Oxford Handbooks Online

# Designing a Game for Music: Integrated Design Approaches for Ludic Music and Interactivity

Richard Stevens and Dave Raybould

The Oxford Handbook of Interactive Audio
*Edited by Karen Collins, Bill Kapralos, and Holly Tessler*

Print Publication Date: May 2014
Subject: Music, Applied Music
Online Publication Date: Jul 2014
DOI: 10.1093/oxfordhb/9780199797226.013.009

## [–] Abstract and Keywords

This chapter examines the inherent conflict between player autonomy and musical structure within videogames. Ludic music in games is typically congruent with the action and can heighten feelings of mastery by providing emotional rewards for player achievements. However, the confirmations or violations of musical expectancy that are effective in provoking emotional responses in the kind of tonal music typically utilized in games are difficult to achieve within the temporal uncertainty of a game, where the player has the autonomy to act at any time. The chapter examines the changes in attitudes, tools, and production processes that would allow the progression from current dynamic or adaptive approaches, which treat the music system as a passive receiver of instruction, to a more authentically two-way interactive approach where musical structure inputs to the game's decision-making processes in order to create a more powerful alignment of musical emotion and game events.

Keywords: games, video, music, interactive, adaptive, dynamic, ludic game

THE question of how interactive music should function in games is perhaps a misleading one, as there are many different types of games and many different types of players. One of the most compelling explanations for the huge popularity of videogames is that they meet people's intrinsic psychological needs quickly, with consistency, and with great frequency (Rigby and Ryan 2011). The apparent drivers of the development of games and their marketing—such as the fidelity of graphics and audio, or as the popular press would have us imagine, the degree of violence—are far less significant factors than the drive to increase our sense of well-being through meeting the basic needs of competence (or mastery), autonomy (or volition) and relatedness (social connection) (Przblinkski et al. 2010) or the desire to become immersed in narrative worlds (Cairns 2006). Since it is clear that player satisfaction is a product of "needs met" over "needs," it is important that we recognize that music should operate in different ways in different circumstances.

Players will choose a genre of game that best matches their intrinsic needs (Madigan 2012) and they will also adopt different gameplay strategies according to their personality type (Bartle 1996). A player's desire for relatedness or fellowship (Hunicke, LeBlanc, and Zubek 2004) might be met through music that rewards cooperative play (Kristian and Girard 2011) or that allows them the ability to perform music with others (Collins 2007), but is also likely to be met by hearing music of their preferred genre. Given the importance of music to a sense of social identity and group membership and the links between personality type and musical preference (North and Hargreaves 2007), it is perhaps not surprising that there appears to be a strong correlation between game genre and musical style (Summers 2011). So the next time we complain about the marketing department conducting its research on Facebook to identify the bands to (p. 148) use on the soundtrack to the latest racing game (Baysted 2012), perhaps we are missing the point. A comprehensive assessment of the psychological needs of the player and how these can best be met by music in games is beyond the scope of this chapter, but we raise this in our opening remarks to highlight that, although the remainder of the chapter will be focusing on "interactive" music, we appreciate that music should function according to the needs of the game and of the player, and that some of these needs may be perfectly well met by traditionally linear music.

Of the player needs mentioned above, the “innate desire to grow our abilities and gain mastery of new situations and challenges” (Rigby and Ryan 2011) is seen by many to be the most important determinant of enjoyment in games (Vorderer and Bryant 2006). Termed “hard fun” by Lazzaro (2008), the success of this “voluntary effort to overcome unnecessary obstacles” (Suits 2005) is thought to produce a release of chemicals in the brain (Bateman and Nacke 2010), strongly associated with reinforcement and motivation (Salimpoor et al. 2011). Finding oneself at the optimal point between being suitably challenged and having the skills to master those challenges is referred to as being within the highly desirable and immersive state of “flow” (Csíkszentmihályi 1992). The emotional state of “fiero” (or triumph over adversity; Ekman, 2004), brought about by overcoming obstacles, contributes to maintaining a state of flow by providing the positive reinforcement the player needs to continue to meet the increasing challenge, and is recognized as an important source of pleasure or “fun” (Koster 2005).

In contrast to meeting players’ social needs (where the focus is on musical genre) or the narratologically immersive needs (met through the evocation of time, place, and mood), music that contributes to flow by helping players to achieve competence (by providing information, or by motivating and rewarding us) or music that guides and supports players by making them feel like they are acting of their own volition and that their actions are meaningful (fulfilling the need for autonomy) must be synchronized tightly to game events. The requirements to ensure that feedback is immediate (Bond and Beale 2009) and that music is congruent with the game action (Wharton and Collins 2011) represent the inherent conflict between interactivity and musical form. The compromise between “contextual responsiveness and musical integrity” (Bajakian 2010) continues to challenge composers and implementers trying to avoid awkward or clumsy musical results (Munday 2007). Such game-specific, ludic, or metonymic (Whalen 2004) music and the issues that arise out of music synchronization within an interactive medium will be the focus of this chapter.

### 9.1 Musical Structures vs. Interactivity

There are many ways in which music can evoke or induce emotions, but there is clear evidence that strong or “peak” emotions in response to music (such as chills, lump in the throat, etc.) are associated with the creation of, and confirmation or violation of, (p. 149) expectancy (Sloboda 1991). Given that musical training unsurprisingly leads to a heightened sensitivity (Dellacherie et al. 2011), it may be that many commentators with a background in music (such as ourselves) are prone to exaggerate the problems that arise when such patterns of expectancy are interrupted by the need to respond to game events, but there is strong evidence that no formal training is required to make automatic predictions of chord functions (Koelsch 2011), to be acutely aware of phrase boundaries (Nan, Knösche, and Friederici 2009) and expectations of metrical or pitch patterns (Huron 2006), and that breaking these patterns of expectation can cause disorientation (Margulis 2007) and negative responses (Steinbeis, Koelsch, and Sloboda 2006).

It is of course possible to evoke a variety of emotions through musical styles that are not heavily expectation-based, and that rather than relying upon schematic expectations (derived through familiarity with the musical syntax of style), expectations may be the product of familiarity with the specific piece or dynamically generated from the piece itself (Huron 2006). Indeed in some genres (such as platformers), it can be seen that learned schematic expectations have allowed musical forms that are much more flexible, responsive, and cartoon-like. In the horror genre, where the lack of a tonal center or metrical pulse is often used to destabilize the audience or player (Summers 2011) or to parallel the characters psychological crisis (Whalen 2004), the cross-fading between atonal, arhythmic music of different intensities can induce the appropriate emotional effects without breaking any musical expectations, since the musical form itself (or lack of it) does not imply any. Likewise static tonality or drone-based music can make it much easier to transition between different segments without upsetting the implicit expectations of chordal progressions (Stuart 2010).

While there are exceptions, such as those outlined above, it must be recognized that the player’s significant exposure to the paradigms of film and television music (Nielsen 2011) and the wish to activate the strongly associated cultural codes (Gorbman 1987) mean that many games based within fictional narratives bring with them the expectations of a Hollywood-style soundtrack (Jackson 2011), a strongly tonal and expectation-based form almost uniquely unsuited to the temporal uncertainty of games.

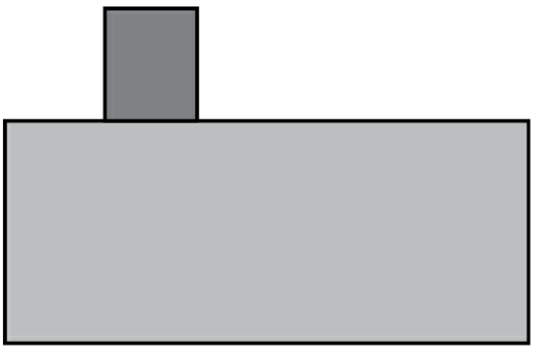
A fundamental form of musical expectancy that can be easily “broken” through the need to represent, or at least remain congruent with, game events is that of pulse. Using parallel forms (sometimes referred to as vertical re-orchestration; Collins 2009), where layers or “stems” are composed such that they work in vertical combination, can be very effective in maintaining musical continuity while allowing for significant changes in texture and instrumentation (see Figure 9.2). In

*Splinter Cell: Chaos Theory*, the layers act as a warning to indicate the proximity of enemies, and in *Fallout: New Vegas*, concentric circles of triggers attached to musical stems help the player to navigate the Wasteland (Lawlor 2012). Layers can tell the player whether special modes are active, notify them of the alertness state or current health of nonplayer characters (NPCs), or represent overall progress through a puzzle (*Portal 2*) or battle (*Tom Clancy's EndWar*). The attenuation of different layers of music to represent different game states or continuous variables can be highly effective in providing the player with information to support success (enhancing their skill within the flow state) and can increase layers of tension (to (p. 150) heighten the impression of challenge). However given that *Splinter Cell's* musical form is predetermined (composed to be essentially static and allowing the game to generate its dynamics; IGN 2006) it is less suited to providing reward (enhancing fiero), since it lacks the ability to respond to game events with specific timed musical gestures.

Feedback on actions or game events can be transmitted via music using ornamental (Figure 9.1), or transitional forms (Figure 9.3). It is frequently the case that we want to acknowledge events in the game but they are not significant enough to warrant a whole scale change in music. In this case, games typically use an ornamental flourish or stinger that might reward a successful jump (*Uncharted 3*), a successful attack (*The Legend of Zelda: Skyward* Sword), or shot (*The Operative: No One Lives Forever*). Typically these are not aligned to musical pulse but happen immediately over the top of the currently playing musical bed (e.g., *CryEngine3*).

The function of musical feedback could be viewed from a human–computer-interaction perspective (indicating confirmation or rejection of action; Jørgensen 2010), but it also carries an implicit emotional message. The ludic or metonymic is not separable from the metaphoric (that which relates to the game as a story or world; Whalen 2004). A piece of music may confirm that an action has been successful (defeat of the enemy) and thus provide the positive reinforcement important to flow, but at the same time the music is also providing an insight into character, as it does in film (Hoeckner et al. 2011). Since the player is the character, this music is informing them of their place in the fictional world, their heroism, and their role in shaping the events of the world around them, supporting the player's sense of autonomy by making their choices appear meaningful. Given the audiovisual expectations formed from a lifetime of narrative media mentioned above, we expect these musical responses to be both synchronized and dramatic.

The simple transitional cross-fade can work if music is composed in such a way as to avoid or at least lessen musical expectations, or musical transitions can be masked with sound effects (Porter 2010), but the most effective way to maintain musical expectations within transitional forms is to restrict the changes to musically appropriate times. By carefully constructing matrices of possible transitions between sections of music that take account of potential entry or exit points and the types of transition permitted (immediate, next measure, next beat, etc.; Selfon 2003), it is possible to construct highly "musical" scores (that maintain musical expectations). However the by-product of this musicality is that there is a "lag" between game events and the music's response (Collins 2007). Again we are attempting to "adhere to the sound of film music while losing sight of its *raison d'etre*; the heightened emotional impact provided by the close synchronisation of musical and visual events" (Munday 2007).

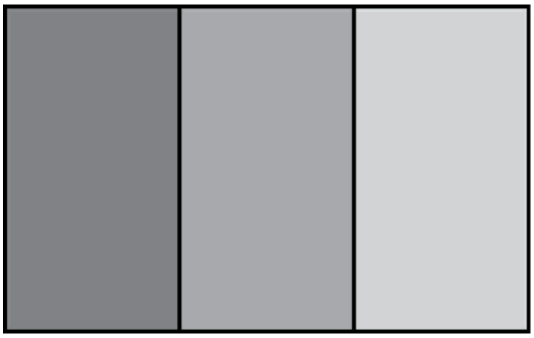


*Click to view larger*

*Figure 9.1* Ornamental forms.

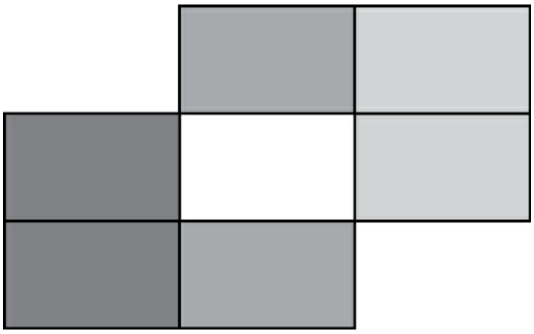
*Click to view larger*

*Figure 9.2* Parallel forms.



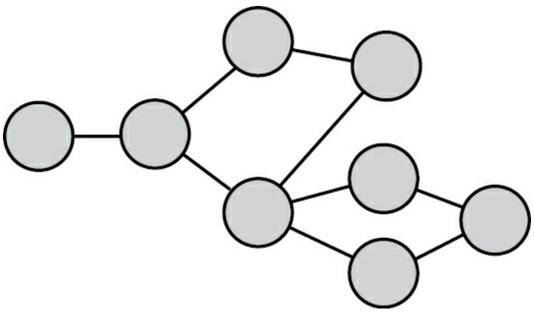
*Click to view larger*

*Figure 9.3* Transitional forms.



*Click to view larger*

*Figure 9.4* Cellular forms.



*Click to view larger*

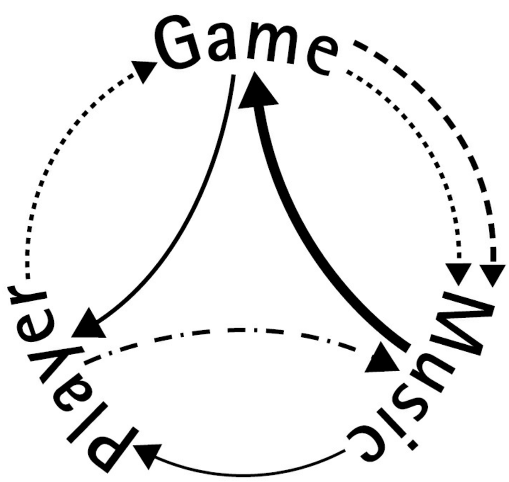
*Figure 9.5* Algorithmic forms.

It is acknowledged by many in the game music industry that "interactivity = modularity" (Ashby 2008) and a focus on temporally aware cells of music (Figure 9.4) or "micro scores" (Folmann 2006) can allow music to more quickly respond to events while maintaining musical flow. However, the production of such cellular forms remains problematic, as when transitioning from one cell to another the musical parts need to retain their natural decay portions or "tails" in order to sound natural (Selfon 2009). Certain styles (p. 151) (p. 152) of music that have rigid time-based structures and short percussive elements (e.g., some “pop” music) can move effectively between segments or cells using short cross-fades (Durity and Macanulty 2010). Other approaches, such as Whitmore’s dovetail technique,[1] or applying reverbs to smooth over transitions (by artificially creating decay tails in real time), can also work well, but these are rarely satisfactory for acoustic instrumental forms, as getting musicians to perform in short chunks (so you can capture the authentic decay within the correct acoustic space) is both time consuming and unnatural. The highly modular, or “granular,” note-level approach of MIDI and sample-based systems resolves the decay problem (since the tail exists authentically within each sampled note) and also provides for the kind of parametric control ideally suited to interactivity (Collins 2009), but it has fallen spectacularly out of fashion within many genres as a victim of the quest for a Hollywood sound (Collins 2008). Senior figures within the game audio industry agree that the return of note-level or MIDI control in some form is the inevitable response to addressing questions of musical interactivity (Page and Kelly 2007), and others have suggested that the development of cloud-based processing and streaming might mitigate the perceived quality issues (in terms of addressing RAM for high-quality samples and processing for mastering) (Drescher 2010). There is an innate reluctance to replace activities seen as innately human, such as music composition, with processes or algorithms (Cope 2000) (Figure 9.5), but the potential for musical models (McAlpine 2009), stochastic (or generative) approaches (Weir 2011), and parameterized control (Livingstone and Brown 2005) adds weight to the need to move beyond the stereo wave file or the pre-rendered stem.

Although the return of granular, note-level control within games would undoubtedly improve the ability of the music to respond to, and support, game events more elegantly, it still remains a theoretical impossibility to align expectation-based musical structures with unpredictable events. If we imagine the music system as a black box containing a highly talented silent movie piano player, we can appreciate that he could quickly adapt the music to the action on the screen, using his highly evolved knowledge of musical harmony and form to neatly segue, via an appropriate passing chord or note, into a new “piece” or state. But it would not be immediate and irrespective of his skill: he could never build toward an anticipated event and synchronize precisely with the climatic point. In other words the synchronization of game fiero and musical peaks, paralleling the highly rewarding climax of many a Hollywood chase sequence, cannot happen, unless we reconsider the nature of the relationship between game design and music.

### 9.2 Interactivity?

Although there is general agreement that the umbrella term “dynamic” music somehow differs from the linear music of film (Collins 2007), the remaining terminology with regards to music in videogames is varied and confusing. The term interactive when applied to this field has a long history of ambiguity (Ross 2001), and although there is (p. 153) an inclination to use the term “adaptive” where the music may respond to game events without any direct input from the player (Fay 2004) (or at least when there is a degree of abstraction or a layer of interpretation between the player actions and the output; Farnell 2007), the usage of these terms is often interchangeable or contradictory. The shifting, or at least poorly defined, meaning of the term “interactive” is not unique to videogames (Aarseth 2003), and although there is little to gain from trying to impose a meaning here, it is worth pursuing briefly, as a number of definitions call for a reappraisal of what we might currently call interactive.



*Click to view larger*

*Figure 9.6* Game music systems.

Although some commentators might consider any engagement with media to be interactive in some sense (Manovich 2002), our current common usage of the term within game audio to encompass all audio events that respond to user input (Selfon 2004) can detract from the idea of interactivity as a continuum, within which there are there are differing degrees. At one end of this scale is the notion, as yet unconsidered in many games, that interactivity is a cyclical process (Crawford 2003), where the agents within a system act upon each other (inter + act; Harper 2012), and that the receiver can also act as a transmitter (Gianetti 2007). McQuail (2005, 497) defines interactivity as "The capacity for reciprocal, two-way communication attributable to a communication medium or relationship. Interactivity allows for mutual adjustment, co-orientation, finer control and greater efficiency in most communication relationships and processes," and states that we might describe the degree of interactivity as being "indicated by the ratio of response or initiative on the part of the user to the "offer" of the source/sender" (2005, 144). If we consider the music, player, and game as components of a system, we can see that most current practice within music for games could be considered as simply "reactive," acting in response to events from the player, mediated by the game engine (shown as the dotted line in Figure 9.6), or in direct response to the game engine itself, "adaptive" (the dashed line in Figure 9.6).[2]

(p. 154) By reserving the use of the term "interactive" for systems that are truly bidirectional, where the game's decision-making processes also take input from the music system as to its current state (indicated by the thick arrow in Figure 9.6), we raise the possibility of approaching the seemingly intractable interactivity vs. musical structure problem in a new way.

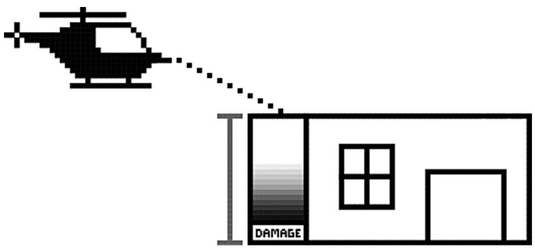
#### 9.3 Thresholds, Windows, and Notifications

The game designer Clint Hocking (2012) refers to the design challenge of the "threshold problem" as being "any problem that arises as a result of a discrete state change that occurs at an arbitrary, designer-defined threshold in an analogue range," and points out that in order to avoid frustration these need to be clearly communicated to the player, or made "sticky," so that if they get near enough to the value they are automatically snapped to it.

In order to facilitate greater interactivity between the music and game state (so that moments of fiero can be heightened by synchronization with pleasurable structural points in music) we'd like to suggest that these arbitrary thresholds might instead be considered as windows of opportunity. When the game state is looking to take an action (the window is open) it might look at the condition of the music (which would be inputting its current state) to inform when that action might actually occur. This process would require a more integrated approach to music and game design that we will illustrate below with a few examples.

### 9.3.1 Example 1: Helicopter Gunship

You are in a helicopter attacking a fuel depot at the entrance to an enemy compound. The game system is set up so that it takes 100 direct hits with your weapon to destroy the depot (Figure 9.7).



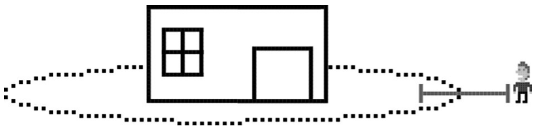

*Click to view larger*

*Figure 9.7* Helicopter gunship.

Within a normal "reactive" system, when the direct hit variable equals 100, the depot explode animation is triggered. The currently playing music is cut off immediately and the triumphant brass music cue is played. "Interactively," when the direct hit variable equals 100 the game engine checks the music state. It sees that the music is currently at the fourth beat of the bar and, given that it knows the ideal (most pleasurable) musical transition point would be on beat one, it continues taking additional direct hits, until a musically appropriate musical time. Then the triumphant brass cue is played, and the depot explode animation is triggered simultaneously. The moment of fiero produced by the triumph coincides with the musical expectation implied by the 4/4 time signature, and therefore the pleasure (p. 155) is heightened. To take this one step further, it might be appropriate to consider that a window may open up around the threshold (direct hits = 100), meaning that, if musically appropriate, the event may actually take place slightly earlier than the threshold point (e.g., direct hits = 97).

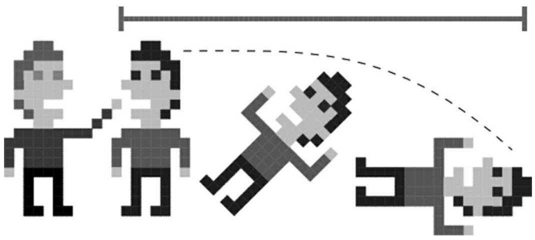
### 9.3.2 Example 2: Find the Enemy

Having gained entry to the enemy compound you need to find and detain the chief bad guy. On approaching the hut where he's hiding out, the game will jump to an in-game cut scene that shows your final steps up to the door, you kicking in the door, and gracefully leaping through, to the bad guy's surprise and horror (Figure 9.8).



*Click to view larger*

*Figure 9.8* Cut-scene.



*Click to view larger*

*Figure 9.9* Death.

In a reactive system, when the player passes the threshold (illustrated by the circle trigger around the hut) the in-game cut-scene is triggered. The currently playing music is cut off immediately and the cut-scene music is played. Interactively, we consider a window around the threshold point (indicated by the gray line) where the game state starts to look at the music state. Whenever the music state reaches the next appropriate musical juncture (for example approaching beat one of the bar again) the cut-scene is triggered to coincide with the musical change it also instigates at this moment. (p. 156)

**9.4 Timing and Animation**

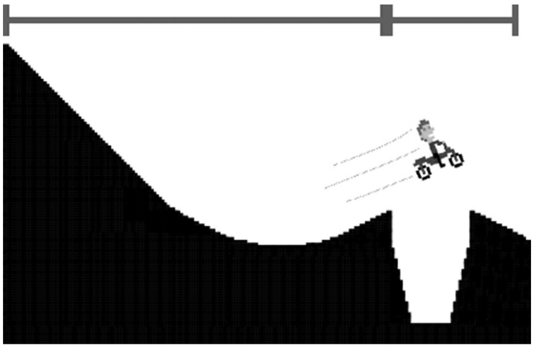
### 9.4.1 Example 3: NPC Death and Collapse

Unsurprisingly, the bad guy's henchman rushes to his aid. A thick-set man with an aggressive nature, he has a threshold of twenty blows before he will collapse and die (Figure 9.9).

Interactively, this could do the same as Figure 9.7 above, and actually trigger the event (death) to happen at nineteen or twenty blows, when close to a musical juncture. However the player may be attuned to the strength of the enemy and feel that this somehow does not feel right. Instead it may be possible to adapt the collapse animation, speeding up or slowing it down by interpolating differently between key frames, looking to the music system for timing, so that the impact onto the ground is timed to coincide with the appropriate transition point within the musical structure.

### 9.4.2 Example 4: Jump

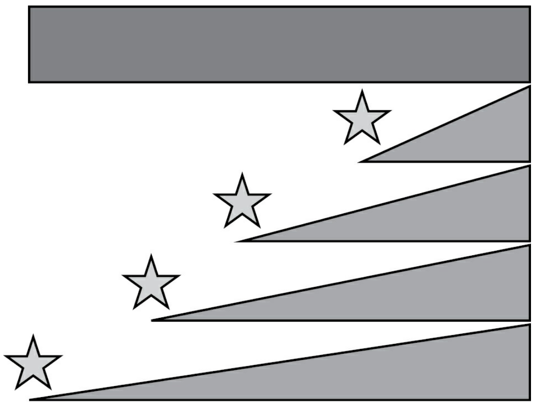
In pursuit of the chief bad guy, who has now left the compound on a motor bike, you speed downhill toward a gaping chasm (Figure 9.10). We want to accompany your leap off, and landing, with an appropriately dramatic music cue, but you are weaving through a number of trees on your way down so we can make only a rough guess at your arrival time. Interactively, we could calculate the exact time required to hit the leap at an appropriate musical point. We then manipulate (constantly update) the speed of the vehicle to compensate for the player's turns so that they hit the jump in synchrony with the music, then also adjust their air speed and trajectory so that they land with a satisfying, musical, bump.



*Click to view larger*

*Figure 9.10* Jump.

With the examples above we hope we have communicated some simple ways in which a more interactive and integrated approach to game design could exploit (p. 157) the pleasurable benefits of aligning game events and musical structure. However, they also probably raise concerns as to the effect on the player's sense of autonomy or agency, raising the risk of this becoming another type of frustration-inducing "Quick Time Event" (Miller 2010), an attempt to add some limited interaction into what would otherwise be a passive cut-scene, typically through the sudden appearance of an onscreen icon prompting the player to "press X now…". The danger is that the satisfaction produced from the musical synchronization of game events will not be powerful enough to outweigh any frustrations that this wresting of control may induce. Anecdotal evidence from people already innovating in the area of integrated game and music design suggests that as long as players feel that their actions have been acknowledged, through some form of audio or visual feedback, they are happy to accept a momentary pause before the action (Kastbauer 2011). This feedback could be as simple as the rumble of a depot about to explode or the groan of an enemy about to die. This could also be accomplished with music through the introduction of a short stinger (star) and the fading in of a percussive part (ramp) that leads into the event measure (as illustrated in Figure 9.11).



*Click to view larger*

*Figure 9.11* Feedback.

The manipulation of animation and event timings and the use of opportunity windows rather than discrete thresholds are simple concepts to support two-way interactivity between game and music systems. In order to generate and support more innovation around this idea it is vital that attitudes, production processes, and tools are re-examined and developed. (p. 158)

**9.5 Requirements for Change**

## 9.5.1 Attitudes and the Production Process

Excluded in part by music's cultural status as the mysterious preserve of specialists (Margulis 2007), in part by the sound isolation and acoustic treatment required for music production (Bridgett 2012), and poorly served by the game design literature, it is perhaps unfair to expect producers and game designers to be experts in understanding the contribution that music can make to games.

In the film-making process, the opportunity for the composer to play a role in offering their insight and suggestions is provided through the spotting process (Larsen 2007), and the ability of the director to try out different approaches in a hands-on way themselves is enabled through the common use of temp tracks throughout the editing process (Sadoff 2006). However, in games, the frequent outsourcing of music—often to composers from a linear film background—exacerbates the lack of integration between game design and music.

We have outlined above why we think there could be benefits to the game experience by aligning moments of fiero with structurally significant musical points in order to induce a heightened sense of pleasure in the player. The implementation of this concept requires a shift in both attitudes and production processes. To some, it is self-evident that the challenge of interactive music for games lies with the composer and that the implementation design should inform composition (Bajakian 2010), that one must spend hands-on time with a game in order to recognize its intrinsic rhythms (Kondo 2007), and that "The ability to understand game technologies and mechanics is becoming increasingly important for the composer" (Folmann quoted in Latta (p. 159) 2006). However, there appear to be a large number of composers who have little knowledge of games (Steighner 2011) and who do not consider it part of their remit to learn or understand the implementation tools (Graves 2011). Even if there were not inherent incentives in triple-A game development to go for the safest possible choice, using music in the tried and (un)tested way it has been used in previous titles within the genre, it is perhaps not surprising, given the common practice for such composers to be working remotely from images (Inglis 2012) or a few lines of instruction on a spreadsheet (Pham 2008), that more integrated design approaches are rare.

Although there are some companies that appreciate the importance of the in-house composer in creating a more integrated design approach (Broomhall 2011), there is much evidence that the practice of composers working in "the linear style that comes naturally" (Bajakian et al. 2000) remains problematic. Although in-house integrators may be (and often are), highly talented musicians themselves, it remains evident that it would be preferable for the composer to be more closely involved in the process of understanding how game variables might be translated into musical meaning. Furthermore they should not consider themselves to be above such "minutiae" (Mayer and Leary 2008) if music is to be composed with the medium in mind, rather than relying on the manipulation of pre-made assets. The claim that they "don't want interactivity to have a detrimental effect on the creativity of the composer" (Garry Schyman, quoted in Pham 2008) appears to parallel similar historical arguments from composers and theorists about the injurious effects on musical structure arising from having to compose to film events (Cooke 2008). Like the concert-hall composers before them who moved into film, the film composers who are now moving into games must also reappraise the role of music within the medium and become more involved in an integrated approach to finding solutions. As composer Guy Whitmore points out:

> If a composer simply supplies long, linear musical pieces for a game, that composer is not "scoring" the game; they are just providing music that is in the correct genre and style. Imagine if a film composer did the same thing —created music that had nothing to do with the images and action on screen. That composer would be fired! Scoring to picture is half the art in film composing, and the same applies to game scores.
>
> (Whitmore 2003)

Although we can be critical of the willful ignorance of film composers hired for marketing considerations, or a producer's personal preference (Broomhall 2012), it has long been recognized that judging music in isolation from the medium for which it was intended can be misleading (Gorbman 1987). The inclination to think that music should somehow be able to "stand alone" (Dabl 2010), together with the commercial incentives to promote the game "soundtrack" as a product (Kärjä 2008), further exacerbates the problems of considering music properly within its game context, which are already extant, given the lack of integration between the content-creation tools and implementation tools (Taylor 2012).

### (p. 160) 9.5.2 Tools

Although there have been significant advances in audio middleware tools in recent years, game development remains a fundamentally iterative process and it is desirable that the time necessary to test and iterate be as short as possible

(Fullerton 2008).

The concept of affordances and constraints explores how the design of objects conveys messages about their possible uses and influences our abilities to carry out tasks with them (Norman 1988). The practice of contemporary composition is almost without exception carried out within what is commonly referred to as a digital audio workstation (DAW). It is rarely, as the name might suggest, a piece of hardware but in fact a personal computer and combined software sequencer and audio-editing package. By examining the spectrum of affordance (what is easy, and thus more likely, to what is difficult, and therefore less likely) (Mooney 2010) of a DAW it can be seen to be highly unlikely to produce music suited to interactivity, and that the production of interactive music is in spite of the tools, not because of them (see also Chapters 23 and 24 in this volume). It is worth noting that the unique and iconic style that is generally referred to when speaking of “game music”—that of the 8-bit chiptune era—is very much a product of the affordances and constraints of the sound chips on early games consoles (Collins 2008). The DAW has the granular note- and parameter-level controls ideally suited to interactivity, but lacks the stochastic capabilities and game engine integration of the middleware, while the wave file-based middleware lacks the granular control. This means that the iteration process involves, at the very least, the time-consuming rendering of all assets to wave files, importing of the wave files into middleware, the construction of interactive systems within the middleware, and the setting up of, and receipt of, the appropriate hooks (game variables) from the game itself. Any changes to the music after evaluation will then require a return to the DAW to modify and re-export the musical assets. It is worth reiterating that this is a best-case scenario: more typically this process is further worsened by the composer working remotely, by the involvement of live recording of musicians rather than the rendering from DAW, and by the evaluation process being undertaken without the composer’s participation (Graves 2012). The original system within which the music is composed contains all of the control that is desirable for the iteration process (and for use in the final game) and yet the existing tools and processes involve rendering out material to the inflexible mediums such as Wave, MP3, or Ogg format files (Marks 2009).

To enable faster iteration and deeper integration of music in the game design process, there is a clear need to allow game engine variables to plug directly into DAWs, and for those DAWs to develop the compositional mechanisms and export formats to translate music into flexible formats for use in games. The aims of the interactive XMF (iXMF) working group (IASIG 2012) to establish a universal transfer format appears to have stalled, but perhaps there are initiatives to come from the new IASIG DAW working group, from the younger DAW pretenders (Kirn 2009), or indeed from the more unexpected direction of web audio (Rogers 2012).

## (p. 161) 9.6 Conclusions

Although we may question and debate the directness of the mapping of game information or actions to music from an aesthetic point of view, there are times at which the ludic function of music in providing information and motivational reward to the player, or the narrative function of enhancing the player’s actions so they are seen to have a “spectacular influence” on the game (Nielsen 2011), emphasizes the need for it to be congruent with game events.

Through parallel forms we can provide information to the player within musical structures, and through ornamental gestures we can provide micro rewards to motivate and enhance the pleasurable flow state, but enhancing the peak emotion of triumph (fiero) when overcoming the frustration or stress invoked by major obstacles in the game (Hazlett 2006) requires the more powerful emotional responses associated with musical form. No matter what level of granularity or complexity of algorithm is involved, it is, and always will be, theoretically impossible to reconcile the indeterminate actions of the player with the kinds of expectation-based musical structures that induce such peak moments of pleasure.

We appreciate that a huge range of fascinating and brilliant games such as platformers, explicitly music-based games, or games that have audiovisual synaesthesia ideas as a core mechanic, already treat music as a highly integrated design element. However, within more narrative-situated games there are certain moments that deserve to deliver the powerful emotions associated with their Hollywood archetypes. Without the right tools, better integration of music into the iterative game design process is difficult, and without the right personnel and attitudes, the kind of *Gesamtkunstwerk* anticipated from the medium (Bridgett 2005) seems elusive, but by invoking a more nuanced interpretation of interactivity, that encompasses a range of possible exchanges, rather than accepting music in a purely reactive role, it is possible that new, as yet unexplored, possibilities will arise. It is our hope that the first game to fully use this interactivity to emotionally engage the player will provoke a paradigm shift in thinking about games and music.

## References


Aarseth, Espen. 2003. We All Want to Change the World. In *Digital Media Revisited*, ed. Gunnar Liestøl, Andrew Morrison, and Terje Rasmussen, 415–439. Cambridge, MA: MIT Press.

Ashby, Simon. 2008. Interactive Audio for Video Games. Paper presented at Concordia Electroacoustic Studies Student Association, March 20, 2008, Concordia University, Montreal, Canada. .

Bajakian, Clint 2010. Adaptive Music: The Secret Lies within Music Itself. Paper presented at the Game Developers Conference, San Francisco, California, March 9–13, 2010.

Bajakian, Clint, Peter Drescher, Duane Ford, Chris Grigg, Jennifer Hruska, Mike Kent, Ron Kuper, Mike Overlin, and Rob Rampley. 2000. Group Report: General Interactive Audio. *Project Bar-B-Q, 2000, Report, Section 7*. .

Bartle, Richard. 1996. Hearts, Clubs, Diamonds: Players who Suit MUDs. .

Bateman, Chris, and Lennart E. Nacke. 2010. The Neurobiology of Play. In *Proceedings of the International Academic Conference on the Future of Game Design and Technology*, 1–8. New York: ACM.

Baysted, Stephen. 2012. Palimpsest, Pragmatism and the Aesthetics of Genre Transformation: Composing the Hybrid Score to Electronic Arts. Paper presented at Ludomusicology: Game Music Research [Royal Musical Association Study Day], April 16, 2012, St Catherine's College, Oxford, UK.

Bond, Matthew, and Russell Beale. 2009. What Makes a Good Game? Using Reviews to Inform Design. In *Proceedings of the 23rd British HCI Group Annual Conference on People and Computers: Celebrating People and Technology*, 418–422. Swinton, UK: British Computer Society.

Bridgett, Rob. 2005. Hollywood Sound: Part One. *Gamasutra*. .

——. 2012. A Revolution in Sound: Break Down the Walls! *Gamasutra*. .

Broomhall, John. 2011. Heard About: Batman: Arkham City. *Develop Magazine*, November 24, 2011 122, 44.

——. 2012. Heard About: Composition in Games. *Develop Magazine*, May, 127, 63.

Cairns, Paul, Anna Cox, Nadia Berthouze, Samira Dhoparee, and Charlene Jennett. 2006. Quantifying the Experience of Immersion in Games. In *Proceedings of Cognitive Science of Games and Gameplay Workshop at Cognitive Science*, Vancouver, Canada, July 26–9, 2006.

Collins, Karen. 2007. An Introduction to the Participatory and Non-Linear Aspects of Video Games Audio. In *Essays on Sound and Vision*, ed. Stan Hawkins and John Richardson, 263–298. Helsinki: Helsinki University Press.

——. 2008. *Game Sound: An Introduction to the History, Theory, and Practice of Video Game Music and Sound Design*. Cambridge, MA: MIT Press.

——. 2009. An Introduction to Procedural Music in Video Games. *Contemporary Music Review* 28 (1): 5–15.

Cooke, Mervyn. 2008. *A History of Film Music*. Cambridge, MA: Cambridge University Press.

Cope, David. 2000. *The Algorithmic Composer*. Madison, WI: A-R Editions.

Crawford, Chris. 2003. *Chris Crawford on Game Design*. Berkeley, CA: New Riders.

Csíkszentmihályi, Mihalyi, and Isabella Selega Csíkszentmihályi. 1992. *Optimal Experience: Psychological Studies of Flow in Consciousness*. Cambridge, MA: Cambridge University Press.

Dabl, Gideon. 2010. Editorial: Context Is Everything. *Original Sound Version*, August 10, 2010. .

Dellacherie, Delphine, Mathieu Roy, Laurent Hugueville, Isabelle Peretz, and Séverine Samson. 2011. The Effect of Musical Experience on Emotional Self-reports and Psychophysiological Responses to Dissonance. *Psychophysiology* 48 (3): 337–349.

Drescher, Peter. 2010. Game Audio in the Cloud. Game. *O'Reilly Broadcast*, March 26, 2010. .

Durity, Gordon, and Iain Macanulty. 2010. Contextually Driven Dynamic Music System for Games. Paper presented at the Vancouver Computer Music Meetings, Centre for Digital Media, Vancouver, Canada, October 6, 2010. .

Ekman, Paul. 2004. *Emotions Revealed: Recognizing Faces and Feelings to Improve Communication and Emotional Life*. New York: Holt.

Farnell, Andy. 2007. An Introduction to Procedural Audio and its Application in Computer Games. .

Fay, Todd. 2004. *DirectX 9 Audio Exposed: Interactive Audio Development*. Plano, TX: Wordware.

Folmann, Troels. 2006. Tomb Raider Legend: Scoring a Next-Generation Soundtrack. Paper presented at the Game Developers Conference, San Jose, California, March 20–24, 2006.

Fullerton, Tracy. 2008. *Game Design Workshop: A Playcentric Approach to Creating Innovative Games*. 2nd edn. San Francisco, CA: Morgan Kaufmann.

Giannetti, Claudia. 2007. Digital Aesthetics: Introduction. *MedienKunstNetz*, February 15. .

Gorbman, Claudia 1987. *Unheard Melodies: Narrative Film Music*. Bloomington: Indiana University Press.

Graves, Jason. 2011. Dead Space 2: Musical. Postmortem presented at the Game Developers Conference, San Francisco, California, February 28–March 4, 2011.

——. 2012. Audio Boot Camp. Paper presented at the Game Developers Conference, San Francisco, California, March 5–9, 2012.

Harper, Douglas. 2012. Online Etymology Dictionary. .

Hazlett, Richard L. 2006. Measuring Emotional Valence during Interactive Experiences: Boys at Video Game Play. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 1023–1026.

Hocking, Clint. 2012. In the Click of It: Living on the Edge. *Edge Magazine* 241: 152.

Hoeckner, Berthold, Emma W. Wyatt, Jean Decety, and Howard Nusbaum. 2011. Film Music Influences How Viewers Relate to Movie Characters. *Psychology of Aesthetics, Creativity, and the Arts* 5 (2): 146–153.

Hunicke, Robin, Marc LeBlanc, and Robert Zubek. 2004. MDA: A Formal Approach to Game Design and Game Research. In *Proceedings of the AAAI-04 Workshop on Challenges in Game AI*, July 25–29, 2004, 01–05. .

Huron, David. 2006. *Sweet Anticipation: Music and the Psychology of Expectation*. Cambridge, MA: MIT Press.

IASIG. 2012. Interactive XMF Working Group. .

IGN. 2006. Michael McCann Interview. *IGN*. .

Inglis, Sam. 2012. Music and Sound Effects for Videogame Mass Effect 3: Interview, Rob Blake (Bioware). *Sound on Sound*, June. .

Jackson, Leah. 2011. Nobuo Uematsu: Interview with a Legendary Video Game Composer. *G4tv*, September 9, 2011. .

Jensen, J.F. 1998. Interactivity: Tracking a New Concept in Media and Communication Studies. *Nordicom Review* 12 (1): 185–204.

Jørgensen, Kristine. 2010. Time for New Terminology? Diegetic and Non-Diegetic Sounds in Computer Games Revisited. In *Game Sound Technology and Player Interaction: Concepts and Developments*, ed. Mark Grimshaw, 78–97. Munich: Information Science Reference.

Kärjä, Antti-Ville. 2008. Marketing Music through Computer Games: The Case of Poets of the Fall and *Max Payne 2*. In *From Pac-Man to Pop Music: Interactive Audio in Games and New Media*, ed. Karen Collins, 27–46. Aldershot, UK: Ashgate.

Kastbauer, Damian. 2011. Audio Implementation Greats #10: Made for the Metronome. *Designing Sound*, January 3, 2011. .

Kirn, Peter. 2009. Inside the Rock Band Network, as Harmonix Gives Interactive Music its Game-Changer. *Create Digital Music*, August 27, 2009. .

Koelsch, Stefan. 2011. Response to Target Article "Language, Music, and the Brain: A Resource-sharing Framework." In *Language and Music as Cognitive Systems*, ed. Patrick Rebuschat, Martin Rohrmeier, John A. Hawkins, and Ian Cross, 224–234. Oxford: Oxford University Press.

Kondo, Koji. 2007. Painting an Interactive Musical Landscape. Paper presented at the Game Developers Conference, San Francisco, California, September 5–7, 2007.

Koster, Ralph. 2005. *Theory of Fun for Game Design*. Phoenix, AZ: Paraglyph.

Kristian, David, and Olivier Girard. 2011. Between 4 Ears: Splinter Cell: Conviction Co-op Sound Strategies. Paper presented at the Game Developers Conference, San Francisco, California, February 28–March 4, 2011.

Larsen, Peter. 2007. *Film Music*. London: Reaktion.

Latta, Westlee. 2006. CDM Interview: Tomb Raider: Legend Composer Troels Brun Folmann on Adaptive Micro-Scoring. *Create Digital Music*, October 11, 2006. .

Lawlor, Scott. 2012. The Music of the Wasteland: Interactive Music in an Open World. Paper presented at the Game Developers Conference, San Francisco, California, March 5–9.

Lazzaro, Nicole. 2008. The Four Fun Keys. In *Game Usability: Advancing the Player Experience*, ed. Katherine Isbister and Noah Schaffer, 315–342. San Francisco: Morgan Kaufmann.

Livingstone, Steven R., and Andrew Brown R. 2005. Dynamic Response: Real-time Adaptation for Music Emotion. In *Proceedings of the Second Australasian Conference on Interactive Entertainment*, 105–111. Sydney, Australia: Creativity & Cognition Studios.

Madigan, Jamie. 2012. The Psychology of Genres. *Edge Magazine* 241(June) 96–103.

Manovich, Lev. 2002. *The Language of New Media*. Cambridge, MA: MIT Press.

Margulis, Elizabeth Hellmuth. 2007. Surprise and Listening Ahead: Analytic Engagements with Musical Tendencies. *Music Theory Spectrum* 29 (2): 197–217.

Marks, Aaron. 2009. *The Complete Guide to Game Audio: For Composers, Musicians, Sound Designers, and Game Developers*. 2nd edn. Burlington, MA: Focal Press.

Mayer, Jonathan, and Keith Leary. 2008. Interactive Music Systems: Planning, Producing and Executing. Paper presented at the Game Developers Conference, San Francisco, California, February 18–22.

McAlpine, Kenneth B., Matthew Bett, and James Scanlan. 2009. Approaches to Creating Real-time Adaptive Music in Interactive Entertainment: A Musical Perspective. In *Proceedings of the 35th AES International Conference on Audio for Games*. New York: Audio Engineering Society.

McQuail, Denis. 2005. *McQuail's Mass Communication Theory*. Thousand Oaks, CA: Sage.

Miller, Ben. 2010. Immersive Game Design: Indigo Prophecy. In *Well Played 2.0: Video Games, Value and Meaning*, ed. Drew Davidson, 189–200. Pittsburgh, PA: ETC.

Mooney, James. 2010. Frameworks and Affordances: Understanding the Tools of Music-making. *Journal of Music, Technology and Education* 3 (2): 141–54.

Munday, Rod. 2007. Music in Video Games. In *Music, Sound and Multimedia: From the Live to the Virtual*, ed. Jamie Sexton, 51–67. Edinburgh: Edinburgh University Press.

Nan, Yun, Thomas Knösche A., and Angela D Friederici. 2009. Non-musicians' Perception of Phrase Boundaries in Music: A Cross-cultural ERP Study. *Biological Psychology* 82: 70–81.

Nielsen. 2011. State of the Media: Consumer Usage Report 2011.

Norman, Donald. 1988. *The Design of Everyday Things*. Cambridge, MA: MIT Press.

North, Adrian C., and David J. Hargreaves. 2007. Lifestyle Correlates of Musical Preference: 1. Relationships, Living Arrangements, Beliefs, and Crime. *Psychology of Music* 35 (1): 58–87.

Page, Jason, and Michael Kelly. 2007. PS3 Audio: More Than Extra Channels. Paper presented at the Game Developers Conference, San Francisco, California, September 5–7, 2007.

Pham, Alex. 2008. Their Scores Can Be Huge. *Los Angeles Times*, December 8. .

Porter, Tony. 2010. Goldeneye DS Dynamic Music. *Game Audio Forum* .

Przybylski, Andrew K., C. Scott Rigby, and Richard Ryan M. 2010. A Motivational Model of Video Game Engagement. *Review of General Psychology* 14 (2): 154–166.

Rigby, Scott, and Richard Ryan. 2011. *Glued to Games: How Video Games Draw Us in and Hold Us Spellbound*. Santa Barbara, CA: Praeger.

Rogers, Chris. 2012. Web Audio API : W3C Editor's Draft. .

Ross, Rob. 2001. Interactive Music...er, Audio. *Gamasutra*. May 15, 2001. .

Sadoff, Ronald H. 2006. The Role of the Music Editor and the Temp Track as Blueprint for the Score, Source Music, and Scource Music of Films. *Popular Music* 25 (02): 165–183.

Salimpoor, Valorie N., Mitchel Benovoy, Kevin Larcher, Alain Dagher, and Robert J. Zatorre. 2011. Anatomically Distinct Dopamine Release during Anticipation and Experience of Peak Emotion to Music. *Nature Neuroscience* 14 (2): 257–262.

Selfon, Scott. 2003. Linear Playback. In *DirectX 9Audio Exposed: Interactive Audio Development*, ed. Todd M. Fay, 17–40. Plano, TX: Wordware.

——. 2004. DirectMusic Concepts. In *DirectX 9Audio Exposed: Interactive Audio Development*, ed. Todd M. Fay, 3–16. Plano, TX: Wordware.

——. 2009. Interactive Music Techniques for Games. Paper presented at the 127th AES Convention, October 9–12, New York.

Sloboda, John, A. 1991. Music Structure and Emotional Response: Some Empirical Findings. *Psychology of Music* 19 (2): 110–120.

Steighner, Mark. 2011. Interview: Assassin's Creed: Revelations Composer Lorne Balfe. December 6, 2011. .

Steinbeis, Nikolaus, Stefan Koelsch, and John A. Sloboda. 2006. The Role of Harmonic Expectancy Violations in Musical Emotions: Evidence from Subjective, Physiological, and Neural Responses. *Journal of Cognitive Neuroscience* 18 (8): 1380–1393.

Stuart, Keith. 2010. Redemption Songs: The Making of the Red Dead Redemption Soundtrack. *The Guardian*, May 26. .

Suits, Bernard. 2005. *The Grasshopper: Games, Life and Utopia*. Peterborough, ON: Broadview.

Summers, Tim. 2011. Playing the Tune: Video Game Music, Gamers, and Genre. *Act: Zeitschrift für Musik & Performance* 2, July. .

Taylor, Michael. 2012. Interview with Michael Bross. *Designing Sound*, May 7. .

Vorderer, Peter, and Jennings Bryant. 2006. *Playing Video Games: Motives, Responses, and Consequences*. London: Lawrence Erlbaum.

Weir, Paul. 2011. Stealing Sound: The Application of Generative Music. Paper presented at the Game Developers Conference, San Francisco, California, February 28–March 4, 2011.

Whalen, Zach. 2004. Play Along: An Approach to Videogame Music. *Game Studies* 4 (1). .

Wharton, Alexander, and Karen Collins. 2011. Subjective Measures of the Influence of Music Customization on the Video Game Play Experience: A Pilot Study. *Game Studies* 11 (2). .

Whitmore, Guy. 2003. Design with Music in Mind: A Guide to Adaptive Audio for Game Designers. *Gamasutra*. .

## Notes:

(1) . In this technique the music cells start and end at performance boundaries that encapsulate a “pre” and “post” section, rather than simply containing the musical section itself. This means that the cells overlap when transitioning, allowing the decay of the current phrase to finish naturally (Whitmore 2003).

(2) . There is an additional form described in Figure 9.6, where the player acts directly on the musical form, such as in rhythm action games, termed here “performative”‘ (dotted and dashed lines).

**Richard Stevens**

Richard Stevens is a Senior Lecturer and Teacher Fellow at Leeds Metropolitan University where he leads the MSc. in Sound and Music for Interactive Games. He is a leading evangelist for game audio education, chairing the Education Working Group of the IASIG (Interactive Audio Special Interest Group) through to the publication of their ‘Game Audio CurriculumGuideline’ Document, and promoting the subject through regular conference talks, panels and workshops. In 2011 he co-authored the first practical textbook in the field, ‘The Game Audio Tutorial’.

**Dave Raybould**

Dave Raybould is a Senior Lecturer at Leeds Metropolitan University where he teaches game audio, sound design and synthesis. He has produced a number of presentations at game audio conferences and co-authored 'The Game Audio Tutorial: a practical guide to sound and music for interactive games”.