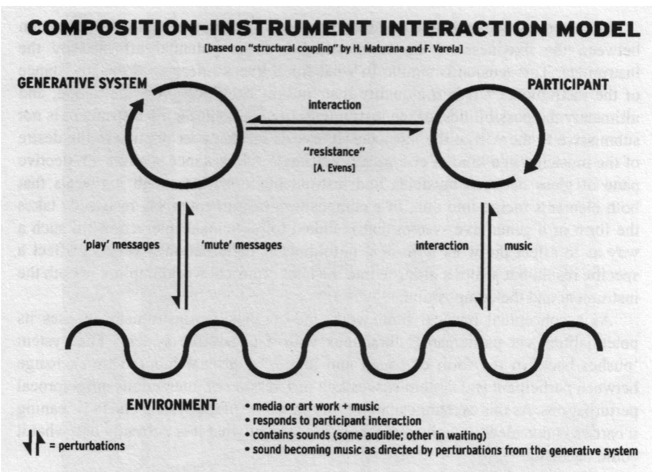


Fig. 48: The Composition-Instrument Interaction Model shown in Herber (2008)

81 http://www.britannica.com/EBchecked/topic/399171/musical-instrument [Accessed 12/05/08]

A primary challenge of designing music-based games is mapping the game device's acoustic possibilities to the interface. This mapping depends upon the game setting and its game world. As mentioned in the music and games history chapter, the ties between instruments, media art, and music-based games are strong. Many characteristics of instruments hold true for music-based games. Especially when non-games and toys are concerned, depth of expression is more necessary to keep the gameplay interesting than for goal-based games. Sergi Jordà writes about music and playing,

> "New interactive music instruments do not only allow to play music with them; they also allow to *play* with them."
> (Jorda, 2005)

Thus, to provide for *sandbox play*, games must establish a setting that allows players to experiment playfully and to set their own goals. For music-based toys, this means that games have to allow for the individual creation of musical output. This requirement poses the interesting challenge of balancing the ease of use and depth of expression. A challenge that is described well in Golan Levin's (2000) thesis "Painterly Interfaces for Audiovisual Performance". He proposed a list of desiderata for color-music performance systems:

"

- The system makes possible the creation and performance of dynamic imagery and sound, simultaneously, in realtime.
- The system's results are inexhaustible and extremely variable, yet deeply plastic.
- The system's sonic and visual dimensions are commensurately malleable.
- The system eschews the incorporation, to the greatest extent possible, of the arbitrary conventions and idioms of established visual languages, and instead permits the performer to create or superimpose her own.
- The system's basic principles of operation are easy to deduce, while, at the same time, sophisticated expressions are possible and mastery is elusive."

(Levin, 2000).

The above list details the requirements for an ideal performance system and thus can only be applied cautiously to the design of music-based games. Still, it serves as a good starting point to discuss the instrumental traits of music-based games.

The first requirement can be translated to games as *immediacy* of the interface. This immediacy is not only necessary for instruments but for all sorts of games. Without a reactive interface, a game's principles cannot be understood and frustration arises. If the simple guitar toy *GuitarDS* would play struck chords with a delay, it would be impossible to keep a rhythm and thus be rendered useless. A reactive interface is also one of the requirements for gestural musical interfaces defined by Wessel and Wright:

> "Is the low entry fee with no ceiling on virtuosity an impossible dream? We think not and argue that a high degree of control intimacy can be attained with compelling control metaphors, reactive low latency variance systems, and proper treatment of gestures that are continuous functions of time. With the potential for control intimacy assured by the instrument, musicians will be much more inclined to the continued development of performance skill and personal style."
> (Wessel & Wright, 2001)

Wessel and Wright additionally call for understandable control metaphors that are translated to gestures (see the later section on this principle) to achieve *control intimacy*. The term control intimacy also encompasses part of the fifth requirement made by Levin, which calls for easily comprehensible principles of operation. Looking at the game *Sim Tunes,* it is immediately apparent how the system works - if an insect touches a square, a sound sample is played. The different insects each represent a distinct instrument, while the color determines which note is played. As players color the squares on the path of a particular insect, they write the musical score for that instrument. But Sim Tunes also allows for more complicated expressions, a feature that Levin describes as extremely variable, but plastic, results. In Sim Tunes, a whole bunch of insects can be let loose on the score, which can also have modifiers for the paths of the insects. The combinations of acoustic output in *Sim Tunes* are endless yet easily reproducible and understandable due to the simplicity and clarity of its notation. This is a trait common to instruments where notation and scores ensure the reproducibility of a musical pattern. While the game *Otocky* is a scrolling shooter at its core, it features an unlockable music editor. In this editor, a custom musical score can be created and replayed according to the player's design. Thereby, *Otocky* introduces a musical notation built upon its gameplay elements. In *freQuency,* the player also has access to an editor that lets players create remixes in the game's notation.

Levin's third requirement is for proportional depth in the visual and aural dimensions. This requirement is especially important for painterly interfaces. It makes particular sense in games where acoustic output is also visual. *Electroplankton,* which uses the second screen of the Nintendo DS for close-up views of the action, serves as an example.

The fourth point made by Levin is problematic when applied to music-based games. Most games do indeed establish new visual languages for music. These are often only new to music but are well-established principles of game design (e.g. the scrolling shooter *Otocky* or the sandbox gameplay in *Sim Tunes*).

The last and most important requirement is for accessibility and depth of expression while maintaining a steady learning curve. This requirement expresses a trait typical to musical instruments and illustrates the initially-stated challenge of balancing ease of control and depth of expression. In two papers on interactive music and digital instruments, Sergi Jordà (2003; 2004) proposes a formula for assessing the efficiency of musical instruments depending on the complexity of input and output and the amount of freedom granted to performers:

$$MusicInstrEffic_{correct} = \frac{MusicOutputComplexity \times PerformerFreedom}{ControlInputComplexity}$$

Fig. 49: Jordà's formula for calculating the efficiency of musical instruments

In fact, many music-based games with an instrumental character focus primarily on accessibility, thus reducing control input complexity. The principles of operation for *Electroplankton*'s minigames can be understood at first glance; and mechanisms like quantization and the use of pentatonic scales ensure harmonic and rhythmical output regardless of input. The *PetroriOn* also uses a pentatonic scale to maintain harmonic output, while *GuitarDS* and *Thumbtack* use samples selected to fit together in arbitrary sequences. *MicPlay* allows the player to record samples and aligns them rhythmically.

In contrast, *bagatelle concrète's* musical output seems at first to elude the control of the player. The game, a pinball machine whose principles of operation are generally known, is very accessible. The sound produced by *bagatelle concrète* inititally appears non-deterministic due to the volatility of the ball. *bagatelle concréte* requires the player to decode its principles of music creation the same way that players normally decode the scoring mechanism of a pinball machine. Mastering *bagatelle concrète* is possible, yet elusive and due to its volatile nature, reproduction is sometimes impossible.

Overall instrumental play is a trait of music-based games that can be used to seperate the analyzed games into two groups: those that allow for freedom of expression in music creation and those that do not. The latter are all rhythm-based games whose game mechanics enforce a euphonic musical output, meaning that music-based games can be divided into instrument games and rhythm-based games. For instrument games, many other principles (to be described later) influence their design and help provide playful interactivity and depth of expression. This is also the primary challenge in designing instrumental play - balancing between accessibility and malleable results. In music-based games, the balance is generally weighted towards accessibility.

Rhythm Action

> "code is beats is rhythm is algorithm is digital."
> (Paul Miller a.k.a. DJ Spooky, 2004)

Together with harmony and tones, rhythm is a primordial component of music. Nowadays, music is digitized, remixed, reproduced, and aligned to the grids of sequencer software, and rhythm has become an even stronger defining quality of music. It sets the speed and temporal succession of notes. It is a distinct, repetitive, and memorable quality of a song. When a song is reduced to a basic rhythmical representation, it retains many of its defining qualities and even remains recognizable. The interpretation or reproduction of such reduced rhythmical patterns is at the core of rhythm-based games. By acting in rhythm, the player advances the song being played and progresses in the game. For this reason, many rhythm-based games have licensed soundtracks from popular musicians. Replaying known songs makes gameplay easier and enhances the player's identification with the game. All the games tagged with *rhythm action* in this study are goal-oriented. The core mechanics of rhythm-based games is best described as *hit or miss* gameplay; matching rhythmical patterns drives up the score and ensures progression in the game. Missing many patterns leads to the inevitable *game over*. In that sense, rhythm-based games are very traditional games that give the player challenges to surmount, rewarding with points and progression in the game. This strong goal-orientation distinguishes rhythm-based games from instrument games, which are usually less bound by rules and generally do not have game over conditions. Improvisation in rhythm-based games is rare, though when playing well, *freQuency* offers a short passage in each song that is reserved for free-form scratching.

When observing rhythm-based games, several differences become apparent. The first distinction concerns the soundtrack. Most rhythm-based games feature a linear progression within a single song, but gameplay can differ. One type of game gives the players visual patterns to match, and another performs rhythmical patterns that must be mimicked exactly by the player. Some games have a rhythm-based gameplay but the musical progression is non-linear.

Linear Rhythm Action

> "Music is closely related to human perceptions of time and its segmentation. [...] Musical movement is a metaphor and simulation of movement through space, was well as an enactment, actual and metaphorical, of time and its elasticity. Music takes time and makes time, yet only takes up space [...] by vibrating the air. [...] Despite this insubstantiality, music has a remarkable capacity to convey the experience of movement."
> (Toop, 2002)

This first category of rhythm-based games is the largest and includes *freQuency*, *Guitar Hero, Vib Ribbon,* and *Rock Band*. Linear rhythm-based games focus on replaying commercial music. Music in linear rhythm action conveys movement and is also literally manifest in the game space. Songs are mapped to the game space as progressing rhythmical patterns that must be matched by correctly mashing buttons (or touching, strumming, shaking, or waggling an equivalent device) in sequence. Complexity depends on the chosen degree of difficulty. A level is completed by matching the rhythmical patterns with a sufficient degree of accuracy. Since songs are reduced to sets of rhythmical patterns, it is common to use notations that convey progression in the song to a spatial representation:

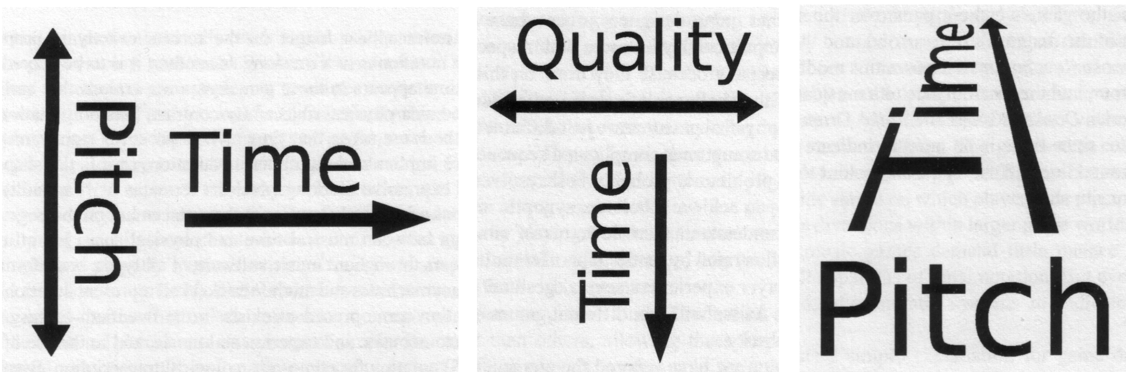


Fig. 50: The different modes of rhythm-based music games: Reading mode (left), Falling mode (middle) and Driving mode (right) as shown in Shultz (2008).

Shultz (2008) differentiates three different modes of spatial representation in rhythm-based music games. The *reading mode* follows the convention of perceiving content from left to right and is a view applied in many games like shooters and jump 'n' runs. Examples of rhythm-based music games that follow the reading mode are the *Vib Ribbon* series, *Donkey Conga*, and the karaoke series *SingStar* and *Karaoke Revolution*. The *falling mode* is borrowed from puzzle games and vertical shooters. It is used by all Bemani brand games like *Beatmania*, *Dance Dance Revolution* and *Guitar Freaks*. The *driving mode*, named after driving games, maps time to the depth axis. This perspective is employed by most Harmonix games like *freQuency, Amplitude, Phase*, *Guitar Hero* and *Rock Band*.

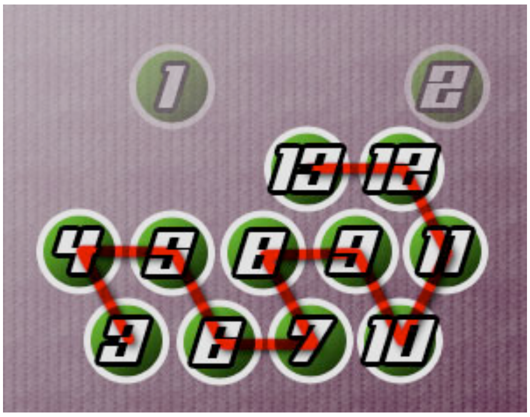


Fig. 51: An illustration of the display mode for a pattern of Jumping Jack Flash in Elite Beat Agents in a walkthrough by (Gun, 2008).

One game that eludes this categorization is *Elite Beat Agents*, which uses the reading mode as an additional challenge to the player. The player has to follow a path through patterns spread across a touchscreen. The higher the difficulty, the more complex the paths become, as is shown in the figure to the left.

The four figures presented in this section show how the progression of time in music-based games is mapped to the game space. Aside from *Elite Beat Agents*, the gameplay itself is not affected by these different forms of notation. One thing common to all linear rhythm-based games is that they map a song to a spatio-temporal representation. The player then has to translate the resulting visual patterns to rhythmical actions. The basic game mechanics in linear rhythm-based games can be described as hit and miss gameplay following an underlying song.

Mimicry

Atari's *Touch Me* and *Simon* by Ralph Baer and Howard Morrison were presented as the earliest ancestors of music-based games. The core of their gameplay is the mimicking of light and sound sequences. The exact reproduction of a given pattern advances the player to the next, longer and more complex, pattern. Patterns need not be reproduced rhythmically, although rhythmic actions facilitate patterns memorization. The first rhythm-based video game, *Parappa the Rapper,* also imposes the rhythmical reproduction of patterns. The game plays short sequences of rhythmical button presses to the player, who has to reproduce them as exactly as possible to move on to the next pattern. The mimicry can be compared to a rhythmic version of *Quick Time Events*. This mechanic is also used in other rhythm-based games, like *Space Channel 5* or many of the mini-games in *Rhythm Tengoku* (Nintendo R&D1, 2006) and the Zelda series.

Non-Linear Rhythm Action

Radiolaris was designed with the intention of trying a non-linear approach to a rhythm-action game. Radiolaris' core control mechanic is the use of rhythmically executed combos at arbitrary times. It is used to build offensive and defensive structures in a real-time strategy setting. The combos must be executed in time to the background music. This approach makes strictly non-linear rhythmic interaction possible. The player decides which pattern to use at which moment in time. Thereby, the spatial and temporal linearity of other rhythm-based games is broken.

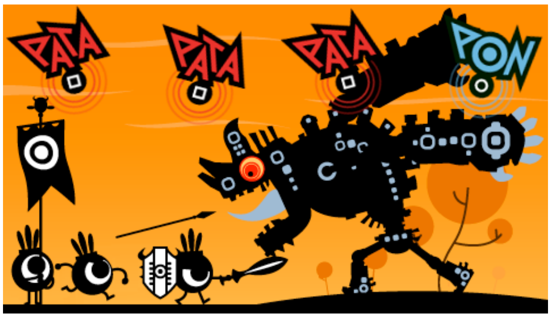
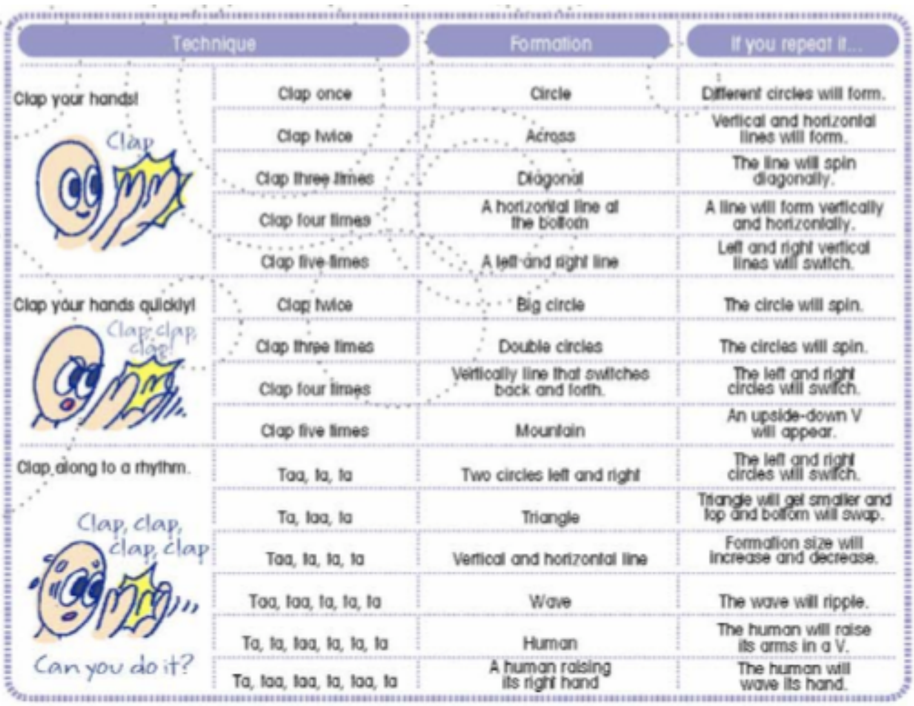


Fig. 52: A screenshot of the PSP game Patapon.

At the same time *Radiolaris* was designed, another non-linear rhythm-based game was released. *Patapon* (Pyramid, 2007) uses rhythmical combos to control a small army that progresses through a hostile 2D environment. Actions like movement, retreat, and offensive patterns are triggered by rhythmical sequences of four button presses (hence the title of the game, as illustrated in the picture by the sequence *Pata-Pata-Pata-Pon*). As the player progresses in the game, new commands (rhythmical combinations of button presses) become available.

Interaction in *Patapon* is similar to *Radiolaris* in that the control is detached to enable non-linear rhythm action. Both games employ a real-time strategy setting. The player acts from the outside, controlling onscreen action by indirectly influencing it with her or his commands. The games both have background music. Combos must be triggered in rhythm with the background music, thus forcing the player to ensure a euphonic acoustic result.

In the *Electroplankton* mini-game *Nanocarp,* the player can control plankton formations by clapping his or her hands. Handclaps are detected with the DS' built-in microphone. The following figure shows the possible commands:



Technique		Formation	If you repeat it...
Clap your hands!	Clap once	Circle	Different circles will form.
	Clap twice	Across	Vertical and horizontal lines will form.
	Clap three times	Diagonal	The line will spin diagonally.
	Clap four times	A horizontal line at the bottom	A line will form vertically and horizontally.
	Clap five times	A left and right line	Left and right vertical lines will switch.
Clap your hands quickly!	Clap twice	Big circle	The circle will spin.
	Clap three times	Double circles	The circles will spin.
	Clap four times	Vertically line that switches back and forth.	The left and right circles will switch.
	Clap five times	Mountain	An upside-down V will appear.
Clap along to a rhythm.	Taa, ta, ta	Two circles left and right	The left and right circles will switch.
	Ta, taa, ta	Triangle	Triangle will get smaller and top and bottom will swap.
	Taa, ta, ta, ta	Vertical and horizontal line	Formation size will increase and decrease.
	Taa, taa, ta, ta, ta	Wave	The wave will ripple.
	Ta, ta, taa, ta, ta, ta	Human	The human will raise its arms in a V.
	Ta, taa, taa, ta, taa, ta	A human raising its right hand	The human will wave its hand.

Fig. 53: Rhythmical commands in Nanocarp as shown in the Electroplankton manual.

Summary

Three distinct types of rhythm action are used in rhythm-based games. All three of them rely on the mapping of a song to a symbolic rhythmic interpretation. In linear rhythm-based games, the rhythmic structure of the song is mapped to a spatial representation in the game world that is traversed by the player. In games employing mimicry, rhythmical sequences have to be memorized and reproduced by the player. In non-linear rhythm-based games, the player can use given rhythmical combinations at arbitrary times to trigger actions in the game world.

Quantisation

In a technical sense, all digital sound signals are quantized. A continuous sound signal is transformed to a discrete signal by taking samples at a given sample rate (e.g. 44.1 kHz for audio CDs) with a specified quantization that measures the data used for storing a sample (16-bit for audio CDs). Seen in a broad sense, both are acts of quantization: one is a temporal quantization and the other a quantization of data at a particular point in time. In music-based games, temporal quantization is the primary safety net used by designers to maintain rhythm. In music-based games, quantization means that sounds are mapped to the next beat, thereby matching the music's underlying rhythm. This alignment of music to a grid relates to the way notes are displayed on sheets of music and how music is displayed in digital sequencing software. Stephen Janis talks about the role of quantization in popular music in his text on "Quantized Culture":

> “This means, that despite the fact that digital technology has liberated us from the synchronized rigors of the mechanical clock, we have in a sense ceded our timing to the new forms of precision embedded in the variant idioms of popular musical culture.”
> (Janis, 2005)

Reflecting popular musical culture, music-based games remain within this grid-like pattern. Sounds incurred by the player interacting with the game are mapped to the next beat of the game’s soundtrack. This withdraws creative freedom of expression from the player in exchange for a pleasing, homogeneous, and rhythmic experience. The idea is to let the player create a continuous harmonic stream of music that annuls irregular tones created by unpredictable player behavior.

Quantization is employed in many of the analyzed examples. In the shooting games *Rez* and *Otocky,* all gameplay events (such as shots and explosions) are aligned to the beat of the soundtrack. The result is a more immersive experience, since all elements of the game act in flow. The musical toys in *Electroplankton* are partly quantized. The effect is subtler, since sounds are aligned to grids with a finer granularity, but erratic input is still converted into a harmonic stream of music. In *Sim Tunes,* quantization is handled implicitly by the speed of the insects and by the grid colored by the player. *Sim Tunes* is the most direct representation of a sequencer in a game-world - a grid traversed by a playback head (the insects). In *Thumbtack,* quantization is handled by setting a fixed speed for all widgets. *MicPlay* also quantizes implicitly by using a playback cue to trigger stored audio samples. The only reason *MicPlay* can be used to create music is that arbitrary sounds are rhythmically aligned and repeated, thus creating a musical structure. At a low level, *bagatelle concrète* quantizes samples as well, not to a rhythm preset but to rhythms created during play.

The *PetroriOn* is designed to be a digital instrument. To facilitate play, sounds triggered by swiping the touchscreen are quantized to a set tempo. In *Radiolaris,* an attempt was made to combine a quantized environment with rhythm action. The player must act in rhythm to the beat in order to trigger actions, and the whole game-world is scripted to conform to that beat. All enemy actions and the player-built structures act rhythmically, thus making rhythm into an accessible element of strategy.

Quantization is a tool used to make music and music-based games accessible. It detracts from freedom of expression but greatly increases game flow (see below) by providing a safe and harmonic environment in which player actions are rhythmically embedded.

Game Flow

The following quote by Harmonix co-founder Alex Rigopulos describes immersion as a result of the player incorporating acoustic and visual perception into gameplay:

> "When a gamer starts to play Frequency, he plays it using the gaming skills he already has: the ability to react to symbolic visual information with a precisely timed manual response.... What we noticed again and again in playtesting was that there is a certain point at which novice players stop playing entirely with their eyes and start playing with their ears (or, rather, their "internal ears"): they start to feel the musical beat; then, as a stream of gems approaches, they look at the oncoming stream, "imagine" in their ears what that phrase will feel like or sound like rhythmically, and begin to "play the notes" (rather than "shoot the gems"). As soon as players cross this threshold, they begin excelling much more rapidly in the game."
> (Alex Rigopulos of Harmonix in an e-mail correspondence with the Henry Jenkins, March 1 2002. printed in Jenkins, 2005)

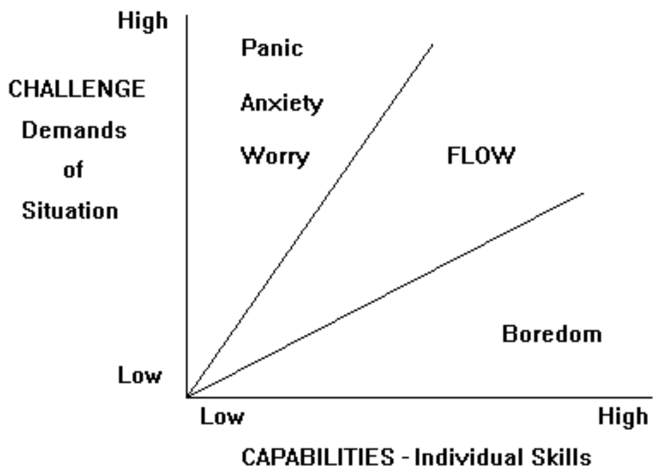


Fig. 54: The flow region as shown in (Csíkszentmihályi, 1975).

The psychological state of flow was first described by Hungarian professor of psychology Mihály Csíkszentmihályi in his book *Flow: the psychology of optimal experience* (Csíkszentmihályi, 1990). It denotes a mental state in which a person is fully engaged in what he or she is doing, thus reaching a state of total immersion called *flow.* Douglas and Hargadon (2001) have adapted this concept to apply to games; and Jenova Chen (2007) has expanded it to include different flow regions for different player skill levels.

Synaesthesia

> "synaesthesia: the unity of the senses and, by extension, the arts. According to the principle of synaesthesia, sensory perception of any kind may manifest itself as sensory experience of another - one example being the phenomenon of seeing color when one hears certain sounds."
> Jeremy Strick in "Visual Music", (Brougher et al., 2005)

The term *synaesthesia* is rooted in the ancient Greek words *syn* (together) and *aisthēsis* (perceive). The phenomenon is an involuntary neurological sensation that combines one sense with another, thereby transcending traditional boundaries of sensory perception. Examples include associating colors with sounds or musical patterns and vice versa, or even the association of a taste with a specific word or letter. Although the term *synaesthesia* is often understood as a creative practice or way of expression, it is originally a medical term that signifies a neurological condition. It is believed that synaesthesia could be caused by a phenomenon called *cross-activation (*Ramachandran & Hubbard, 2001), where adjacent areas for sensory perception are activated in the brain. A similar explanation sees reduced inhibition along neural pathways as a possible cause (Grossenbacher & Lovelace, 2001). This reduction of inhibitors would also explain the occurrence of synaesthesia in neural conditions induced by hallucinogenic substances like LSD or psilocybin.

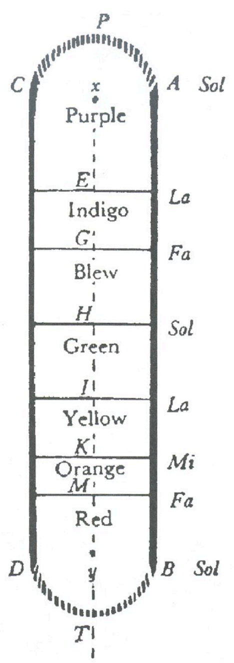


Fig. 55: Isaac Newton's mapping of colours and tones.

Aside from its psychological definition, synaesthesia is also known for its meaning to the arts. In the course of history, many attempts have been made to align notes with corresponding colors, the earliest dating back to Aristotle. Italian painter Guiseppe Arcimboldo (1527-1593) conducted the first experiments on the subject, linking tones and colors according to their respective pitch and hue (van Campen, 2008). Sir Isaac Newton approached colors and tones according to their frequency (see the figure to the left) (Newton, 1675 in van Campen, 2008). Many systems describing *visual music* have been tried out over the years and have also formed the basis for several visual instruments, called *color organs.* Early examples include the *Clavecin Oculaire* (Ocular Harpsichord), created by Louis-Bertrand Castel in 1734, and the *Pyrophone* built by Frederic Kastner in 1869. The Clavecin Oculaire coupled a harpsichord with a display made of colored transparent paper and illuminated by candles. The Pyrophone ignites gas in crystal tubes. A detailed account on color-music performance instruments can be found in Levin (2000).

Aside from early dynamic visualizations of music, the paintings of Wassily Kandinsky (as shown below) beautifully illustrate the principle of synaesthesia. Kandinsky claimed to see colorful shapes when listening to music and, conversely, to hear the colors and forms of his drawings while painting.

> "The main inspiration was the work of Wassily Kandinsky, one of the most famous 20th century artists who was one of the first to paint really abstract works. I believe he coined the term 'Synesthesia', which is the culmination of all senses simultaneously. As he painted he could hear tones and chords, and believed every sound and colour were connected somehow through pure vibration. This was the inspiration for K-Project ('K-pro' internally)., standing for Kandinsky Project."
> (Jake Kazdal, an artist and animator with United Game Artists on the inspiration for the development of Rez, cited in Edge, 2007).

Rez is a prime example of using synaesthesia as an inspiration for a game. A deep trance music soundtrack sets the scene together with minimal and psychedelic graphics. As can be seen in the two figures below, artistic inspiration was taken explicitly from the works of Wassily Kandinsky. The gameplay of *Rez* is designed to be totally in sync with its sound and graphics. All gameplay events are quantized to the beat of the music and the rumble feature of the controller is used to underline that rhythm.

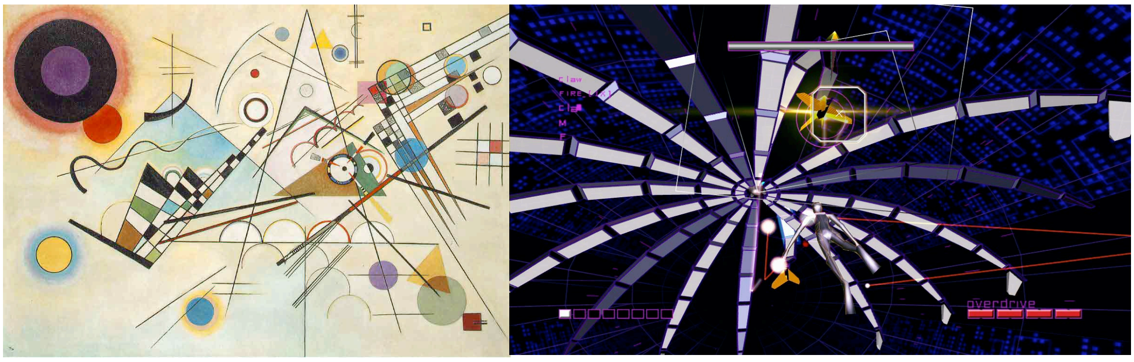


Fig. 56: Wassily Kandinsky's painting Composition VIII (1923) (left) and a screenshot of Tetsuya Mizuguchi's game Rez (right).

In a talk at the *Utopia of Sound Symposium*[82], Michel Chion describes synchronism of image and sound as being especially important to video games. In this context, he defines *syncresis* as "perceiving the simultaneity of a localized sound event and a localized visual event as a single phenomenon" (Chion, 2008).

82 http://utopiaofsound.akbild.ac.at/index_en.php [Accessed 12/05/08]

Other games that implement this approach are *Electroplankton*, *Vib Ribbon,* and *POSE*. In *Electroplankton*, the upper screen of the Nintendo DS shows a close-up of particularly interesting spots where sounds originate, thus very directly visualizing music generation. *Vib Ribbon* transcribes arbitrary songs from the user's library to the game's minimal graphic notation. The game also features a "visualizer mode" where visuals are generated without player interaction. *POSE* invites the participant to playfully interact with various audio and video compositions. Each composition has a distinct appearance expressed through visual and audible content. In combination, they give clues to the player on how to proceed through the game space created by the art piece.

Synaesthesia is not only a principle of design but also a neurological phenomenon that has fascinated artists for centuries. The interplay of musical and visual characteristics has been the basis of many artworks. From paintings and early color-music systems to contemporary music visualization and video games, synaesthesia is employed to intensify the experience of the participant. The interactive nature of music-based games can deepen this experience even more since the player's action are synced with the game's graphics and music. Thus, synaesthesia is closely related to player immersion and game flow.

Kinaesthetic Play

> "Damn, by the end I was writhing on the floor! Synesthesia indeed."

says Jane Pinckard [83] after a session of *Rez* enhanced by the use of the official *trance vibrator* peripheral. *Rez* unites the synaesthetic nature of its gameplay with rhythmic feedback using the rumble feature of the controller and the optional trance vibrator peripheral. *Rez HD* takes this concept a step further by enabling the use of up to three additional controllers, each rumbling to different rhythms in the game's soundtrack. Tetsuya Mizuguchi, designer of *Rez*, likes special positions for the extra controllers to get a more bodily experience: "I'd like to step on one -- I think the distance from my hands is the farthest place. I feel some space." (Nutt & Sheffield, 2007)

Kinaesthesia is the ability to feel the body's movement. Games that provoke bodily reactions in the player invoke a kinaesthetic experience, such as the way that the rumble feature of *Rez* enhances the perception of physical movement while playing. According to Westecott (2008), the feedback loop between kinaesthetic reception and physical input intensifies the experience of a

83 http://www.gamegirladvance.com/archives/2002/10/26/sex_in_games_rezvibrator.html [Accessed 12/05/08]

game and even improves reaction time. Henry Jenkins (2005) notes that games in general have a far greater potential for triggering kinetic energy in players and the audience than other media like film.

For music-based games, this means a far greater potential for multi-sensory perception and engagement. In addition to *Rez*, the following games also especially intensify physical play and kinaesthetic experiences:

All games that use instrument peripherals provide physical play.

- *Guitar Hero* encourages the player to stand up while playing by a strap attached to the guitar. *GuitarDS* also motivates the player to hold the DS in a guitar-like position. Other games, like *Dance Dance Revolution,* can only be played while standing.
- *Wii Fit* (Nintendo EAD, 2007) has a rhythm-based mini-game that requires the player to rhythmically step on and off the balance board peripheral.
- *bagatelle concrète* gameplay is inherently physical, given the rugged nature of old pinball machines. Tilting the machine and hammering the buttons to control the paddles is an essential part of playing pinball.
- In *POSE,* large gestures control the installation and it requires the player to move around the square in which it is exhibited.
- *beat'em up* prompts the player to perform rhythmic punching motions by its use of the accelerometer-driven Wii Remote.

Kinaesthetic play is a rudimentary attribute that can be assessed in all games. Muscle memory processes occur regularly when using a game controller, but some games take this concept further. By using peripherals, force feedback, and gestural input, music-based games have the potential to provide an experience that not only encompasses the visual and auditory senses but also activates kinetic perception.

Gestures

> "Every time I naturally sense that something is interesting, I try to connect each of my senses. I try to connect my visual senses with my auditory senses. I also want to connect these to the movement of my body and hands."
> (Iwai, 2006a)

This section[84] explains how gestures and their underlying metaphors are used in music -based games. Gestural interaction is used quite commonly in new media art, like the electronic instrument *ReacTable* or the acoustic environment *A Small Fish* (see the chapter on the history of music and games). Their tangible nature is a significant factor of their interface. Focus is put on the sense of touch that enhances visual cognition and gives the interface a graspable, tactile quality (Hornecker, 2004). During recent years, the use of tangible interfaces has found its way into the home entertainment market with, for example, the physical nature of Harmonix' hugely successful *Guitar Hero*, the rise of Nintendo's portable console Nintendo DS with a touchscreen interface, or the mainstream appearance of accelerometers. The latter are used by two of the three "next-gen" consoles – Sony's PS3 and the Nintendo Wii, whose controller also has a pointing function. The significance of this shift to tangible interfaces is underlined by the sales dominance of Nintendo's latest consoles on the portable and next-gen console market.

In the context of these new interfaces, gestures are the means of expression. In human-computer interaction (HCI) research, gestures are understood as the result of a cognitive process that combines a sequence of atomic actions to a single mental unit. This process is referred to as *chunking* (Buxton, 1995). Using Aristotle's definition of a metaphor in the sense that a specific term stands for a super-ordinate set of similar terms or meanings (Aristotle, 335 BC, translated in Aristotle, 1984), a gesture becomes meaningful when linked to a metaphor. A set of gestures linked to suitable musical metaphors builds a vocabulary for a game that features gestural interaction with music.

Examples of gestures for musical interfaces are:

- strumming the guitar bar in *Guitar Hero*.
- the combined gesture of pressing a chord and strumming in *GuitarDS*.

84 Parts of the introduction to this section have been published in "Gestural Interaction in Music Video Games" (Kayali, 2007) and in "Mobile Tangible Interfaces as Gestural Instruments" (Kayali et al., 2008).

- the list of gestures (catch, drag, throw, confine, etc.) presented for the *Thumbtack* prototype[85].
- tipping, sliding, rotating, and throwing the small planktons in *Electroplankton.*
- tapping and following the beat in *Elite Beat Agents*
- the combination of tapping and swiping to trigger notes on the *PetroriOn*
- bodily gestures like moving to a specific spot, extending the arms, or whirling them are used in *POSE* as the player is challenged to find the right gestures to trigger a state change.
- rhythmically punching and flicking with the Wii remote controller in *beat'em up* to trigger fighting moves
- very simplified instrumental gestures in the upcoming *Wii Music* [86] (Nintendo, 2008).
- bodily gestures in the rhythm-based fitness game *Helix* (Ghostfire Games, 2008) for the Nintendo Wii.

> "People frequently use gestures to communicate. Gestures are used for everything from pointing at a person to get their attention to conveying information about space and temporal characteristics."
> (Kendon, 1990)

Kendon means that gestures are a universal means of expression. In games, metaphors linked to a gesture and to an effect on the game result in usable interaction patterns related to the game-space. The following figure details the process of using metaphors for devising gestures to interact within a music-based game's rule set.

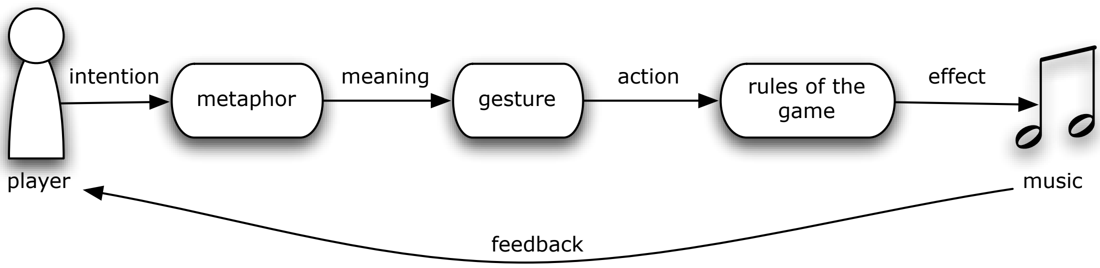


Fig. 57: The process of using gestures for musical interaction

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85 see the section *Gestural Interaction on the Nintendo DS* in the chapter on experimental prototypes.

86 Several videos that demonstrate the instrumental gestures in Wii Music can be watched at http://www.nintendowiifanboy.com/tag/wii-music [Accessed 12/05/08]

A similar process of mapping player action to the effects of gestures on musical output is presented in Wessel & Wright (2001) in their account "Problems and Prospects for Intimate Musical Control of Computers".

The above graph is best explained using an example. In the experimental prototype *Thumbtack*, the player has a specific goal (e.g. to establish a musical pattern). She or he decodes a control metaphor of the game to attain a gesture suitable to achieving the result (e.g. dragging a thumbtack so that it confines another one at the edge of the screen, aligning them in horizontal or vertical loops). Player action is then transformed by the rules of the game (e.g. in *Thumbtack* all widgets are normalized to an overall speed to ease the creation of rhythmical patterns). The rhythmical collisions of widgets with themselves or the edge of the screen are then translated to musical output by triggering distinct sound samples. Upon hearing the result of a previous action, the player can then add elements to that structure.

Gestures are a powerful means of providing musical interaction. Their continuous nature enables malleable results especially suited for instrumental games. Many of the games analyzed use gestures because their underlying metaphors are easily understandable; either through similarities to musical instruments or tactile qualities of the interface.

Play as Performance

> "It's like a wannabe. I think most people want to be something, they want to be in a rock band, be a rock hero, be a DJ. I think they are, it's a really huge market, the wannabe market. I think it's very healthy and natural."
> (Tetsuya Mizuguchi on Rock Band in an interview with Kohler, 2008)

Many music-based games relate to the desire of players to perform. Bodily engagement and a plain way of showing off skills increase the involvement of the player with the game. Games in general thrive on giving the player the impression of control over actions, balancing between challenging the player and providing the means to overcome those challenges. Music-based games satisfy the desire to be a composer and skillful musician, at the same time challenging the player to perform according to the game's rules. Henry Jenkins writes the following about music-based games and performance as he refers to *freQuency* and *Rez*:

> "Both games start with the sensation of traveling at high speeds down winding tunnels of light and color. As we move through these stylized but representational spaces, our interactions help to shape the sound and rhythm of their techno-based soundtracks. As we get into

the spirit of the game, we stop thinking simply in terms of our physical movements and become more in tune with the pulse of the music. Such games start to blur the line between play and performance, creating a context where even novice musicians can start to jam and advanced players can create complex and original musical compositions."
(Jenkins, 2005)

Music-based games move along the blurred line between play and performance that Jenkins describes. As they simulate the sensation of playing music they also have to capture an essential component of music - performance. This statement meshes with the view on music-based games established in the chapter on their history; they are situated on the borderline between games and instruments. Thus, they take certain properties of instruments, such as the ability to perform, and implement them in the context of a video game.

Of the analyzed examples, the following games are associated with *play as performance:*

- *Guitar Hero* lets the player literally take the stage by grabbing the guitar peripheral and performing a song in front of a virtual (and in many cases a small real) crowd.
- *Vib Ribbon* acts as a dynamic music visualizer and can even be used as an audiovisual performance system without playing it as a game.
- *Rez* is an on-rails shooter at its core but also features a *travelling mode* that voids dying and enables the player to consciously use the game to perform.

- *Electroplankton's* mini-games, though small and restricted individually, can be used in combination with each other or with other instruments to compile a performance (see the performance by Toshio Iwai at the Futuresonic Festival 2006 [87], where *Electroplankton* was played alongside the *Tenori-On*). *Electroplankton*'s standard mode of play is called performance mode and the game encourages playing in front of a crowd (see the picture to the left).

Fig. 58: A picture from the manual of Electroplankton that encourages players to perform.

87 http://10.futuresonic.com/urban_play/instrument/ [Accessed 12/05/08]

- *bagatelle concrète* and *POSE* feature performance aspects as interactive art pieces and the bodily engagement required to play them.
- *GuitarDS,* an abstract version of a real instrument, and *PetroriOn,* a new digital instrument, are both intended for instrumental performance in a playful setting.
- *Thumbtack* and *MicPlay* are simple, restricted musical mini-games, similar to the style of *Electroplankton*'s mini-games, and enable dynamic composition and performance.

Play as performance is a broad term. When regarding skill-based, competitive gaming, one sees that many games are suitable for a performance setting. In terms of music-based games, the notion of performance is inherent to music itself. Therefore, all games with an instrumental character can be used to perform. Games like *Guitar Hero, Rock Band* and *SingStar* strongly encourage social and bodily gaming experiences, consciously enhancing the gaming experience through a performance setting.

Sound Agents

One of the challenges in designing music-based games is how to visualize and manifest music for playful interaction. In rhythm-based games, this manifestation is realized by specialized, reduced musical notation. In games that offer sandbox, free-form, and instrumental play, other methods of mediating player input and musical results are needed. Some games provide instrumental interfaces, either as physical interfaces or as a depiction of a real instrument. Another method is to use dedicated objects that act as audio representations and acoustic attributes. The player can influence partially autonomous objects that act according to the game's set of rules, thus enabling accessible, yet diverse, musical creations.

> "A contemporary design pattern for screen-based computer music is built on the metaphor of a group of virtual objects (or "widgets") which can be manipulated, stretched, collided, etc. by a performer in order to shape or compose music. The foundation of this schema is an assumption that 'a sound can be abstracted as an aural object' "
> (Levin, 2000 following Abbado, 1988)

This definition of widgets, or aural objects, concurs with the view of sound iconization (see *auditory icons* and *earcons,* Grimshaw, 2007 and Friberg & Gardenfors, 2004) and has also been treated in relation to movies in Michel Chion's *Guide des Objets Sonores* (A guide to auditory objects) (Chion, 1995).[88]

Applying this term to video games creates the definition of a *sound agent:* playful widgets that exist aurally and also visually as interactive gameplay elements. Playfulness is key to the sound agents' use in music-based games. Sound agents are subject to a game's set of rules and can implement artificial intelligence and/or physics to create a lively experience. Their interaction with each other and with the game environment makes them suitable for triggering emergent gameplay.

The following examples of sound agents have been drawn from the qualitative analysis:

- In *Rez* and *Otocky,* all enemies act as sound agents. They can be marked and shot down to produce individual sounds. In *Otocky*'s editing mode, the player can set enemies, devising a musical score that unfolds as the created level is played. Both games feature *travelling* modes that make the player's avatar invulnerable and thus allow for gameplay focused on musical creation and experimentation with the enemies (who act as sound agents).
- In *Sim Tunes,* the musical insects act as sound agents. They are independent playback heads, each with a distinct timbre, that can be placed and removed by the player and that act depending on objects placed on the playfield.
- In *Electroplankton* and *Thumbtack,* the small planktons and widgets present in most of the mini-games are sound agents. Depending on the mini-game, they act in accordance with simple physical rules for the manipulation of their environment and can be tapped, pushed, dragged, rotated, aligned, or swiped by the player.
- *Radiolaris* uses all units and enemies produced within its real-time strategy setting as sound agents. When placed on the playfield, they can be triggered rhythmically and emit actions and notes.

Sound agents are a diverse means of rendering musical interaction playful. They are mostly used in sandbox play settings and offer possibilities for experimentation. Their character as gameplay elements and musical interfaces combines two major characteristics of music-based games.

88 A detailed overview of these concepts can be found in the chapter *Game Sound and Music Terminology.*

Active Scores

The mostly linear spatial representations of progression in rhythm-based games are one form of musical notation, but games that feature non-linear and free-form gameplay need other ways to represent music. This approach is tightly connected to the previous description of sound agents often found in active scores. Interactive music art often lets the player access and devise music through an active score (e.g. *Small Fish*, the *ReacTable*, or the *Audiopad*). This approach is also taken by a group of music-based games (e.g. some of the mini-games in *Electroplankton* originate in previous active-score artworks, see *Composition on a Table*). But the ancestors of active score music go back further than interactive media art.

> "There was, at the beginning of every new composition, an inner vision to discover a world, which I had never experienced before. I thought, "How can I ever, with the means and with the notation and with the technique of this planet realize this?" And then it became a translation. Most of the time I have invented new notations... to approach at least to some extent what I had innerly experienced."
> (Stockhausen, quoted in Duffalo, 1989)

In 1959, Karlheinz Stockhausen composed a score with a cyclic refrain called *Refrain for Three Performers*. Transparent sheets of music are overlaid with the score of the refrain. The transparent sheets can be rotated by the individual performers, causing the refrain to become a new combination of patterns with every performance. Even earlier, Wolfgang Amadeus Mozart (1756-1791) invented a game that allowed for the playful composition of a waltz called *Das musikalische Würfelspiel* (a musical game of dice) (Mozart, 1793). He composed a series of waltz patterns that can be recombined by rolling dice (Jones, 1991; Noguchi, 1996).

Such playful and dynamic approaches to composition are called active scores and are implemented by many music-based games:

- Otocky's editing mode allows the player to build a level, thus creating a musical score to be traversed while playing.
- Sim Tunes lets the player dynamically draw a score crossed by musical insects that are also partly subject to the player's control.
- Electroplankton's mini-games and Thumbtack give the player a group of sound agents that can be manipulated and put into balance by the player.

- MicPlay depicts a sequencer loop where the player can dynamically decide which recorded sample is played when by drawing on the screen.
- Radiolaris and bagatelle concrète offer environments that have rich sound generation structures. In Radiolaris, these are the enemy and player units. In bagatelle concrète, the obstacles on the playfield generate the sounds. Both scores are traversed by the player who triggers the sound effects and thus shapes the music.

Active scores are an old means of providing musical interactivity. By transforming musical scores into combinable elements, an accessible, interactive, and in many cases playful manifestation of music is offered to the player. The player thereby becomes a composer of continually recombined variations on given themes.

Audio Input

Music-based games do not necessarily focus only on musical output. Playing music can also mean playing with existing music or contributing one's own samples. Games and music are also converging on the level of electronic devices. The iPod games *Phase* and *Musika* use the music library as a source for generating levels in the same way that *Vib Ribbon* and *Audiosurf* dynamically generate gameplay by analyzing audio CDs chosen by the player. One of the challenges these games offer is a revised perspective of one's music collection. Experimenting with the selection of tracks is a playful experience in itself. Another class of games uses audio input by working with microphones:

- *Guitar Hero: On Tour* (Vicarious Visions, 2008) for the Nintendo DS prompts the player to shout into the DS' microphone to trigger *star power* (a temporarily increased score multiplier).
- Two mini-games in *Electroplankton* and *MicPlay* revolve around the recording, manipulation and playback of user-recorded audio samples.
- *bagatelle concrète* uses several microphones to sample gameplay and extract rhythmical structures to which transformed versions of those samples are aligned.
- The games in the S*ingstar* series of karaoke games analyze the player's voice to track if the correct pitch is maintained while singing and to score the performance accordingly.

Audio input enriches the gameplay experience by adding unlimited musical variation through recorded samples and custom soundtracks. Advances in the field of music information retrieval will further the dynamic usage of user-selected tracks in music-based games.

Narrative

The scope of this text does not allow for an in-depth analysis of each game's narrative[89]. Narrative is a powerful means of engaging a player in the game. This section briefly evaluates how narrative drives the gameplay of music-based games. Narrative is not included in the table at the beginning of this chapter because it is, at least rudimentarily, present in all of the described games.

A game's narrative is meant to set the scene for gameplay and thus explain to the player the scope of possible actions. It is especially important for the player to understand the metaphors presented by the game (e.g. when applying gestures). Many of the games analyzed apply a very basic scene setting (e.g. *Rez* sets the player in a computer to battle viruses). In other games, it establishes a setting that makes the interaction paradigms apparent to the player (e.g. when set in a pond swirling with life in *Electroplankton,* it is obvious that the planktons can be stirred up with the DS' stylus). The embedding of a game within a narrative structure helps explain basic game mechanics such as the score and game-over conditions. When the player performs a song in *Guitar Hero,* he or she is increasingly cheered on when notes are hit in succession, thus driving up the score multiplier. When several notes are missed, the cheers turn to boos and, if even more note are missed, a game-over occurs. *Guitar Hero*'s stage setting gives it an audience that enables the game to transparently implement the score and game-over mechanics.

Then, there are music-based games with a continuous narrative. In *Elite Beat Agents* and *Space Channel 5,* gameplay is embedded in a story that highlights the importance of music. Thus, music-based gameplay is explained by the story and put into the context of the game's narrative.

Adaptive Music and Musical Puzzles

This aspect is also not shown in the list of principles of design because it is not featured in any of the qualitative or experimental examples. As the genre of music-based games has solidified, its mechanics have diffused to other genres. Games like *Pixeljunk Eden* or *flOw* do not focus on playing music, but game elements and player actions repeatedly blend with the soundtrack. This is one step further than adaptive game music. The background music is not only adapted continuously according to the progress and state of the player, but small gameplay events also have acoustic feedback that is rhythmically or harmonically aligned to the soundtrack. A concept similar to that of *Rez*, with the important distinction that *Rez* also subordinates gameplay to the rhythm of the music.

89 see Espen Aarseth's text *"Cybertext: Perspectives on Ergodic Literature"* (Aarseth, 1997) and Jesper Juuls chapter on *"Games Telling Stories?"* (Juul, 2005b) for an introduction to games and narrative.

Musical puzzles are small musical challenges presented to the player in the context of a regular game. A prime example is *Zelda: The Ocarina of Time*. The instrument, already mentioned in the title, is used by the player to complete various small musical challenges (Whalen, 2004).

These principles of design, described here exclusively in the context of music-based games, can also be applied to game genres not explicitly dedicated to music. For example, when music is used as a basis for puzzles or for the closer integration of gameplay and soundtrack.

Cross-References between different Principles of Design

When regarding the principles of design, it is obvious that many of them relate to one another. Most games do not focus on a single design principle, but rather on a combination of multiple approaches. Some principles may void the use of another. The principles will be revisited in this section and their relation to other principles discussed.

Looking at music-based games from a player's perspective, a distinction can be made between playing music and playing games. The experience of rhythm-action games and sonificated traditional games like *Rez* can be seen as *playing games.* Playing games with instrumental play that revolve around free-form musical creation is *playing music*. Of course, games may also feature aspects of both forms of play.

The following list of cross-references is organized according to the distinction between playing music and playing games:

Playing Music

- Games that feature instrumental play usually do not implement rhythm action, as the fixed structure of rhythm games contradicts the sandbox gameplay of instrumental games. Non-linear rhythm games may pose an exception to this generalization, as they often overcome the usual linearity of the genre.
- Instrumental play is often supported by quantization to ensure rhythmic and therefore euphonic results. This decision is made when designing many instrument games as a concession to the accessibility of the game (in *Otocky,* for example, or implicitly in *Sim Tunes* through the speed of the insects).

- In many games, instrumental play and play as performance go hand in hand when they are used in live concerts, like Toshio Iwai demonstrated with his game *Electroplankton* at the Futuresonic 2006 festival.
- *Active scores* often are used as an accessible notation for instrumental play (e.g. *Sim Tunes*).
- The quantization of active scores is often implicit, defined by the method of traversing the score. When grids (*Sim Tunes*) or regular intervals (*MicPlay*) are used, quantization becomes visually apparent.
- Sound agents are musical widgets often used as a visual icons for instrumental play (e.g. the planktons in *Electroplankton*).
- Sound agents usually employ implicit methods of quantizing results. This is realized through a set of rules giving them fixed intervals or speed settings.
- Sound agents relate well to active scores. Their symbolic, iconized character enables them to be visual representatives on a playfield that acts as a musical score.
- Gestures allow for more depth of expression and provide a haptic interface to the music (see the four experimental prototypes designed on the Nintendo DS).
- Gestures are connected to sound agents. The widgets controlled by gestures are a suitable control metaphor for touchscreen-based interaction.
- Narrative sets the scene of a game and thus helps the player decode metaphors and apply suitable gestures.
- Synaesthesia, as a design principle, conveys the perception of synaesthetes to players.
- Quantization is tightly connected to synaesthesia because it ensures continuity and therefore flow by bonding music and gameplay.
- Synaesthesia is connected to kinaesthetic play. Haptic feedback greatly enhances immersion by joining the sense of touch with acoustic and visual perception.

Playing Games

- Rhythm-based games do not apply quantization because rhythmical actions are imposed on the player as the primary challenge. If events occur outside the rhythm of the underlying music, the player is sanctioned by the game.
- Rhythm-based games are the primary source of instrument peripherals. They are tightly linked to kinaesthetic play through a wide array of plastic peripherals, including guitars, drums, bongos, maracas, and dance-mats.

- The close connection with kinaesthetic play also links rhythm-based games to play as performance, which is intensified by the haptic nature of the instrument peripherals.
- Kinaesthetic play and play as performance depend greatly on one another. When performing, the willingness to be physically engaged rises greatly. Vice versa, kinaesthetic play immediately triggers a performance, when players get up, move, and otherwise expressively engage in the game.
- Kinaesthetic play is closely related to the use of gestures, which often require larger body movements than those of the control patterns performed on a game controller. Most physical interfaces use abstract gestures for input.
- The linear nature of many rhythm-based games allows for the easy incorporation of linear narratives (e.g. in *Elite Beat Agents, Space Channel 5, Parappa the Rapper*).
- Sound agents are generally not present in rhythm-based games because other abstract forms of musical notation are used.

Genres

The above list of principles is a list of factors influencing music-based games design and not a sharp categorization. However, it does make genre distinctions possible. In the games press, music-based games are usually tagged with the terms *music game* or *rhythm action*, depending on gameplay. Wikipedia's article on *music video games* (at the time of writing) classifies music-based games according to different gameplay variations[90], separating them into *sight-reading music games*, *free form music games,* and *hybrid music games.* While analyzing the games, it became apparent that a distinction of rhythm-based games from other music-based games is possible and has already been made by game journalists. Distinguishing other principles is more difficult. Of course, many games tagged with instrumental play could be used to describe as *free form music games,* and the term *hybrid music games* would accommodate games that combine elements of several genres (e.g. *Rez* and *Otocky*, shooters that implement characteristics of music-based games).

90 http://en.wikipedia.org/wiki/Music_video_games#Major_gameplay_variations [Accessed 12/05/08]

Summary

> "A lot of the comparisons come from how both incorporate music into the game. Contemporary music games such as Guitar Hero treat music as a form of enemy: if you cannot play the music then you lose the game. However, in Rez and Everyday Shooter, music is treated as a form of reaction: as you play the game, music will occur."
> (Jonathan Mak on his game Everyday Shooter in comparison to Rez in Yoon, 2007)

Many distinctions on how music is used in music-based games have been given in this chapter. As the above quote illustrates, the use of music varies greatly. As the principles of music-based design are named, it becomes possible to draw some conclusions. As mentioned above, it is obvious that rhythm-based games are a genre of their own. They all use a similar approach to music and constitute very traditional games that award points and feature game-over conditions, individual levels, and linear progression. When regarding the other principles of design things get blurrier. The games analyzed have some of their roots in arts and instrument design. Consequently, a differentiation between playing music and playing games is made to help organize the cross-references among different design principles.

For example, it is shown that the surface of *active scores* is often built by *sound agents* controlled by *gestures* that result in *instrumental play*. *Kinaesthetic play* and *play as performance* also often depend on each other. *Synaesthesia* and game *flow* are greatly supported when games are bodily, *kinaesthetic* experiences. *Gestures* in turn support *kinaesthetic play* and *play as performance.* Social *rhythm-based games* build their excitement by combining exactly these principles.

This chapter gave an overview on the ways music-based games implement interaction with music and how these concepts may relate to one another. How these concepts are implemented in games in respect to the balance between playing music and playing games is the subject of the next chapter.

Simulation, Gameplay and Game Design

Introduction

> "The modern sports game is no longer a re-creation of an actual sport so much as it is a re-creation of viewing that sport on television."
> (Poole, 2004)

In the above quote, Steven Poole highlights a very distinct quality of sports video games. He means that sports video games [91] primarily simulate the presentational layer of sports. Of course, they simulate many aspects of a sport with specific game mechanics, yet the most striking similarity with real sports is their presentation. "In-your-face marketing. Extreme camera angles. Trash-talking superstars. Sound like TV sports? Try sports video games," says Evan Ratliff (2003) in an article on sports video games in the magazine *Wired*. The ongoing quest for more realistic representation spurs sports video games to become more like the "real thing". The current generation of sports video games appear to be a consummate emulation of reality. Authentic stadiums and jerseys, perfectly recreated player tattoos, cheering crowds singing songs for the teams on court, colorful commentators, statistical inserts that often exceed even the most professional sports television coverage - the audiovisual appearance of sports video games is a nearly perfect replica of reality. However, the underlying game mechanics trail behind this audiovisual realism as analogue, athleticism, skill, and experience-based physical movements are mapped to the digitally controllable and accessible representation of the game world. This mirrors the way that many popular music-based games simulate the setting, style, and presentation of music rather than making an authentic model of a specific instrument.

In *Guitar Hero*, the robotic recreation of imposed patterns with a plastic controller that has more characteristics of a piano than of a guitar can make for challenging and very traditional gameplay. The charm, character, and setting of the game are shaped by a strictly simulated cliché that allows the player to immerse his or herself while really performing. Looking at this example, it is not immediately clear which aspects of *Guitar Hero* are subject to simulation. Does the game simulate playing a guitar? Does it simulate being a rock star performing on stage? Or does it

91 I already described the design of sports video games as a concession between simulative and gameplay-driven aspects in "Two Halves of Play - Simulation versus Abstraction and Transformation in Sports Video Games Design" (Kayali & Purgathofer 2008). By using the terms *abstraction* and *transformation*, deviations from reality in sports video game design are explained. Some passages in the introductory sections to the chapter at hand build directly on the research done in that article.

simulate going to a rock concert? Does *Guitar Hero* simulate *playing music* or is it more an interactive progression of listening to music?

The previous chapters make apparent that both the roots and current manifestations of music-based games are not solely restricted to the sphere of video games. They are closely related to the music industry, instrument-design, arts, and the current evolution of the medium music. This chapter looks at music-based games as simulations drawing on a diverse range of influences. Building on the distinction of design principles in the previous chapter, this part of the thesis examines the balance of simulation-driven and gameplay-driven decisions in the design of music-based games. Laying a foundation for the following discussion of the individual principles, this chapter first introduces play, players, simulation, and games as simulations in general. Then, games are characterized as models. In this context, concepts for mapping reality to a game-world are described. These concepts include rules, metaphors, and abstraction as the means for building playful environments that resemble aspects of reality.

Play

> "play is voluntarily activity or occupation executed within certain fixed limits of time and place, according to rules freely accepted but also binding, having its aim in itself and accompanied by a feeling of tension, joy and the consciousness that it is 'different' from 'ordinary life'."
> (Huizinga, 1938)

Play has multiple meanings and definitions. From competitive play in sports, to games of chance in gambling, to child's play, it signifies playful activities where a person engages in a more or less fictional structure of rules, goals or experimentation. Generally, game studies distinguishes between two different kinds of play, detailed in Roger Caillois' book *Man, Play, Game* (2001, originally published in 1958) and in Dutch historian Johan Huizinga's famous book *Homo Ludens* (1938), from which the above quote is taken. *Paidia* is described as free, improvisational play not based upon rules but where players set their own goals and basic conditions. Video games designed primarily for *paidia* are called toys or non-games. *Ludus*[92] is described by Huizinga as rule-based play within set, goal-oriented conditions. This is cohesive with the general understanding of games as rule-based systems with clear measures of success and failure.

92 The term ludus also laid the foundation for *ludology* as a discipline. Ludology focuses on games as a new interactive medium as opposed to regarding them the same way that narrative media like literature and film do. See the paper "Simulation versus Narrative: Introduction to Ludology", by Gonzalo Frasca (2003) for an elaborate introduction to games studies as a scientific discipline.

Both terms are of importance to this thesis and can often be used to make a distinction among music-based games. Instrumental play relates to paidia and improvisational play. Popular, linear, rhythm-based games correspond to *ludus* and the traditional mode of games as rule-based challenges to a player. Both are examples of applying this terminology to music-based games.

The Player

When designing a game, one must focus on the experience of the player and his or her involvement with the game. Ideally, an immersive game experience suspends the player in a state of flow. Being immersed and acting in flow with a game world leads the player to a *"willing suspension of disbelief"*, a mental state first described by Samuel Taylor Coleridge (1817) in relation to literature and the reader. It signifies the willingness of the reader (or in this case the player) to "buy into" the prepared fictional world, putting aside rational doubts about its authenticity. The recipient suspends disbelief, diving into the presented world and greatly raising involvement. To enhance this state of immersion, a fictional world must provide a consistent setting that does not disrupt this willing suspension of disbelief. In the context of fantasy literature, J. R. R.Tolkien (1966) describes the importance of believable worlds that, through their own rules and laws, preserve an "inner consistency of reality". The same reasoning that Coleridge and Tolkien apply to literature relates to drama as well:

> "It is key to the success of a dramatic representation that all of the materials that are formulated into action are drawn from the circumscribed potential of the particular dramatic world". (Laurel, 1991)

Brenda Laurel evokes essentially the same notion when she contends that the world presented in a theatrical play must justify the materials and concepts presented to the audience. The same inner consistency is important to game worlds, not only as narrative structures but also as playgrounds for interaction. To properly support the player's willing suspension of disbelief, video games have to present believable and consistent worlds and experiences. Simulating and mapping reality to a game world is a valid a way to achieve this goal, as is creating new worlds with stable and understandable settings. Establishing stable models is the way to describe and implement a consistent setting for a game. Believable game worlds allow experiences to be shaped by playing with a player's expectations of the game. Subconscious player expectations of and conscious reflection upon the game world are an integral part of what makes games emotionally engaging[93].

93 For a detailed account of how expectations shape player emotions, see the paper "Intentions, Expectations and the Player" (Kayali & Pichlmair, 2008).

Simulation, Modeling and Rules

> "The discovery that there could be a computer that could compute any computable number does not sound like the most shattering intellectual advance. But that is because we have got used to the idea of the computer. In 1936, it meant a person. Following Turing's insight, it meant a machine: he had proved, in other words, that it was possible to mechanize what had previously only been possible by means of mental effort. The machine had crossed a critical barrier. Before, machines had taken over the body, now they threatened to take over the mind"
> (Woolley, 1992)

In 1936, Alan Turing wrote his famous paper "On Computable Numbers with an Application to the Entscheidungsproblem" (Turing, 1936), which lays out the concept for the *Turing-machine*. He proposed that a machine (the first computer had not yet been built at that time) could solve any problem that can be written out as a series of rules. To extract the relevant and significant qualities of a "real" object or circumstance, a rule-set must be defined as a basis. A simulation can be defined as such a set of rules. In game studies, a concentrated effort has been made to define games as rule sets[94]. The process of formalizing real world aspects to a set of rules is commonly understood as the process of *modeling*. Craig A. Lindley (2005), sees modeling as an overall design approach that enables game designers to structure player experiences. The experience of the player is shaped by choosing factors that are significant for the modeled system and relevant to the game world.

"to simulate is to model a (source) system through a different system which maintains to somebody some of the behaviors of the original system". The key term here is "behavior". Simulation does not simply retain the – generally audiovisual– characteristics of the object but it also includes a model of its behaviors. This model reacts to certain stimuli (input data, pushing buttons, joystick movements), according to a set of conditions." (Frasca, 2003)

> "Models are idealisations of a system, in which certain aspects of the system are captured and other aspects are ignored. [..] Good models are those who are simple yet still manage to reproduce even quite roughly a large number of features of a particular system. [..] the main difficulty to construct a model is to identify the important aspects of the system." (Grünvogel, 2005)

94 See the book *Rules of Play* by Katie Salen and Eric Zimmermann (2004) for a detailed account of the relation between games and rules from a structural point of view.

As the two quotes illustrate, models present only a segment of a real system termed relevant to the player. A good model must not only represent the significant attributes of the original system but also react accordingly to player actions.

In traditional scientific models, rules are defined so that the modeled system resembles the real one as closely as possible. *Representational games* try to simulate every detail of reality and it is evident that they set a very high standard for successfully conveying all important aspects of the modeled system (Wolf, 2003). When thriving for complete realism, every shortcoming is deemed fatal as it has the potential to distract the player from the state of “willing suspension of disbelief”. To sufficiently meet player expectations, video games map and translate a real world to a consistent, gratifying, and constrained game experience based upon rules.

> "To play a video game is therefore to interact with real rules while imagining a fictional world, and a video game is a set of rules as well as a fictional world."
> (Juul, 2005a)

With respect to gameplay, such a mapping requires significant design decisions to ensure that the fictional world resembles aspects of the original system. With respect to rules, there are two related, yet distinct, ways to establish such a resemblance: the newly introduced rules that render a video game playable, and the rules of the simulated world.

If a system is modeled so that the results of the modeled system converge with the results of its archetype, the internals of the model can be built on arbitrary rules (e.g. based on a neuronal network or on statistical data). Such a system is only a simulation insofar as its results are concerned. In fact, many games (in particular sports games and role-playing games) are partially built this way. Rather than simulating by accurate physics, success is determined by ratings and statistical data. In Kayali & Purgathofer (2008), the term *transformation* is used to describe the process of modeling by changing real behaviors into playable experiences in sports video games.

Equally interesting to the scope of this thesis is modeling by extracting the significant rules of the original system. When regarding reality, the amount of rules that could be simulated is usually endless. While some rules of a modeled reality can be transferred without loss, video games try to reduce rules to those relevant for gameplay and for recognizing the simulated system. Jesper Juul (2007) calls this game design process *abstraction*.

This section introduced the concepts of simulation and modeling. Games need to present consistent and believable worlds that support player immersion. Representational games model a real-world system. The process of modeling necessitates game design decisions on which and how rules are implemented. The resulting rule-sets represent the original system and map reality to a constrained, playable experience. This mapping can be achieved by introducing new rules supported by the real archetype and by extracting the significant rules of the original system.

Metaphors

> "[..] metaphor is pervasive in everyday life, not just in language but in thought and action. Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature."
> (Lakoff & Johnson, 2003)

Both of the previously described methods of modeling rely on the concept of metaphors. Metaphors attach meaning to an object or action by referring to a super-ordinate semantic level (as described according to Aristotle in the section on gestures). In language, individual words are metaphorical signifiers. In video games, objects often have an attached metaphorical meaning. For example, the mushrooms in *Super Mario* stand for strength. Action metaphors arise when a player pretends to do something, the metaphor being the meaning expressed by that action. The game that most articulately illustrates this concept is *Wario Ware: Smooth Moves* (Intelligent Systems, 2006). Small mini-games, each relying on one simple concept, prompt the player to quickly decode the presented metaphor and react with an adequate gesture with the Wii Remote (see Rusch (2007) for a detailed analysis of the use of metaphors in *Wario Ware*). Looking at *Guitar Hero*, game designer Tetsuya Mizuguchi, called players "wannabes." Playing with the guitar peripheral in *Guitar Hero* can be regarded as pretending to play a guitar in a metaphorical sense. Metaphors can be used in games to emphasize certain aspects of the simulation and shadow others.

Abstraction

The ability to decode metaphors is the reason players can interpret reduced models of reality in games. Conversely, finding metaphors that transport certain aspects of an original system is the way to meaningfully abstract reality to a game world. Consequently, abstraction in games is understood as the process of mapping reality to a constrained, understandable, and thereby playable experience. Abstraction is a means to mediate between reality and gameplay. In his paper "A

Certain Level of Abstraction", Jesper Juul (2007) writes, "The level of abstraction is the level on which the player can act: The actions that are available to the player" (Juul, 2007).

Juul describes abstraction as the level of detail of the represented world that is implemented in the fictional world. The most visible examples of abstraction are found in control schemes. The complex and malleable actions that are available in reality must be mapped onto the control layout of a game controller. This process requires specific decisions to be made about which actions (or in an even more constrained view: which manifestations of an action) should be offered to the player to perform or initiate, and which actions should be left out of the game. In this sense, abstraction can also be understood as a form of designing by constraints; abstraction is the constraints that are placed upon the players' actions in order to liberate from decisions deemed unnecessary in the context of the video game.

Gonzalo Frasca describes a similar way of constraining player experiences in his description of the fictional *"simulatógrafo"* (*The Simulatograph*, Frasca, 2008). He describes it as a "mystical, inexistent, imaginary machine". The simulatograph is a metaphorical tool for describing constrained mappings of reality to games that compares the view given by a game with looking at the real world through a camera lens. The *zoom* determines the dimension of the simulation. A wide-angle depicts deep simulations with many variables, while a tele-lens zooms in on a very specific thing. Just as a photographer decides what remains in the picture and what is left out, the *frame* determines which aspects are included in the simulation. The *focus* is used to highlight a specific feature depicted in the frame. This feature is the core feature of the game around which its goal(s) revolve.

The simulatograph is a beautiful metaphor for how games simulate reality. By picking a distinct point of view with a specific focus, certain factors and variables are featured or highlighted by a game and some are left out. This is exactly what Juul also means when he discusses levels of abstraction. It signifies the variables and actions available to a player in a constrained implementation of reality.

Summary

This chapter introduced simulation and gameplay-driven design decisions in games. Representational games are faced with implementing a multitude of factors, necessitating strategies for transferring reality to the game world. Game worlds must be consistent and believable to permit a "willing suspension of disbelief" and consequently player immersion. In order to create consistent game worlds, attempts are made to simulate real world systems. Models breaking down the original system into significant factors are used to achieve this goal. These models lead to rule sets that characterize the system. To devise these rules, designers must transfer the innate rules of real systems to the game world. Within this context, understandable metaphors help make the rules of play understandable for players, who are able to interact with an abstract game world by decoding the metaphors.

Playing Music and Playing Games

Introduction

The different levels of abstraction in music-based games can be illustrated with two examples. The first example is playing the guitar in *Jam Sessions*, a guitar simulator for the Nintendo DS that enables the player to replay songs according to sheet music and also features a mode for free-form improvisational play. Playing chords is abstracted to choosing eight different chords with the direction pad and the gesture of strumming is retained as the player swishes across the screen with the stylus to trigger the chosen notes.

A higher level of abstraction can be assessed in many of the individual games in Toshio Iwai's *Electroplankton*. Sounds in the *Marine-Snow* mini-game are triggered by sweeping across the planktons with the stylus, a gesture resulting in harmonic sequences of notes. The sweeping gesture and the tone of the musical result resemble the act of playing a harp or other stringed instrument; yet the appearance and many of the plankton's behaviors have nothing in common with the instrument modeled upon.

As illustrated above, music-based games, similar to many simulation games, have a strong tie to their archetypes. Still, many music-based games are not especially interested in actually simulating a physical instrument the way sports games model a vision of a specific sport. Music-based games instead try to blend important aspects of playing music with the setting of a video game. An import design goal that exemplifies this coalescence is stated by Golan Levin (2000) who points out that an ideal interface for audiovisual performance "has a quickly apprehensible interface that affords immediately satisfying results; yet at the same time, provides for a wide range of possible expression that one can continue to master over time." Simple and easy-to-learn interfaces are a common attribute of well-designed video games and elusive mastery over time is typical of musical instruments. However, most instruments are not very accessible at first use. The blending of these two qualities poses a challenge to designing music-based games. A music-based game's design needs to be abstract to be playable and accessible.

This chapter revisits the principles of design established in the previous chapter. Following the previous sections on simulation, modeling, and mapping, the principles of design are analyzed regarding their functions for simulation and gameplay. For this purpose, the principles are clustered into more convenient units. The appearance of music-based games, the representation of music in rhythm-based games, and active scores will be dealt with in the section *Representation* *of Music*. Kinaesthetic and gestural play will be handled together when describing *The Instrument*. *The Player* will be analyzed regarding instrumental play, performance, and synaesthesia. In following, clusters of design principles are listed and analyzed.

Representation of Music

This section is mostly concerned with representation, and principles will be clustered and analyzed from that point of view. All music-based games use a form of notation that makes music accessible to the player. There are several ways in which music-based games use notation to represent music:.

Linear rhythm-based games always use an abstracted form of notation similar to sheets of music, played either from left to right, top down, or tilted into space (see the various modes in the section on linear rhythm games). Mimicry-based games present a series of rhythmical button presses for the player to reproduce, and non-linear rhythm games allow sequences to be arbitrarily used by the player. All three cases essentially use the same abstract representation of music. Music is abstracted to rhythm. The exact number of notes played is often sacrificed. Pitch is also greatly abstracted to roughly correspond to the different buttons that must be pressed in succession. The following figure illustrates this mapping of notation for several degrees of difficulty using a song from *Guitar Hero*:

Fig. 59: An transcription of the Guitar Hero song "Less Talk More Rokk" on the different difficulty levels. The last line is the original song (Shultz, 2008).

The above sheet of music illustrates very well the concessions to gameplay that are made in rhythm games. The mapping of the notes appears arbitrary. Indeed, some notes have a different tone on each difficulty level. One feature that is retained are notable changes in pitch (especially those that occur at rhythmically significant moments), which are transferred to pitch changes in the reduced notation. The basic rhythm of the song is maintained at all difficulty levels. Depending on the degree of difficulty, the rhythm is reduced to quarter, eighth, or semiquaver notes.

Rhythm-based games abstract music to a rhythmical structure where rhythm is quite accurately simulated (especially on higher levels of difficulty) while pitch is greatly abstracted for the purposes of gameplay. Harmonix even claims that Rock Band's drum tracks on the expert difficulty level exactly match the real tracks note by note.

Instrumental play is usually realized using one of the two following approaches: By depicting or physically reproducing an instrumental interface (these will be dealt with later regarding kinaesthetic play and gestures) or by active scores.

Active scores are a dynamic form of representation that can be modified in real time by a player, who consequently triggers musical change. Simulation is applied to active scores on different levels. Many active score games are actually an abstract simulation of a dynamic system. The different ponds of living planktons in *Electroplankton* are a good example for the representation of a simple ecosystem that serves as a playground. *Thumbtack*'s widgets simulate a simple physics-based environment that implements realistic collision and reflection angles. Other active score games, like *MicPlay*, directly depict sequencer software as software instruments. *Sim Tunes* is a combination of both these concepts, as living creatures, the musical insects, crawl across a sequencer grid. On another level of abstraction, active scores support means of interaction that use input metaphors from real instruments. The harp-like interaction (mentioned in the introduction to this chapter) in many of *Electroplankton*'s mini-games is as a good example. This relation will be dealt with later in detail, when examining gestural input.

Summarized, music always has a distinct abstract representation in a game world. While most rhythm-based games use similar abstracted versions of linear musical notation, active score games pose a different challenge. These games take metaphors from software instruments, dynamic systems, and instrumental interfaces and transfer them to interactive playgrounds.

The Player

This section looks at music-based games from the perspective of the player. The design principles of instrumental play, play as performance, and synaesthesia all deal with the player's experience of a game. They are looked at in terms of their meaning to simulation and gameplay.

Instrumental Play

The borders between the clusters presented in this chapter are fluid. Instrumental play not only relates to the player, but is also strongly related to the interface of the instrument, an aspect dealt with in the following section. This section looks at instrumental play from the perspective of the player and his or her perception of the possibilities of musical expression offered by a music-based game. The discussion of instrumental play as a simulation of a real instrument goes along the lines of the comparison of requirements for audiovisual instruments and music-based games (see the previous chapter). This section will briefly summarize these insights and link them to simulation and gameplay.

Generally, games give players access to actions they normally cannot afford to or are not able to do. In this sense, making instrumental play accessible to non-musicians who do not want to go through the steep learning curve of mastering a real instrument is one of the prime design goals of a music-based game. Yet representational games must offer a degree of simulation that makes the characteristics of the game-world believable. This means that music-based games focused on instrumental play must incorporate some of the attributes of real instruments. Most importantly, malleability, diversity of musical output, and an increasing degree of mastery that can be achieved by extended, focused play. Achieving a balance between accessibility and ease of play on the one hand, and freedom of expression and mastery on the other hand, is a prime challenge to the design of music-based games. These attributes shape how the player perceives the game at first sight and how long it is able to keep up interest over time.

Play as Performance

Performance is connected to a distinct role in making music, the musician. A common trait of musical instruments is that they can be played live. Music-based games can also be played in front of a crowd in a musical performance. It was already mentioned that *Electroplankton* has been used for live performances by its creator Toshio Iwai. Some music-based games can even be used together with other instruments in a live setting.

Performance has a different meaning for rhythm-based games, especially for those that use instrument peripherals. In accordance with Steven Poole's previous comment that sports games simulate a TV broadcast of the particular sport, many rhythm-based games simulate a live-performance on a home television screen. In *Guitar Hero* and in karaoke games, the player is actively encouraged to participate in this performance. When playing in front of a real audience, the player even transcends the boundary of the game's simulation shell and becomes a traditional performer. The karaoke game *SingStar* encourages players even more strongly to perform - their interpretations of songs can be recorded with the Playstation Eye camera and published online. This transcendence of play correlates to the term *real play* (Jahrmann, 2007) that signifies rules of play that are deliberately transferred from a game world to real life.

When a game is set in a performance environment, game concepts can be explained through that setting. It can explain game-over conditions (like the increasing boos from the crowd in *Guitar Hero*) or dedicated game mechanics like *Star Power*. Star Power is activated by abruptly raising the guitar to double the score multiplier. In *Guitar Hero: On Tour,* Star Power is activated by shouting into the DS' microphone. Both are flashy acts of performance used to access traditional game mechanics.

Summarized, instrumental and rhythm-based games feature aspects of performance. In instrumental games, performance is not part of the game but the game can be used as a performance instrument. In rhythm-based games, the player can decide to perform virtually or in the real world. Performance can also be used as a metaphor for gameplay actions, as exemplified by the use of Star Power in *Guitar Hero*.

Synaesthesia

Synaesthesia is a neurological condition restricted to children and a small number of affected adults, called synaesthetes (van Campen, 2008). In games and art shaped by its distinct style, the synaesthetic perception is simulated for recipients. Synaesthesia has a great influence on both music and the visual arts, and can be artfully transferred to games. The game Rez best illustrates this. By tight synchronization of acoustic and visual traits and the addition of haptic feedback, synaesthesia connects with gameplay, player immersion, and game flow. As such, it can be understood as a concept supporting gameplay. Tetsuya Mizuguchi claims to further the reception of music by interconnecting it with visuals and, more importantly, by involving the recipient (the player) through added interactivity, "[..] how can we create a groove interactively? This is the basic core of the game design, the basic response" (Mizuguchi, 2007).

Summarized, synaesthesia simulates an audiovisual perception normally constrained to synaesthetes. It combines the game's acoustic and visual dimensions with player interactions, thereby furthering game flow and player immersion.

Narrative

Narrative can convey real or realistic stories. As illustrated by the comic-based narratives of *Elite Beat Agents* and *Parappa the Rapper*, story embeds the game in a lifelike context. Narrative also supports gameplay by setting the scene for the game's mechanics and paradigms, as discussed in the context of play as performance and *Guitar Hero*.

Summary

The player's perception of a music-based game as a simulation depends on various factors that are all difficult to analyze in isolation. Instrumental play is closely related to how real instruments are constituted and players expect instrumental play to permit creative play and freedom of expression. These aspects are closely related to the interface of the game or instrument (see below). Seemingly contradicting this, players also want to play a game and expect safeguards and accessible play that yields immediate results. Bridging these expectations is the vital balancing act between simulation and gameplay.

Performance emotionally connects the player with the interface. The bodily experience of a music-based game furthers realism and player immersion. The design principle of synaesthesia simulates a distinct style, already established in the visual arts. Narrative is a design principle that does not directly allow for a distinction between simulation and gameplay. Instead it serves as a means of setting the scene for both the simulation and gameplay aspects of a game.

The Instrument

This section analyzes music-based games as instruments. Previous sections described how music is represented in games and what instrumental play means to the player. Consequently, this section regards how instrumental play manifests itself in the interface. For this purpose, the presented view encompasses the design principles of kinaesthetic play, gestures, and sound agents and also discusses the many instrument peripherals available for music-based games. Additionally, quantization as a means of shaping musical results is analyzed later in this section.

The Interface

Rhythm-based games have spawned a huge number of instrument peripherals. In a sense, all peripherals serve the same purpose - they replace button presses on a game controller with a rhythmical input device. The devices themselves are diverse but all use the original purpose of an instrument as a metaphor for the more abstract ways the peripherals are used in the context of games. The maracas in *Samba De Amigo* must be shaken to the beat of the music but the force of the movement made is not relevant as long as a certain threshold is reached. The guitar controller used for *Guitar Hero* abstracts the strings of a guitar to five buttons and strumming to a rocker switch that can be triggered from two directions.

Gestural interfaces in music-based games can be based on two different concepts. First, they can be based upon real dynamic systems and their rules. The resulting interaction with the system is then transferred to the musical parameters of the game's logic. The above-quoted example of *Thumbtack* is representative for this type of gestural interaction. As the player applies gestures like catch, throw, drag, and drop, he or she prompts movements of the four widgets that occur according to the simulation of physics implemented in the game. When the widgets collide, sounds are triggered depending on the color of the widget. Musical output is controlled indirectly through interaction with the widgets. Similarly. the planktons in *Electroplankton* mediate between player gestures and musical output. In *Hanenbow,* the player controls the angle of the leaves of a plant and the emission of planktons that bounce between these leafs, triggering instrumental samples. Secondly, control metaphors for gestural interfaces can be drawn from instruments. The interaction in *Electroplankton*'s *Marine-Snow* (see the picture below) is inspired by stringed instruments and allows sweeping across several strings or picking each one individually.

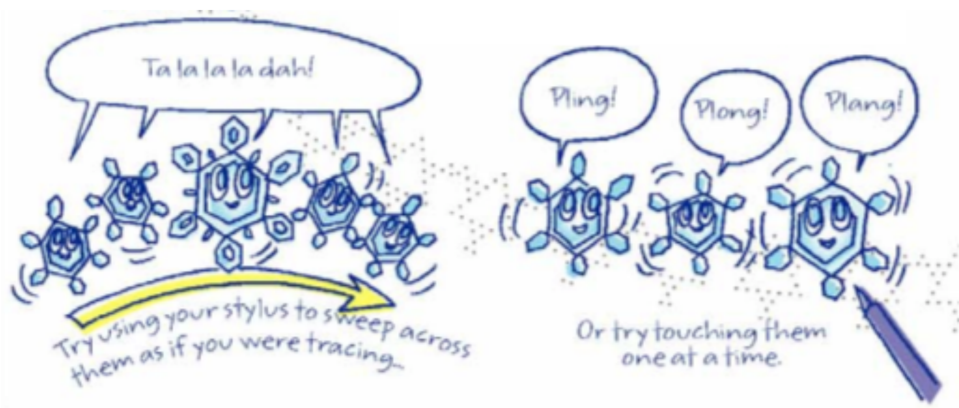

Fig. 60: Interaction with the Marine-Snow game as detailed in the manual to Electroplankton

In a similar way, spinning the *Lumiloop* planktons to trigger continuous sounds is reminiscent of singing bowls or the rubbing of wine glasses to produce resonant sounds.

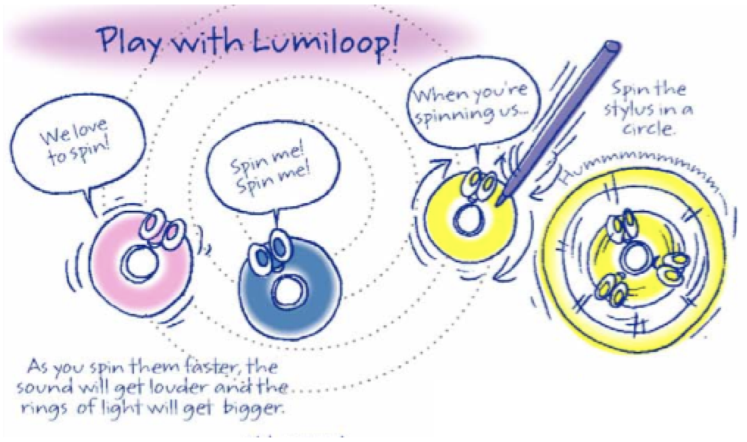

Fig. 61: The manual page describing the Lumiloop plankton.

In context with the above examples of gestural interaction, sound agents (like *Planktons* or *Thumbtacks*) play an important role. They link notation and active scores to instruments and their related gestures, thereby establishing a physical, kinaesthetic link between musical interaction and the game world.

The interface defines to a great extent the possibilities of a music-based game. All interfaces analyzed during the course of this work rely on a core metaphor that makes the game accessible. Rhythm-based game peripherals are, more or less, game controllers that have the physicality of an instrument combined with fixed and very abstract gestures for playing. Their physicality retains the kinaesthetic quality of their instrumental archetypes.

Gestural instrumental games have more malleable ways of interaction. Their interaction is also shaped by metaphors that support the abstract gestures used to control the game. Metaphors can be taken from the simulation of dynamic systems, the representation of an instrument, or by mediating between interaction paradigms related to an instrument and a differing visual representation in the game world.

Quantisation

A physical "instrument" that comes to mind in the context of quantization is the hurdy-gurdy, an old music box that operates by turning a crank. In the chapter on music-based games history, Toshio Iwai's affiliation with punch cards was described. These cards, punched in reference to a grid, implicitly ensure quantized rhythmic output.

Similarly, some music-based games ensure quantization implicitly through the simulated environment. The grid alignment in *Sim Tunes* and *Thumbtack*'s widgets travelling at fixed speeds are examples of implicit quantization. In sequencer software, quantization is ensured implicitly. *MicPlay* and *PetroriOn* are both instrumental games that partially rebuild the functionality of sequencer software, thus ensuring quantized results. The last group of games uses quantization strictly as an unexplained gameplay element. *Rez*, *Otocky*, and *Radiolaris* all quantize samples and gameplay events as a challenge to the player.

It is difficult to talk about "simulating" quantization. Often an implicit quality of a musical environment, quantization is a means of supporting rhythm. If not implicit to the environment, quantization can be added to ensure euphonic results and enhance gameplay.

Summary

This section looked at the manifestation of musical interaction at the interface. Musical instruments have an interface; and instrumental interfaces are presented to players in music-based games. The range of interfaces is diverse. Rhythm-based games present very strong simulations of the visual and haptic traits of instruments by using a wide range of peripherals. Yet their gameplay is a strongly abstracted version of actually handling a real instrument. Games that feature instrumental play provide more depth of interaction. The analyzed examples show that free-form play can be achieved by simulating dynamic systems that provide lively experiences and emergent gameplay, or through the use of active scores and sound agents. Simulating instruments, be it the mapping of physical instruments to a different interface or using the traits of electronic instruments like sequencers, provides for games with an instrumental character.

The depth of gameplay in dynamic systems and the instrumental character of music-based games are manifested by the use of adequate instrumental metaphors. The means of interaction are translated to the player through the use of gestures relying on these metaphors.
Quantization, seldom an implicit trait of physical instruments but a frequent attribute of software instruments, is used to provide a safety net and is thus a concession to gameplay that renders music-based games more accessible.

Conclusion

Organizing the design principles and analyzing their significance for simulation and gameplay leads to a distinction between playing music and playing games. This is not a differentiation of genres but a distinction between two modes of play.

playing music	***playing games***
generally in instrument games and non-games / toys	generally in sonification games & rhythm-based games
freedom of musical expression	generally constrained to linear reproduction
play is unstructured and open-ended	play is structured and goal-oriented
primary form of play is *paidia*	primary form of play is *ludus*
more other design principles are involved	fewer design principles are involved
appeals to a niche demographic	appeals to a mainstream demographic
player can act as a real performer	player acts as a "wannabe" performer
simulation-oriented (regarding music)	gameplay-oriented (regarding music)
gameplay-oriented (regarding interfaces)	simulation-oriented (regarding interfaces)

Fig. 62: A table[95] *detailing the differentiation between playing music and playing games*

It is apparent that most design principles support both simulation and gameplay aspects. When designing for gameplay and simulation, the decisions made by a designer can be compared to operating a crossfader. Pure simulations are devoid of designed gameplay. Games require concessions to be accessible and enjoyable. In the figure below, the *simulation space* represents the traits of the simulated, and the *design space* contains attributes shaped by intuition, good practice, and traditional game design culture.

95 The claim that playing games appeals more to a mainstream demographic than playing music is in reference to the much larger number of rhythm-based games sold than of other music-based games. Ten of the 100 top-selling video games of 2007 are music-based games, nine of them are rhythm-based games and the 10th is a version of *SingStar*. See the Edge-Online article for the complete list: http://www.edge-online.com/features/the-top-100-selling-games-last-12-months?page=0%2C0 [Accessed 12/05/08]

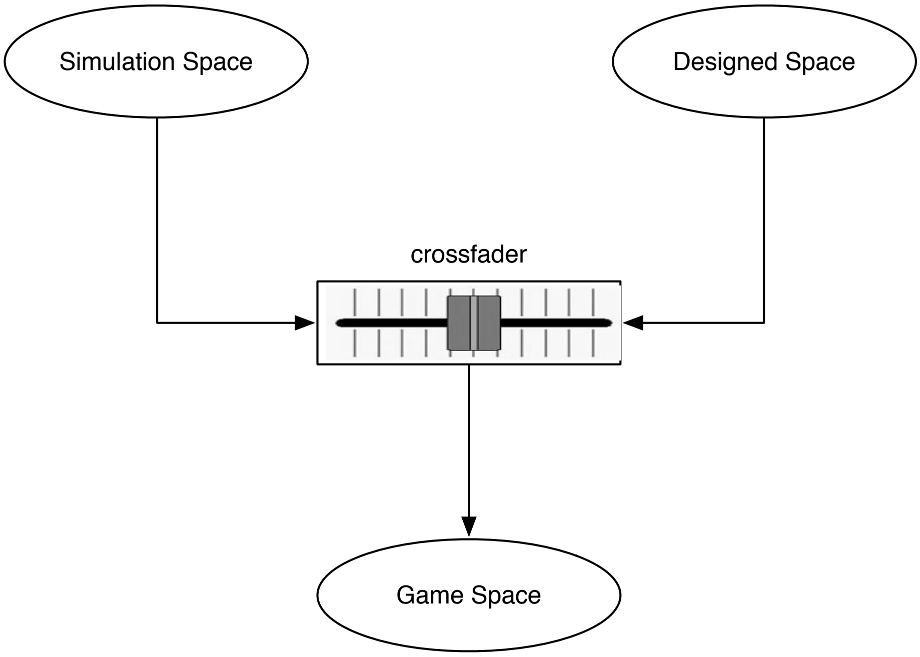

Fig. 63: A visualization of the balance between decisions driven by design and simulation considerations.

This balance between game design and simulation manifests in various ways. In some music-based games, the simulation is scaled to support the shadowing of scruffy aspects of reality and emphasize spectacular moments. A prime example is the reduction of sex, drugs, and rock'n'roll to plain rock in *Guitar Hero*. While the former two are omitted, the game highlights difficult guitar solos that are frenetically cheered or relentlessly booed by a virtual crowd while the player spectacularly raises the guitar to activate star power. In games with intensive sonification like *Rez*, *Wipeout HD*'s (SCE Studio Liverpool, 2008) *zone mode,* and *freQuency*, player immersion even reaches a level similar to drug-induced or meditative mental states. In other games, simulation is scaled to support gameplay. Examples are frequency-scale quantization (no disharmonious notes can be played), time-scale quantization (no arrhythmic notes can be played), and abstract instrument peripherals.

Summarized, the act of designing music-based games and game design in general can be seen as a balancing act between allowing freedom of expression and constraining the game space to ensure accessibility.

Summary

> "[...] Harmonix is thinking of ways to actually have players be musicians instead of just pretending. Rigopulos categorizes music games today largely as 'performance simulations', but few actually give people the opportunity to create music. 'There's some untapped potential in having freestyle and creative elements in games', says Rigopulos, calling that area an exciting part of Harmonix's current R&D efforts."
> (Graft, 2007)

This thesis is an analysis of music-based games from a design perspective. As illustrated by the above quote, music-based games are situated at the crossroads of playing a game and playing music. Ideally, their design enables them to provide players with a musical experience and instrumental play while maintaining the playful and accessible context of a game.

The defined terminology provides a better comprehension of the use of sound and music in games, which consequently facilitates the definition of music-based games design principles. The results of a qualitative analysis of representative commercial games and several experimental prototypes have allowed me to establish a terminology for design principles of music-based games. By highlighting the principles of *synaesthesia, kinaesthesia, play as performance, quantization, gestures, active scores, sound agents, instrumental play,* and *rhythm action*, an understanding of how music-based games are influenced by traditional game design and musical instruments and styles has emerged.

The principles listed above also lead to insights on how music-based games employ simulation. In Kayali & Purgathofer (2008), a method of describing sports video games according to their degree of deviation from reality was developed. For music-based games, a similar distinction can be made between games with an instrumental character and games that focus on rule-based gameplay. The differences between simulation-driven and gameplay-driven design decisions do not apply to sports videogames and music-based games alone. The acts of 'playing games' and 'free-form playing' (as in 'playing music') are significant for game design in general. Further research into this topic could yield interesting results on the balance between simulation, traditional gameplay, and playful fiction in the design of digital games.

Understanding the technical and theoretical foundations of video game design is vital to game studies and computer science alike. On the one hand, because video games steadily push technology forward through their use of cutting-edge graphics and high-fidelity audio, and on the

other hand because music distribution is shifting from physical stores to digital distribution, which also takes place within game frameworks. To expand upon this research from a technical perspective, frameworks that embed game audio in relation to interactivity should be explored.

There are many intuitive ways to devise musical interaction that allow players to experience music through game flow rather than having to learn the rules and acquire the skills necessary to play a real instrument. This is something that video gamers have always yearned for – obtaining gratification though the illusion of control over a real world subject while reaching to attain a satisfying degree of mastery. This may be the skillful steering of a Formula 1 car to victory through the narrow turns of the Monaco Grand Prix, showing off your smashing skills with a tennis racket in Wii Sports, or impressing the audience with euphonic mastery of a physical instrument in a music video game.

“

T. Mizuguchi: My suggestion for game designers is that game designers should understand, what is the essence of music, from the point of view of a music player or DJ or listener. Everybody enjoying music, but in a different way -- the first-person point of view or a third-person point of view. What is music? Music has many elements, so how can we cut and separate and remake the parts in the process of game design? So then, game designers have to know what is fun, what is the essence of music?

M. Matsuura: Essence of music, I don't know. I really don't understand the essence of music. I've been composing music for thirty years, and I still don't understand what music is. But I'm still looking for the certain shape of my music. Anybody who can define the existence of music, I really respect.

T. Mizuguchi: Yeah, I agree with you. Music is like a universe -- many, many elements. Lyrics, chords, rhythm, beats, playing, listening. Emotionally, you feel something. When I was 11 years old, I listened to my first Beatles music. I couldn't understand English, but I felt emotion or something, sort of… I want to love somebody! It's the power of music, of chords… very physical things, very emotional things. Not logic - - I don't know, maybe logic. If I understand the lyrics, and it's a new chemistry. Music, we have a long history with music, but new music is coming still. I don't know why. It's a universe. Amazing.

“

(Game designers Tetsuya Mizuguchi and Masaya Matsuura in an interview with Kohler, 2008)

Related publications

Kayali, F. & Purgathofer, P. 2008, 'Two Halves of Play - Simulation versus Abstraction and Transformation in Sports Videogames Design', forthcoming in, *Sports and Media (preliminary title)*, ICFAI university press, Hyderabad, India.

Kayali, F. & Pichlmair, M. 2008, 'Playing Music, Playing Games - Simulation vs. Gameplay in Music-based Games', paper presented to the *Vienna Games Conference 2008 'Future and Reality of Gaming' (FROG)*, Vienna, October 17th-19th, 2008.

Kayali, F. & Pichlmair, M. 2008, 'Intentions, Expectations and the Player', paper presented to the *[player] conference, 2008*, Kopenhagen.

Kayali, F., Pichlmair, M. & Kotik, P. 2008, 'Mobile Tangible Interfaces as Gestural Instruments', paper presented to the *5th International Music Workshop 2008*, Vienna, Austria, 05/13/08-05/16/08.

Kayali, F. & Purgathofer, P. 2008, 'Two Halves of Play - Simulation versus Abstraction and Transformation in Sports Videogames Design', *Eludamos. Journal for Computer Game Culture*, vol. 2, no. 1.

Pichlmair, M. & Kayali, F. 2007, 'Levels of Sound: On the Principles of Interactivity in Music Video Games', paper presented to the *Digital Games Research Association 2007 Conference - Situated play*, Tokyo, Japan, 09/24/07-09/28/07.

Kayali, F. 2007, 'Gestural Interaction in Music Video Games', paper presented to the *Digital Games: Theory and Design*, Brunel University, London.

Kayali, F. 2005, 'Sonic~Image, Audiovisual Synchronisation at Live Performances', poster presented to the *Hyperkult XIV conference "AudioKult und Hypersound? Ästhetik und Kultur digitaler Audiomedien"*, Lüneburg, Germany, 06/14-06/16 2005.

Kayali, F. 2004, 'Sonic~Image, Audiovisuelle Synchronisation bei Liveperformances', Master thesis, Vienna University of Technology., Vienna, Austria.

Bibliography

Aarseth, E. 1997, *Cybertext: Perspectives on Ergodic Literature*, Johns Hopkins University Press.

Aarseth, E. 2003, 'Playing Research: Methodological approaches to game analysis', paper presented to the *Game Approaches Conference*, Spilforskning, Denmark, 08/28/03 - 08/29/03.

Aarseth, E. 2007, 'I Fought the Law: Transgressive Play and The Implied Player ', paper presented to the *Digital Games Research Association 2007 Conference - Situated play*, Tokyo, Japan.

Abbado, A. 1988, 'Perceptual Correspondences of Abstract Animation and Synthetic Sound', Master thesis, Boston.

Archambault, D. & Burger, D. 2000, 'TIM (Tactile Interactive Multimedia): Development and adaptation of computer games for young blind children', paper presented to the *ERCIM WG UI4ALL & i3 Sping Days 2000 Joint workshop, Interactive Learning Environments for Children*, Athens, Greece.

Aristotle 335 BC, 'Poetics'.

Aristotle 1984, 'Poetics', in J. Barnes (ed.), *The Complete Works of Aristotle: The Revised Oxford Translation*, Princeton University Press, Princeton.

Bajakian, C., Battino, D. & Charley, K. 2003, 'Group Report: What is Interactive Audio? And What Should It Be? ', *The Eighth Annual Interactive Music Conference Project Bar-B-Q.*, <http://www.projectbarbq.com/bbq03/bbq03r5.htm> [Accessed 12/05/08].

Björk, S., Lundgren, S. & Holopainen, J. 2003, 'Game Design Patterns', paper presented to the *Level Up- 1st international Digital Games Research Conference*, Utrecht.

Boellstorff, T. 2006, 'A Ludicrous Discipline? Ethnography and Game Studies', *Games and Culture*, vol. 1, no. 1, pp. 29-35.

Bogost, I., Mateas, M., Murray, J. & Nitsche, M. 2005, 'Asking What Is Possible: The Georgia Tech Approach to Game Research and Education ', *The International Digital Media & Arts Association Journal*, vol. 2, no. 1, pp. 59-68.

Brougher, K., Strick, J., Wiseman, A. & Zilczer, J. 2005, *Visual Music: Synaesthesia in Art and Music Since 1900*, Thames & Hudson, London.

Bruno, A. 2008, 'Rock Band, Guitar Hero drive digital song sales', *Reuters*, <http://www.reuters.com/article/technologyNews/idUSN1934632220080120> [Accessed 12/05/08].

Burdick, A. 2003, 'Design (as) Research', in B. Laurel (ed.), *Design Research: Methods and Perspectives*, MIT Press.

Buxton, B. 2007, *Sketching User Experiences*, Morgan Kaufmann, San Francisco, California.

Buxton, W.A.S. 1995, 'Chunking and phrasing and the design of human-computer dialogues', in, *Human-computer interaction: toward the year 2000*, Morgan Kaufmann Publishers, San Francisco, pp. 494-499.

Caillois, R. 2001 [1958], *Man, Play ,Game*, University of Illinois Press, Chicago.

Campen, C.v. 2008, *The Hidden Sense - Synesthesia in Art and Science*, The MIT Press, Cambridge, Massachusetts, London, England.

Carlsson, A. 2008, 'Chip music: low-tech data music sharing', in K. Collins (ed.), *From Pac-Man to Pop Music - Interactive Audio in Games and New Media*, Ashgate Publishing, Burlington, USA.

Carr, N. 2001, 'An Interview with Chris Huelsbeck', *remix64.com*, <http://www.remix64.com/interview_chris_huelsbeck.html> [Accessed 12/05/08].

Chen, J. 2007, 'Flow in Games (and Everything Else)', *Communications of the ACM*, vol. 50, no. 4, pp. 31-34.

Chion, M. 1994, *Audio-Vision: Sound on Screen*, Columbia University Press, New York.

Chion, M. 1995, *Guide des objets sonores: Pierre Schaeffer et la recherche musicale*, Paris: Buchet/Chastel: Institut national de la communication audiovisuelle.

Chion, M. 2008, 'Simultaneity and Synchronicity in Cinematic Audio-Visual Relations', talk presented to the *Utopia of Sound*, Academy of Fine Arts Vienna.

Coleman, G.W., Hand, C., Macaulay, C. & Newell, A.F. 2005, 'Approaches to auditory interface design - lessons from computer games', paper presented to the *2005 International Conference on Auditory Display*, Limerick, Ireland, July 6-9, 2005.

Coleridge, S. 1817, 'Biographia Literaria', in H.J. Jackson (ed.), *Samuel Taylor Coleridge*, Oxford (1985).

Collins, K. 2007, 'An Introduction to the Participatory and Non-Linear Aspects of Video Game Audio', in S. Hawkins & J. Richardson (eds), *Essays on Sound and Vision*, Helsinki University Press, Helsinki.

Csikszentmihalyi, M. 1990, *Flow: the psychology of optimal experience*, Harper, New York.

Csikszentmiyalhi, M. 1975, *Beyond Boredom and Anxiety*, Jossey-Bass, San Francisco, CA.

Debatty, R. 2006, 'Insects and pianos: Toshio Iwai's talk at Futuresonic', *we make money not art*, <http://www.we-make-money-not-art.com/archives/2006/07/i-dont-like-it.php> [Accessed 12/05/08].

Douglas, J.Y. & Hargadon, A. 2001, 'The pleasures of immersion and engagement: schemas, scripts and the fifth business', *Digital Creativity*, vol. 12, no. 3, pp. 153–166.

Dufallo, R. 1989, *Trackings*, Oxford University Press, New York.

Edge 2007, 'Rez', in, *Edge presents The Art of Videogames*, vol. 1, Future Publishing, Bath, pp. 8-11.

Edge 2008a, 'Interview: Rock Brand', in vol. 189, Future Publishing, Bath, pp. 12-13.

Edge 2008b, 'Worlds of Sound - industry experts talk game audio and why it needs its own revolution', *Edge*, pp. 76-81.

EGM 2007, 'Interview with Tetsuya Mizuguchi', *Electronic Gaming Monthly*, vol. May 2007.

Ekman, I., Ermi, L., Lahti, J., Nummela, J. & Lankoski, P. 2005, 'Designing Sound for a Pervasive Mobile Game', paper presented to the *Digital Games Research Association 2005 Conference - changing views: worlds in play*, Vancouver.

Elias, J.G. 2007, 'Multi-Touch Gesture Dictionary', *United States Patent Application*, <http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.html&r=1&f=G&l=50&s1=%2220070177803%22.PGNR.&OS=DN/20070177803&RS=DN/20070177803> [Accessed 12/05/08].

Fahey, R. 2008, 'Q Entertainment's Tetsuya Mizuguchi ', *eurogamer.net*, <http://www.eurogamer.net/article.php?article_id=149982> [Accessed 12/05/08].

Farnell, A. 2007, 'An introduction to procedural audio and its application in computer games', *Gamessound.com*, <http://obiwannabe.co.uk/html/papers/proc-audio/proc-audio.pdf> [Accessed 12/05/08].

Fay, T.M.S., Scott & Fay, Todor J. 2004, *Directx 9 Audio Exposed: Interactive Audio Development*, Wordware Publishing, Texas.

Fingerhut, M. 2004, 'Music Information Retrieval, or how to search for (and maybe find) music and do away with incipits', paper presented to the *IAML-IASA Congress*, Oslo, Norway, August 8–13, 2004.

Frasca, G. 2003, 'Simulation versus narrative: Introduction to ludology', in M. Wolf & B. Perron (eds), *Video/Game/Theory*, Routledge, pp. 221-235.

Frasca, G. 2008, 'El simulatógrafo: una herramienta para crear juegos serios', paper presented to the *Homo Ludens Ludens Symposium*, Gijon, Spain.

Friberg, J. & Gardenfors, D. 2004, 'Audio games: new perspectives on game audio', paper presented to the *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in computer entertainment technology*, Singapore.

Fujihata, M., Furukawa, K. & Münch, W. 2000, 'Notes on Small Fish', in, *Catalog Ars Electronica 2000 - Next Sex*, Hatje Cantz Verlag, Germany.

Fullerton, T., Swain, C. & Hoffman, S. 2004, *Game Design Workshop: Designing, Prototyping, and Playtesting Games*, CMP Books.

Gedenryd, H. 1998, 'How designers work', PhD thesis, Lund University, Lund.

Gingold, C. 2005, 'What WarioWare can teach us about Game Design', *Game Studies – the international journal of computer games research*, vol. 5, no. 1.

Graft, K. 2007, 'Harmonix on Rock Band and Beyond', *Next Generation - Home of Edge Online*, <http://www.next-gen.biz/index.php?option=com_content&task=view&id=7570&Itemid=50> [Accessed 12/05/08].

Grimshaw, M. 2007a, 'The Acoustic Ecology of the First-Person Shooter', PhD thesis, University of Waikato, New Zealand.

Grimshaw, M. 2007b, 'Sound and Immersion in the First-Person Shooter', paper presented to the *The 11th International Computer Games Conference*, La Rochelle.

Grimshaw, M. & Schott, G. 2007, 'Situating Gaming as a Sonic Experience: The acoustic ecology of First-Person Shooters', paper presented to the *Digital Games Research Association 2007 Conference - Situated play*, Tokyo, Japan.

Grimshaw, M. & Schott, G. 2008, 'A Conceptual Framework for the Analysis of First-Person Shooter Audio and its Potential Use for Game Engines', *International Journal of Computer Games Technology*, vol. 2008.

Grossenbacher, P. & Lovelace, C. 2001, 'Mechanisms of synesthesia: cognitive and physiological constraints', *Trends in Cognitive Science*, vol. 5, no. 1, pp. 36-41.

Grünvogel, S. 2005, 'Formal Models and Game Design', *Game Studies*, vol. 5, no. 1.

Gun, T. 2006, 'Why we play Guitar Hero instead of "the real thing."', *Cracked Rabbit Gaming*, <http://crackedrabbitgaming.com/2006/10/12/why-we-play-guitar-hero-instead-of-the-real-thing/> [Accessed 12/05/08].

Gun, T. 2008, 'Elite Beat Agents Note Chart: Jumpin' Jack Flash - Sweatin'', *Cracked Rabbit Gaming*, <http://crackedrabbitgaming.com/guides/ds/elite-beat-agents/jjf-sweatin/> [Accessed 12/05/08].

Herber, N. 2008, 'The composition-instrument: emergence, improvisation and interaction in games and new media', in K. Collins (ed.), *From Pac-Man to Pop Music - Interactive Audio in Games and New Media*, Ashgate Publishing, Burlington, USA.

Hornecker, E. 2004, 'Tangible User Interfaces als kooperationsunterstutzendes Medium', PhD thesis, Universitaet Bremen, Bremen.

Huiberts, S. & van Tol, R. 2008, 'IEZA: A Framework For Game Audio', *Gamasutra*, <http://www.gamasutra.com/view/feature/3509/ieza_a_framework_for_game_audio.php?print=1> [Accessed 12/05/08].

Huizinga, J. 1938, *Homo Ludens: A Study of the Play Element in Culture*, Routledge London.

Hunicke, R., LeBlanc, M. & Zubek, R. 2004, *MDA: A Formal Approach to Game Design and Game Research*, <http://www.cs.northwestern.edu/~hunicke/MDA.pdf> [Accessed 12/05/08].

ICC 2006, 'IWAI Toshio - Biography ', <http://www.ntticc.or.jp/Biography/Iwai_t/> [Accessed 12/05/08].

Iwai, T. 1993, 'A Short History of the Works', <http://museum.doorsofperception.com/doors1/transcripts/iwai/iwai.html> [Accessed 12/05/08].

Iwai, T. 2001, 'Piano--As Image Media', *Leonardo*, vol. 34, no. 3, p. 183.

Iwai, T. 2006a, 'Beyond Media, Connecting Senses', in, *Catalog Ars Electronica 2006 – Simplicity The Art Of Complexity*, Hatje Cantz Verlag, Germany.

Iwai, T. 2006b, 'Toshio Iwai keynote at Futuresonic', *Pixelsumo*, <http://www.pixelsumo.com/post/toshio-iwai-futuresonic> [Accessed 12/05/08].

Iwai, T. & Sakamoto, R. 1997, 'Music Plays Images X Images Play Music', in, *Catalog Ars Electronica 1997 – Fleshfactor*, Hatje Cantz Verlag, Germany.

Jahrmann, M. 2007, 'Real Player Manifesto', *Eludamos. Journal for Computer Game Culture*, vol. 1, no. 1.

Jahrmann, M. & Moswitzer, M. 2003, 'nybble-engine-toolZ A radical meta-art system shooter ', in, *Catalog Ars Electronica 2003 - Code*, Hatje Cantz Verlag, Germany.

Janis, S. 2005, 'Quantized Culture', *Link, A Critical Journal on the Arts*, vol. 10 "CUT".

Järvinen, A. 2002, 'Gran Stylissimo: The Audiovisual Elements and Styles in Computer and Video Games', paper presented to the *Computer Games and Digital Cultures Conference*, Tampere.

Järvinen, A. 2008, 'Games without Frontiers: Theories and Methods for Game Studies and Design', PhD thesis, University of Tampere, Finland.

Jenkins, H. 2005, 'Games, the New Lively Art', in J. Raessens & J. Goldstein (eds), *Handbook of Computer Game Studies*, MIT Press, Massachusets.

Jeriaska 2008, 'PixelJunk Eden art and music: Baiyon Interview', *Sliconera.com*, <http://www.siliconera.com/2008/09/27/pixeljunk-eden-art-and-music-baiyon-interview/> [Accessed 12/05/08].

Jones, K. 1991, 'Dicing with Mozart', *New Scientist* no. 132, pp. 26-29.

Jordà, S. 2003, 'Interactive Music Systems For Everyone: Exploring Visual Feedback As a Way for Creating More Intuitive, Efficient And Learnable Instruments', paper presented to the *Stockholm Music Acoustics Conference (SMAC03)*, Stockholm, Sweden.

Jordà, S. 2004, 'Digital instruments and players: part I --- efficiency and apprenticeship', paper presented to the *Proceedings of the 2004 conference on New interfaces for musical expression*, Hamamatsu, Shizuoka, Japan.

Jordà, S. 2005, 'Digital Lutherie - Crafting musical computers for new musics’ performance and improvisation', PhD thesis, Universitat Pompeu Fabra, Barcelona.

Jordà, S., Kaltenbrunner, M., Geiger, G. & Bencina, R. 2005, 'The reacTable*', paper presented to the *International Computer Music Conference (ICMC 2005)*, Barcelona, Spain.

Jørgensen, K. 2007, '‘What are Those Grunts and Growls Over There?’ Computer Game Audio and Player Action', PhD thesis, Copenhagen University, Copenhagen.

Juul, J. 2005a, *Half-Real - Video Games between Real Rules and Fictional Worlds*, MIT Press, Massachusetts.

Juul, J. 2005b, 'Games Telling Stories?', in J. Raessens & J. Goldstein (eds), *Handbook of Computer Game Studies*, MIT Press, Massachusets.

Juul, J. 2007, 'A Certain Level of Abstraction', paper presented to the *DiGRA 2007 International Conference - Stituated Play*, The University of Tokyo, Tokyo.

Kaltenbrunner, M., Geiger, G. & Jordá, S. 2004, 'Dynamic patches for live musical performance', paper presented to the *Proceedings of the 2004 conference on New interfaces for musical expression*, Hamamatsu, Shizuoka, Japan.

Kendon, A. 1990, *Conducting Interaction: Patterns of behavior in focused encounters*, Cambridge University Press, Cambridge.

Kikizo 2007, 'Nintendo Interview: Koji Kondo', *Kikizo*, <http://games.kikizo.com/features/koji_kondo_iv_p1.asp> [Accessed 12/05/08].

Klepek, P. 2007, '1UP Interviews PaRappa's Dad, Masaya Matsuura', *1up.com*, <http://www.1up.com/do/newsStory?cId=3161867> [Accessed 12/05/08].

Kohler, C. 2008, 'Interview: Mizuguchi and Matsuura, Music Gaming Geniuses', *Wired*, <http://blog.wired.com/games/2008/02/interview-miz-1.html> [Accessed 12/05/08].

Kungel, R. 2004, *Filmmusik für Filmemacher - Die richtige Musik zum besseren Film*, Mediabook Verlag, Gau-Heppenheim.

Kuphaldt, T. 2007, 'SID 6581 / 8580', *Commodore Computer Online Museum*, <http://cbmmuseum.kuto.de/zusatz_6581_sid.html> [Accessed 12/05/08].

Kurtz, G. 1998, 'Games and Instruments: Two Ways to Play', *Gamasutra*, <http://www.gamasutra.com/features/19980605/kurtz_01.htm> [Accessed 12/05/08].

Kusek, D. & Leonhard, G. 2005, *The Future of Music - Manifesto for the Digital Music Revolution*, Berklee Press, Boston.

LaBounta, H., Gingold, C., Townsend, J., Gray, K., Buchanan, J. & Caballero, V. 2007, 'Rapid prototyping: visualizing new ideas', paper presented to the *Proceedings of the 2007 ACM SIGGRAPH symposium on Video games*, San Diego, California.

Lakoff, G. & Johnson, M. 2003, *Metaphors We Live By*, The University of Chicago Press, Chicago.

Lammes, S. 2007, 'Approaching game-studies: towards a reflexive methodology of games as situated cultures ', paper presented to the *Digital Games Research Association 2007 Conference - Situated play*, Tokyo, Japan.

Laurel, B. 1991, *Computer as theatre*, Addison Wesley, London.

Laurel, B. 2003, *Design Research: Methods and Perspectives*, MIT Press.

Levin, G. 2000, 'Painterly Interfaces for Audiovisual Performance', master thesis, Massachusetts Institute of Technology.

Lindley, C.A. 2005, 'The Semiotics of Time Structure in Ludic Space As a Foundation for Analysis and Design', *Game Studies*, vol. 5, no. 1.

Marschner, M. 2008, 'Foundations for Music-Based Games', Master thesis, Vienna University of Technology, Vienna.

Matsuura, M. 2008, 'A Sense of Fun: Anybody Could Be Your Player 1', *Gamasutra*, <http://www.gamasutra.com/view/feature/3806/a_sense_of_fun_anybody_could_be_.php?print=1> [Accessed 12/05/08].

McCloud, S. 1993, *Understanding Comics - The Invisible Art*, HarperCollins, New York.

McDonald, G. 2004, 'A History of Video Game Music', *Gamespot*, <http://www.gamespot.com/features/6092391/index.html?tag=result;title;0> [Accessed 12/05/08].

McKenzie, W. 2004, *A Hacker Manifesto*, Harvard University Press, Cambridge, Massachusetts.

McKenzie, W. 2007, *Gamer Theory - Version 2.0*, Harvard University Press, Cambridge, Massachusetts.

Miller, P.D. 2004, *Rhythm Science*, MIT Press, Massachusetts.

Mitchell, G. & Clarke, A. 2007, 'Videogame Music: chiptunes byte back?', paper presented to the *Digital Games Research Association 2007 Conference - Situated play*, Tokyo, Japan.

Mizuguchi, T. 2005, 'Lumines - Press Release', *gamesindustry.biz*, <http://www.gamesindustry.biz/articles/tetsuya-mizuguchi> [Accessed 12/05/08].

Mizuguchi, T. 2007, 'Q&A: Every Extend Extra's Tetsuya Mizuguchi', *gamespot.com*, <http://www.gamespot.com/news/6164638.html?sid=6164638> [Accessed 12/05/08].

Mozart, W.A. 1793, *Anleitung so viel Walzer oder Schleifer mit zwei Würfeln zu componiren so viel man will ohne musikalisch zu seyn noch etwas von der Composition zu verstehen*, J.J. Hummel, Berlin-Amsterdam.

Newton, I. 1675, *An Hypothesis Explaining the Properties of Light*, <http://www.newtonproject.sussex.ac.uk/texts/viewtext.php?id=NATP00002&mode=normalized> [Accessed 12/05/08].

Noguchi, H. 1996, *Mozart: Musical game in C K.516f*, <http://www.asahi-net.or.jp/~rb5h-ngc/e/k516f.htm> [Accessed 12/05/08].

Nutt, C. & Sheffield, B. 2007, 'Expressing The Future: Tetsuya Mizuguchi', *Gamasutra*, <www.gamasutra.com/view/feature/3541/expressing_the_future_tetsuya_.php> [Accessed 12/05/08].

Pidkameny, E. 2002, 'Levels of Sound', *VGMusic.com*, <http://www.vgmusic.com/information/vgpaper2.html > [Accessed 12/05/08].

playstation.com 2004, 'Tetsuya Mizuguchi Interview ', <http://au.playstation.com/news/mizuguchiinterview.jhtml > [Accessed 12/05/08].

Poole, S. 2004, *Trigger Happy: Videogames and the Entertainment Revolution*, Arcade Publishing, New York.

Puckette, M. 1996, 'Pure Data', paper presented to the *International Computer Music Conference*, San Francisco.

Ramachandran, V. & Hubbard, E. 2001, 'Synaesthesia: A window into perception, thought and language', *Journal of Consciousness Studies*, vol. 8, no. 12, pp. 3-34.

Ratliff, E. 2003, 'Sports Rule! ', *Wired Magazine*, <http://www.wired.com/wired/archive/11.01/sports.html> [Accessed 12/05/08].

Röber, N. & Masuch, M. 2004, 'Interacting with Sound - An Interaction Paradigm for Virtual Auditory Worlds', paper presented to the *ICAD 04-Tenth Meeting of the International Conference on Auditory Display*, Sydney, Australia, July 6-9, 2004.

Röber, N. & Masuch, M. 2005, 'Playing Audio-Only Games: A Compendium of Interacting with Virtual, Auditory Worlds', paper presented to the *Digital Games Research Association 2005 Conference - changing views: worlds in play*, Vancouver.

Ruberg, B. 2006, 'MIGS Keynote: Gingold/Hecker On Spore Prototyping', *Gamasutra - The Art & Business of Game Development*, <http://www.gamasutra.com/php-bin/news_index.php?story=11628> [Accessed 12/05/08].

Rusch, D.C. 2007, 'Think Smooth! Challenges, Pleasures and Pitfalls of WarioWare: Smooth Moves', *Eludamos*, vol. 1, no. 1.

Sachs, C. & Hornbostel, E.M.v. 1914, 'Hornbostel-Sachs-Systematik', *Zeitschrift für Ethnologie* vol. 46, no. 1914 (4-5), pp. 553-590.

Salen, K. & Zimmerman, E. 2004, *Rules of play*, MIT Press, Cambridge, Massachusetts.

Sato, Y. 2007, 'Genki Rockets Headlines Live Earth ', *1up.com*, <http://www.1up.com/do/newsStory?cId=3160852> [Accessed 12/05/08].

Schaeffer, P. 1966, *Traité Des Objets Musicaux*, Seuil, France.

Schaeffer, P. 1966, 'Solfege de l'objet Sonore', <http://www.ubu.com/papers/schaefer_solfege.pdf> [Accessed 12/05/08].

Schneider, N.J. 1990, *Handbuch Filmmusik 1 – Musikdramaturgie im neuen deutschen Film*, Verlag Ölschläger, München.

Schnur, S. 2008, 'Games That Launched the Band', *GameCareerGuide.com*, <http://www.gamecareerguide.com/features/495/games_that_launched_the_.php> [Accessed 12/05/08].

Sheffield, B. 2008, 'Matsuura Got Rhythm: The State Of NanaOn-Sha's Founder - Interview with Masaya Matsuura', *Gamasutra*, <http://www.gamasutra.com/view/feature/3521/matsuura_got_rhythm_the_state_of_.php> [Accessed 12/05/08].

Shultz, P. 2008, 'Music theory in music games', in K. Collins (ed.), *From Pac-Man to Pop Music - Interactive Audio in Games and New Media*, Ashgate Publishing, Burlington, USA.

Simons, I. 2007, 'Book Excerpt: Inside Game Design: Harmonix Music Systems', *Gamasutra*, <http://www.gamasutra.com/view/feature/2801/book_excerpt_inside_game_design_.php> [Accessed 12/05/08].

Smith, R. 2008, 'All the way to 11', *Edge*, pp. 72-77.

Spencer 2005, 'Otocky', *Siliconera.com*, <http://www.siliconera.com/otocky/> [Accessed 12/05/08].

Stapleton, A.J. 2005, 'Research as Design-Design as Research', paper presented to the *Digital Games Research Association 2005 Conference - changing views: worlds in play*, Vancouver.

Stockburger, A. 2006, 'The Rendered Arena: Modalities of Space in Video and Computer Games', PhD thesis, London Institute (LCC).

Tessler, H. 2008, 'The new MTV? Electronic Arts and 'playing' music', in K. Collins (ed.), *From Pac-Man to Pop Music - Interactive Audio in Games and New Media*, Ashgate Publishing, Burlington, USA.

Tolkien, J.R.R. 1966, 'On Fairy Tales', in, *The Tolkien Reader*, Ballantine Books, New York.

Toop, D. 2002, 'Life in Transit', in, *Sonic Process. A New Geography of Sounds*, Museu d'Art Contemporani de Barcelona and Actar, Barcelona.

Turing, A. 1936, 'On computable numbers, with an application to the Entscheidungsproblem', *Proceedings of the London Mathematical Society*, vol. 42, no. 2, pp. 230-265.

Weske, J. 2000, *Sound on the PC. Digital Sound and Music in Computer Games*, <http://www.tu-chemnitz.de/phil/hypertexte/gamesound/pcsound-main.html> [Accessed 12/05/08].

Wessel, D. & Wright, M. 2001, 'Problems and Prospects for Intimate Musical Control of Computers', paper presented to the *NIME '01: New interfaces for musical expression*, National University of Singapore, Singapore.

Westecott, E. 2008, 'Bringing the Body back into Play', paper presented to the *[player] conference, 2008*, Kopenhagen.

Whalen, Z. 2004a, 'Play Along - An Approach to Videogame Music', *Game Studies: the international journal of computer game research*, vol. 4.

Whalen, Z. 2004b, 'Play Along: Video Game Music as Metaphor and Metonomy', master thesis, University of Florida.

Whitmore, G. 2003, 'Design with Music in Mind: A Guide to Adaptive Audio for Game Designers', *Gamasutra*, <www.gamasutra.com/resource_guide/20030528/whitmore_01.shtml> [Accessed 12/05/08].

Williams, B.L. 2000, '2000 Leonardo New Horizons Award Finalist Toshio Iwai', <http://lea.mit.edu/gallery/gallery343/iwai2.html> [Accessed 12/05/08].

Williams, D. 2005, 'Bridging the Methodological Divide in Game Research', *Simulation & Gaming*, no. 36(4), pp. 447-463.

Wilson, D. 2008, 'Opinion: Grand Pianola Game Music', *Game Set Watch*, <http://www.gamesetwatch.com/2008/10/opinion_grand_pianola_game_mus.php> [Accessed 12/05/08].

Wittgenstein, L. 1984, *Tractatus logico-philosophicus. Tagebücher 1914 - 1916. Philosophische Untersuchungen: Band 1* Suhrkamp, Frankfurt am Main.

Wolf, M. 2003, 'Abstraction: An Untapped Potential', *IGDA online*, <http://www.igda.org/columns/ivorytower/ivory_Dec03.php> [Accessed 12/05/08].

Woolley, B. 1992, *Virtual Worlds: A Journey in Hype and Hyperreality*, Blackwell, Oxford.

Yoon, A. 2007, 'PS3 Fanboy interviews Everyday Shooter's Jon Mak', *PS3 Fanboy*, <http://www.ps3fanboy.com/2007/07/30/ps3-fanboy-interviews-everyday-shooters-jon-mak/> [Accessed 12/05/08].

Zacny, R. 2008, 'Excellence Never Goes out of Date', *The Escapist*, <http://www.escapistmagazine.com/articles/view/issues/issue_155/4985-Excellence-Never-Goes-out-of-Date> [Accessed 12/05/08].

Zielinski, S. 1996, 'Media Archaeology', *CTHEORY*, vol. ga111.

Zielinski, S. 2002, *Achäologie der Medien: Zur Tiefenzeit des technischen Hörens und Sehens*, Rowohlt Taschenbuch Verlag, Reinbek bei Hamburg.

Ludography

Aikman., Z., Tkach, J., Towns, W. & Maneri, A. 2008, *Synesthete*, (PC)

Alcorn, A. 1972, *Pong*, Atari (Arcade)

Atari 1974-1978, *Touch Me*, Atari (Handheld)

Atari 1980, *Tempest*, Atari (Arcade)

Baer, R.H. & Morrison, H.J. 1978, *Simon*, Milton Bradley (Handheld)

Bungie Studios 2001-2007, *Halo (series)*, Microsoft (XBox, XBox 360)

EA Canada 2005, *NBA Street V3*, EA Sports Big (multiplatform)

Factor 5 1987, *To Be On Top*, Rainbow Arts (C64)

Firaxis Games 2005, *Civilization 4*, 2K Games (PC)

Fitterer, D. 2008, *Audiosurf*, Valve Corporation (PC)

Genuine Games 2005, *50 Cent: Bulletproof*, Sierra Entertainment (multiplatform)

Ghostfire Games 2008, *Helix*, Ghostfire Games (Wii)

Harmonix Music Systems 2001, *FreQuency*, Sony Computer Entertainment (PS2)

Harmonix Music Systems 2005, *Guitar Hero*, Red Octane (PS2)

Harmonix Music Systems 2003, *Amplitude*, Sony Computer Entertainment (PS2)

Harmonix Music Systems 2004-2008, *Karaoke Revolution (series)*, Konami (multiplatform)

Harmonix Music Systems 2007, *Phase*, Harmonix Music Systems (iPod)

Harmonix Music Systems 2007-2008, *Rock Band (series)*, MTV Games (multiplatform)

Higinbotham, W. 1958, *Tennis For Two*, Brookhaven National Laboratory (oscilloscope)

id Software 1999, *Quake III*, Activision (PC)

Indies Zero 2005, *Electroplankton*, Nintendo (DS) iNiS 2005, *Osu! Tatakae! Ouendan!*, Nintendo (DS)

iNiS 2006, *Elite Beat Agents*, Nintendo (DS)

Intelligent Systems 2006, *WarioWare: Smooth Moves*, Nintendo (Wii)

Konami 1997-2002, *Beatmania (series)*, Konami (multiplatform)

Konami 1998-2008, *Metal Gear Solid (series)*, Konami (PS2, PS3)

Konami 1998-2008, *Dance Dance Revolution (series)*, Konami (multiplatform)

Konami 1999-2008, *Drum Mania (series)*, Konami (multiplatform)

Konami 1999-2088, *Guitar Freaks (series)*, Konami (multiplatform)

Konami 2008, *Rock Revolution*, Konami (multiplatform)

Konami Computer Entertainment Tokyo 2001-2008, *Pro Evolution Soccer (series)*, Konami (multiplatform)

Llamasoft 2007, *Space Giraffe*, Llamasoft (XBox 360)

Lucasfilm Games 1990, *Loom*, Lucasfilm Games (PC)

Maxis 2008, *Spore*, Electronic Arts (PC)

Maxis Software 1996, *Sim Tunes*, Maxis Software (PC)

Namco 2003, *Donkey Conga*, Nintendo (GC)

NanaOn-Sha 1996, *Parappa the Rapper*, Sony Computer Entertainment International (PS)

NanaOn-Sha 1999a, *UmJammer Lammy*, Sony Computer Entertainment (PS2)

NanaOn-Sha 1999b, *Vib Ribbon*, Sony Computer Entertainment (PS)

NanaOn-Sha 2001, *Parappa the Rapper 2*, Sony Computer Entertainment International (PS2)

NanaOn-Sha 2003, *Mojib Ribbon*, Sony Computer Entertainment (PS2)

NanaOn-Sha 2004, *Vib Ripple*, Sony Computer Entertainment (PS2)

NanaOn-Sha 2007, *Musika*, NanaOn-Sha (iPod)

Neversoft 2008, *Guitar Hero: World Tour*, Activision (multiplatform)

Nintendo 1985 - 2007, *Super Mario (series)*, Nintendo (multiplatform)

Nintendo 1986-2007, *The Legend of Zelda (series)*, Nintendo (multiplatform)

Nintendo 2008, *Wii Music*, Nintendo (Wii)

Nintendo EAD 2007, *Wii Fit*, Nintendo (Wii)

Nintendo R&D1 2006, *Rhythm Tengoku*, Nintendo (DS)

Nintendo EAD 1998, *The Legend of Zelda: Ocarina of Time*, Nintendo (GC)

Nintendo EAD 2006, *Wii Sports*, Nintendo (Wii)

Nintendo R&D1 2003-2006, *Wario Ware (series)*, Nintendo (multiplatform)

Okamoto, K. 1997, *Beatmania*, Konami (Arcade)

Omega 2004, *Every Extend*, Omega (PC)

Plato 2007, *Jam Sessions*, Ubisoft (DS)

Pyramid / Sony Computer Entertainment Japan Studios 2007, *Patapon*, Sony Computer Entertainment (PSP)

Q Entertainment 2004, *Lumines*, Bandai / Ubisoft (multiplatform)

Q Entertainment 2006a, *Lumines II*, Q Entertainment (multiplatform)

Q Entertainment 2006b, *Every Extend Extra*, Bandai / Buena Vista Games (PSP)

Q Entertainment 2007, *Every Extend Extra Extreme*, Q Entertainment (XBox 360)

Q Entertainment 2008, *Rez HD*, Sega (XBox 360)

Q Games 2008, *Pixeljunk Eden*, Q-Games / Sony Computer Entertainment (PS3)

Queasy Games 2007, *Everyday Shooter*, Sony Computer Entertainment (PS3)

Relentless Software 2005-2008, *Buzz! (series)*, Sony Computer Entertainment (multiplatform)

Rockstar North 2008, *Grand Theft Auto IV*, Rockstar Games / Capcom (multiplatform)

SCE Studio Liverpool 2008, *Wipeout HD*, Sony Computer Entertainment Europe (PS3)

Sedic 1987, *Otocky*, ASCII Corporation (NES)

Sega AM5 1995, *Sega Rally Championship*, Sega (Arcade)

Sonic Team 1999, *Samba de Amigo*, Sega (DC)

Sony London Studio 2004-2008, *Singstar (series)*, Sony Computer Entertainment (PS2, PS3)

Square Enix 1986 - 2004, *Dragon Quest (series)*, Square Enix (multiplatform)

Taito Corporation 1978, *Space Invaders*, Midway (Arcade)

Team Ico 2001, *Ico*, Sony Computer Entertainment (PS2)

Team Ninja 2004, *Ninja Gaiden*, Tecmo (XBox)

thatgamecompany 2007, *flOw*, Sony Computer Entertainment (PS3)

United Game Artists 1999, *Space Channel 5*, Sega (DC)

United Game Artists 2001, *Rez*, Sega (DC)

Valve Software 1998, *Half-Life*, Sierra Studios (PC)

Vicarious Visions 2008, *Guitar Hero: On Tour*, Activision (DS)

Virtual Music 1994, *Born to Rock*, IBM (PC)

Virtual Music 1995, *Quest for Fame*, IBM (PC)

Visual Concepts 2007, *NBA 2K8*, Take Two Interactive (multiplatform)

Warp 1997, *Real Sound: Kaze no Regret* Warp (Saturn)

Media

Huelsbeck, C. & Boecker, T. 2008, *Symphonic Shades "Huelsbeck in Concert"*, MAZ Sound Tools.

Sugiyama, K. 1986, *Dragon Quest I Symphonic Suite*, Aniplex.

Dipl.Ing. Fares Kayali

born on July 17th 1978 in Vienna, Austria

Lenaugasse 7/15, 1080 Vienna, Austria

++43 (0)676 9421442

http://fares.attacksyour.net/

fares.kayali@blackbox.net

current occupations:

[since 2008]	Academic advisor for the International Graduate College (IGC) in cooperation with SAE and Middlesex University
[since 2003]	Occasional national and international gigs as an audiovisual artist at parties, clubbings and concerts.
[since 2001]	Lecturer and scientific assistant at SAE College Vienna with the Web, Audio, Film and Game departments.

selected previous occupations and projects:

[2007]	Project associate at the Institute of Design and Assessment of Technology at the Vienna University of Technology in the project "Playful Interfaces".
[2006-2007]	Stipendiary at the Institute of Design and Assessment of Technology at the Vienna University of Technology in the project "Gestural interaction with time based media".
[2004-2005]	Member of Viennese noise/punk/drum'n'base crew "Phal & dr-K" as laptop musician and video artist.
[1999-2004]	Computer Lab Tutor at the Vienna University of Technology.
[2002]	Assistant director for two TV episodes of "Landschaften erzählen" for Austrian TV station TW-1.
[2001]	Production of two TV openers for viennese local television station "AltErlaa".
[1999, 2000]	Trainee at the Siemens AG Austria.
[1995-1999]	Member of Viennese Rap band "Kablast" as bassist and producer.

exhibitions:

[2008]	Display of the interactive music artpiece "Bagatelle Concrete", a modified pinball machine, at the "Homo Ludens Ludens" exhibition, LABoral Centro de Arte y Creación Industrial, Gijon, Spain, 04/18/08-09/22/08, [http://bagatelleconcrete.attacksyour.net/]
[2005]	Display of the interactive media work "Pose" at the "Echo" exhibition, Ragnahof, Vienna, 12/16/08-12/18/08.

selected talks and lectures:

[2008]	"Playing Music", invited lecture presented to the Computer Space 2008, Sofia, Bulgaria, October 31st - November 2nd, 2008.
[2007]	"Simulation versus Gameplay in Sports Videogames" at the Institute of Design and Assessment of Technology at the Vienna University of Technology
[2007]	"Homebrew Music Game Development" at the dorkbot vienna #3 "hacking game machines", Metalab, Vienna
[2006]	"Sound Games and Game Sound" at the Institute of Design and Assessment of Technology at the Vienna University of Technology
[2005]	"Sonic~Image, audiovisual synchronisation at live performances" at the Institute of Design and Assessment of Technology at the Vienna University of Technology

education:

[since 2004]	Ph.D. student at the Institute of Design and Assessment of Technologies at the Vienna University of Technology.
[1996-2004]	Degree with distinction as a "Diplom Ingenieur" (comparable to Master of Science) in computer science.
[2000-2001]	Finished training of a qualified Multimedia Producer at SAE College Vienna.
[1988-1996]	High school (stressing modern languages) at "Bundesgymnasium Wien 8".
[1984-1988]	Elementary school at "Piaristen Wien 8".

grants:

[2008]	Grant for thesis research, Siemens AG Österreich
[2008]	"Radiolaris", project grant, BMUKK .KUNST (with Martin Pichlmair)
[2007]	"Gestural interaction with time based media", extended research grant, Vienna University of Technology and BMWF.
[2007]	"Playful Interfaces", project grant, Hochschuljubiläumsstiftung der Stadt Wien (with Martin Pichlmair)
[2006]	"Central Pinball Unit", project grant, Bundeskanzleramt .KUNST (with Martin Pichlmair)
[2006]	"Gestural interaction with time based media", research grant, Vienna University of Technology and BMWF.
[2004]	Grant for thesis research, Deanery of Informatics, Vienna University of Technology.