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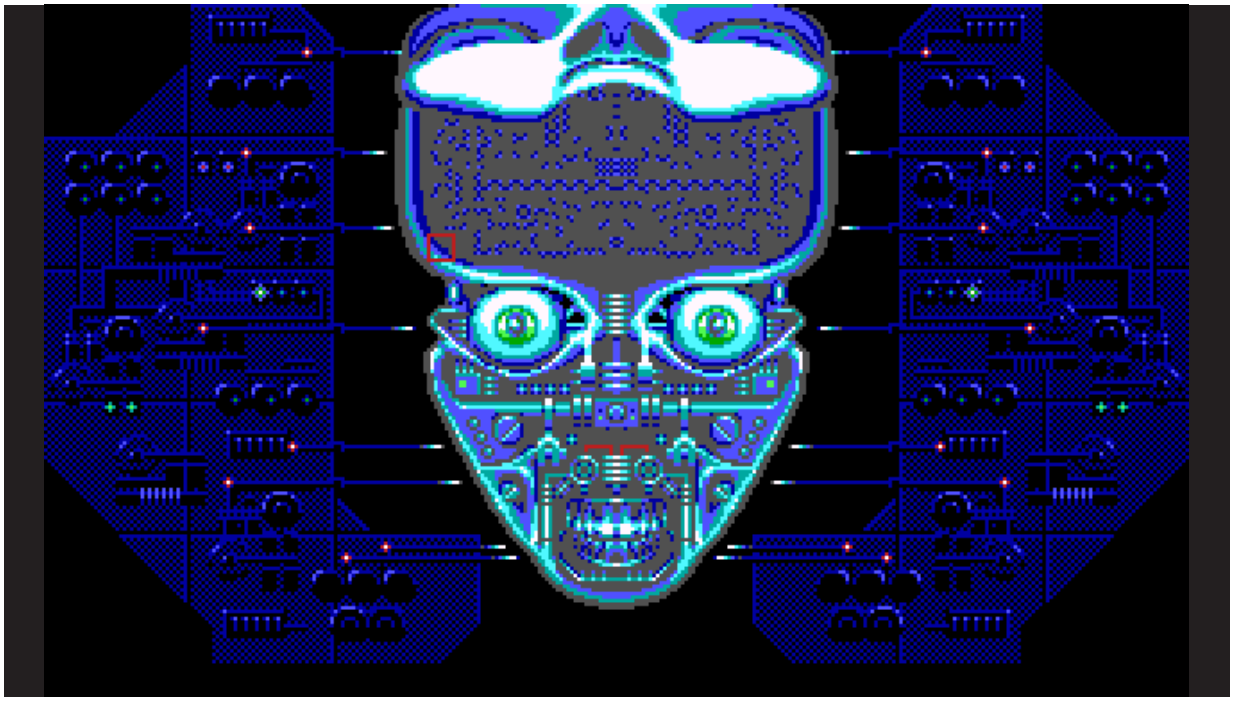
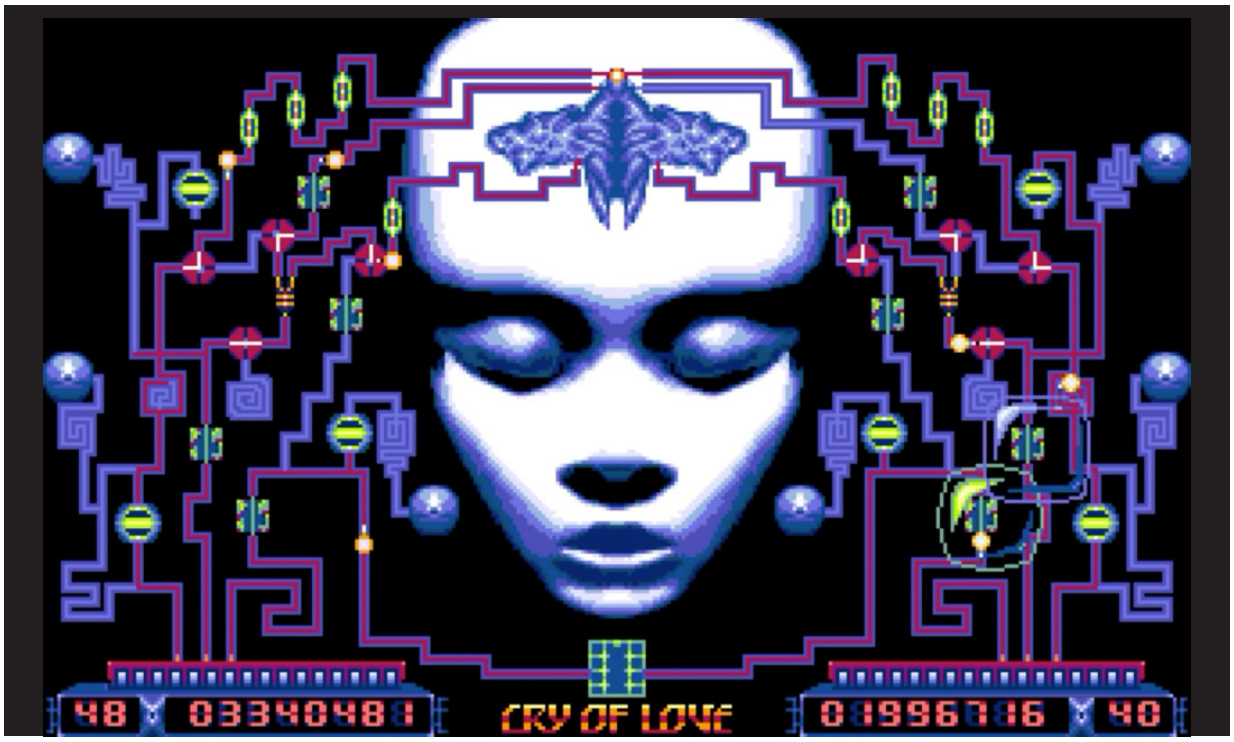
HEAR THE MUSIC, PLAY THE GAME

Music and Game Design: Interplays and Perspectives

Edited by H. C. Rietveld & M. B. Carbone





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JOURNAL ESSAYS

HILLEGONDA C RIETVELD
London South Bank University
h.rietveld@lsbu.ac.uk
& MARCO BENOÎT CARBONE
London College of Communication
marcobenoitcarbone@gmail.com

Introduction

Towards a Polyphonic Approach to Games and Music Studies

There is a growing recognition of the role of music in games by the gaming industry, game fans, and journalists. Several conferences have been established on the roles of music and sound in video games, such as the industry-focused GameSoundCon, first initiated in Los Angeles in 2009, and Game Music Connect, that has taken place annually between 2013-15 in London. Simultaneously, the study of music and audio in games is gaining interest in game studies. For example, Rob Hubbard, most famous for his work on the Commodore 64 system, has been recognized with an honorary degree by Abertay University in Dundee, Scotland (Wawro, 2016). The tendency, however, is not only in response to the industry. It is also in line with an "Auditory Turn" in the humanities and social sciences, providing an alternative sensory approach to a notable visual dominance in the humanities and in media and cultural studies (Herzogenrath, 2017).

Sound has, of course, always been a crucial aspect of gaming audio-visuals. Far from merely accompanying a game, the auditory elements bring life into the game interface.

In line with the auditory turn, the past few years have seen an explosion of studies of sound and music in games. Karen Collins' work has set the wheels in motion in 2008 with an edited collection. In the same year as her the landmark publication, *Game Sound*, offered a systematic understanding of game music. Organizations and study groups also emerged as part of an interest in game sound that covers a broad, multidisciplinary field. The annual North American Conference on Video Game Music also held its first event in 2017. Another specific focus on game music has been offered by the annual *Ludomusicology*conference, which began its work as an RMA (Royal Musical Association) study day in the UK. A Ludomusicology special journal issue for *The Soundtrack* 8/1-2 was published in 2015, and in September 2017 the *Journal of Sound & Music in Games* (*JSMG*) was announced with Mark Sweeney (interviewed in this issue of GAME) as its Director and Michael Austin as Secretary. The study area of *Ludomusicology*addresses the video game music from the perspective of musicology, as can be found further in a recent collection edited by Kamp, Summers, and Sweeney (2016). In addition to musicology, media and cultural studies provided a wider social perspective on games and music. These include works by Austin

(2016) and by Donnelly, Gibbons, and Lerner (2014), both reviewed in this issue of *GAME*. Further publications are now appearing in the field, including a comprehensive textbook by Tim Summers (2016), also reviewed in this issue.

The above overview of recent approaches to game sound is far from exhaustive, but it provides an insight into the importance of reappraising the sonic element in games. Sound has, of course, always been a crucial aspect of gaming audio-visuals. Far from merely accompanying a game, the auditory elements bring life into the game interface. Sound is a sonic vibration that produces embodied affect. It also elicits interpretations, and provides the player an immersed sonic sense of architectural space. Sound effectively build the game space. The sonic dimension has always taken part in orientating game play perspectives, positions, and rhythms of interaction, from the ominous march of *Space Invaders* (Taito, 1978) to the more recent experiences of games based on virtual and augmented reality technologies. Music, moreover, provides sound with the potential for temporal and harmonic forms. Game music is a necessary element of the immersive dramatic pace and rhythm of many games. It would be very hard to think of an experimental music shooter like *Rez* (UGA 2001) without its central sonic element, and it would also be hard to remember a game like *Streets of Rage 2* (Sega 1992) without its Yuko Koshiro soundtrack, or *Super Mario Bros* without its Koji Kondo score (Nintendo 1983). Game studies has only scratched the surface of the importance of music. Interestingly, elements of change come from scholars from the borders of the gaming field. Schartmann, in his study on Super Mario Bros' soundtrack (2015) provides a holistic, contextual analysis of the success of the game that does justice to its audio-visual-interactive complexity. More simplistic analyses from game studies, on the contrary, seem to forget the sonic dimension of the game, describing it often from the mythical perspective of the genius game designer/solo artist, overlooking some of the manifold, eminently choral elements, agents, and contextual elements that made it possible (deWinter, 2015).

A reappraisal of the importance of the auditory elements in games could has two important consequences: first, it could challenge dominant definitions of *video* games, suggesting a more nuanced view of the medium characterized by a recognition of its hybrid and polymedia forms; second, it paves the way for alternate histories of games, in which music and sound would regain their apparent, but often overlooked, centrality in players' experience.

Forthcoming studies on games and music are likely to highlight and look at games from an auditory positionality, as Schartmann (2015) did with *Super Mario Bros.* The directions are manifold. Sound and music are important elements of narration. They can contribute to the story *diegetically*, with music created in the dramatic space–think of the use of radio in the *Grand Theft Auto* series. They can also play their role *non-diegetically* as an accompaniment that is not always hidden as underscore, but that can become distinctive and memorable–think of the gloomy synths of *Shadow of the Beast*(Reflection/Psygnosis 1989). Even more so, the interactive soundscape of the new *Doom* (id Software, 2016)

effectively co-constructs the gaming experience: far from sitting behind the gameplay, it is a dynamic and integral part of the pace of the shooter that works alongside the environment and interaction, and an essential element for its brutal elements of pathos. *Doom*'s music effectively shapes the game with non-linear solutions, taking into full effect previous experimentation with dynamic soundtracks in games. Experimental games like *Extase* (1991), featured on the cover of our issue, are among the earliest and more radical examples of how music can be the game experience. Designed by R. Herbulot with P. Dublanchet, M. Rho, and P. Ulrich, *Extase* features interactive music by Stephane Picq as a key to its success as a music puzzle that works as an interactive soundscape.

Yet, game music also lives on outside the game itself, in various guises. Broadly speaking, the sonic elements add to the emotional and cultural dimensions of the game through a wide range of *paramusical fields of connotation* (Tagg, 2015): elements that take part in defining any gaming text. In effect,As Kamp (2016) shows, music is in menus, start screens and other circumstantial components outside the *diegesis*of the game. Moreover, orchestral and pop performances are popular within specific game subcultures (Carbone & Ruffino, 2013), which throws up debates regarding which version may be more authentic, the original game version or the performed full vision of the composer (Gibbons, 2015). As Mike Gordon, the composer and producer of *Doom*'s 2016 OST (original soundtrack) puts it: "I think video game music should always be able to find some sort of place outside the game; […] that should always be the ultimate goal" (O'Dwyer, 2016, 20:30). In effect, *Doom*'s music is so intertwined with the gameplay as to raise the question of whether or not it can be fully appreciated outside of the game (and vice versa)––in addition to reminding of the deep connections between early first-person shooters like the original *Doom* (id Software 1991) and metal and industrial music from the 80s and 90s.

Game music not only functions as a reminder of games played but is also used to promote the games. By becoming a defining part of gaming franchises, game music can become a successful product in itself. In this sense one literally hears the music, and next plays the game. Original soundtracks can be found in digital formats and, perhaps unexpectedly, on vinyl aimed at distinct collectors' markets (see, for example, Napolitano, 2012), as well as on dedicated online sites that offer game music soundtracks (for example, Spotify's dedicated VGM channel––Vincent, 2016). The pleasure of game engagement is further extended through OST remixes by game fans, subcultural activities that may well become independent of gameplay as techno, grime, dub step, trap, and hip-hop remixes of games such as the *Zelda* techno and the *Super Mario trap;* such experimentations abound on social media sites.

Game music inspires a particular sonic aesthetic in electronic music production by a generation that has grown up within games' cultures. Computer game music is now embedded into the very fabric of electronic music genres and concomitant music cultures.

There is a continuous dialogue, moreover, between games and a wide range of musical styles, from classical to popular, and from fan-based to avant-garde experimentation. As video game music lives on in the sound of contemporary popular music, the chiptune scene particularly celebrates the early low-res game sound, applying this to new contexts. Similarly, perhaps, a reordering of cultural memory takes place in the reuse of game technologies. For example, the obsolete Gameboy handheld game was hacked in the late 90s by Oliver Wittchow as performative musical instrument (Wittchow, 2014), emphasizing the ambiguity between gameplay and obscured music performance (McAlpine, 2016), which is further worked out as a training ground for digital music performance (BeatLab Academy, 2016).

Not surprisingly, game music inspires a particular sonic aesthetic in electronic music production by a generation that has grown up within games' cultures. Computer game music is now embedded into the very fabric of electronic music genres and concomitant music cultures. With reference to the grime music scene in the UK (a music style based on a genealogical mix of electronic dance music and hip-hop), Rob Gallagher demonstrates in this issue, how a generation of music makers that have grown up with game culture and digital music software and now weave this experience into their music. Other examples of game music inspired genres include hip-hop (Dirs. Dwyer & Neill, 2014; Vice Staff, 2014), gabba/gabber house (Schouwenburg, 2013), and a range of other electronica (Hinton, 2017). Making use of MIDI (Music Instrument Digital Interface) that became available during the mid-80s on sound cards, music composition software was developed for the same computers as video games (Manning, 1994). For example, C-Lab's relatively short-lived 1986 *Supertrack* for the Commodore 64 micro (Jenkins, 1986), followed by C-Lab's *Creator* (Trask, 1987), pre-runner of *Notator Logic* and *Logic Pro*, and Steinberg's *Cubase* (Lord, 1989) for the Atari ST home computer, which attractively included a MIDI-to-PC port. Such music production software treats *musemes* (distinct musical components––see Tagg, 2013) as building blocks that are sequenced and triggered. Also, the sequential visual display of music software offers a graphic interface that reminds of music and dance games in terms of moving along musemes on a linear timeline. Mobile gameplay and music apps add a different dimension to this, as musical elements merge with finger movements.

The specific characteristics of interactive and immersive player engagement with non-linear music composition and adaptive audio set it apart from linear music composition, however. This is illustrated in detail in the *BEEP* research project, in which Karen Collins and her team video-document interviews with game composers around the world. Engagement with games, game music and game culture is also addressed from players' perspectives in her work on player interaction (Collins, 2013). In this issue, interview clips from the *BEEP* project are linked to a playlist of her favourite game music, showing a dynamic connection between the personal experience of game music and research in the area. In this

issue, the topic of interactive game sound is further addressed by Tom Langhorst, with a focus on sound effects that provide believable action cues, and by Zander Hulme's investigation of the issue of crossfading between audio components during gameplay. In his recently published monograph, Rob Gallagher (2017) suggests that a socially produced embodied alignment occurs between gamer and the rhythm of the game, a type of "entrainment". Musical pulse and rhythm can significantly enhance the experience of entrainment produced within the rhythms of gameplay interaction through both seductive flow and the challenge of rupture. A type of interactive dialogue is set up in this way between the game environment and player, similarly to the way in which between DJs and dancers become part of a responsive network (Ferreira, 2008; Rietveld, 2016).

Providing a varied series of perspectives on the many directions in which the study of the auditory dimension could bring game studies, as well as games, our edited collection offers a glimpse into its "polyphonic" and still vastly under-explored fields, identifying some of them, and suggesting a long-term cooperation and interplay between music and game studies.

Another critical aspect of game music is its enmeshment in narratives of gaming history that focus on technology and sound to celebrate innovation and appease a nostalgic sense of affection for video games. In this special issue of *GAME*, technostalgia is present in the discussions by James Newman, Kenny McAlpine and Tom Langhorst, each of whom addresses, in various ways, issues that relate to the aesthetics of low-resolution digital sound, which hail back to the early days of gaming. James Newman has worked extensively on the ephemeral ontology of video games as hardware becomes obsolete and software is superseded, and the challenges as well as questions this brings to game preservation (Newman 2012; see also Newman 2004 and 2008). In his study for this issue, Newman focused on the relations between technology and the musical, and on how composers like Rob Hubbard and Martin Galway went on to shape the sound of video game music for generations of players. From the perspective of sound design, Langhorst contributes to the related issue of the relationship between visual and audio realism as a designer, discussing game experience through sound in early games such as *Pong* (Atari 1972). Like Newman, Kenneth McAlpine also explores constraints faced by early programmers. McAlpine focuses on designers working with 48k Sinclair ZX Spectrum and argues that their ingenuity turned limitations into creativity an innovation, effectively shaping an early sound of video games that would go down in history as well as influence modern developments like chiptune music.

Further contributions in our issue show examples of some of the many directions of research that the auditory element of design brings to the attention of game studies. Rob Gallagher's paper, as already discussed, shows how a generation of music makers grew up with game culture weaved this experience into their music. Frederico Peñate Domínguez addresses what he calls "Nazi rock 'n' roll", an imaginary American popular music used to promote *Wolfen-*

stein: The New Order, which simultaneously mythologizes Nazi culture through false musical memory. Peñate Domínguez discusses how music worked as an essential aspect through which the programmers were able to create an alternate, immersive, heterotopic post-WW2 history and to promote the game through it. In his article for this issue, Zander Hulme focuses on more technical aspects related to this issue. He discusses how the implementation of adaptive musical through dynamic, *imbricate* audio could further increase the ability of composers to immerse players in gameplay. Other contributions in this issue include reviews of recent books on the subject of games and music, an interview with the Ludomusicology research group, and an original playlist on memorable moments in game sound history by Karen Collins. Providing a varied series of perspectives on the many directions in which the study of the auditory dimension could bring game studies, as well as games, our edited collection does not aim to provide an exhaustive or linear history of game music. Rather, it offers a glimpse into its "polyphonic" and still vastly underexplored fields, identifying some of them, and suggesting a long-term cooperation and interplay between music and game studies.

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AUTHORS' INFO

Hillegonda C Rietveld is Professor of Sonic Culture at London South Bank University and, between 2011-17, Chief Editor of

IASPM Journal, the journal of the International Association for the Study of Popular Music.

Marco Benoît Carbone (PhD, UCL) is an Associate Lecturer in Media Communications at the University of the Arts, London College of Communication. He is a member of the UK and Italian branches of DiGRA – Digital Games Research Association.

ROB GALLAGHER
King's College London
robert.gallagher@kcl.ac.uk

"All the Other Players Want to Look at My Pad": Grime, Gaming, and Digital Identity

ABSTRACT
A fusion of jungle, garage, hip-hop and Jamaican sound system culture, grime emerged from the housing estates of East London in the early 2000s. The genre has always had strong ties to gaming, from producers who cut their compositional teeth on *Mario Paint* (Nintendo R&D1, 1992) to MCs who incorporate videogame references into their lyrics, album titles and aliases. This article traces grime's relationship with gaming from the genre's inception to the present, focusing on two case studies: veteran London MC D Double E's 2010 track "Street Fighter Riddim" and Senegalese-Kuwaiti musician Fatima Al Qadiri's 2012 *Desert Strike* EP, a "soundtrack" to her experiences of the first Gulf War. Showing how players build videogames into their life stories and identities, these case studies affirm that gaming was never the exclusive preserve of "nerdy" white middle-class males while foregrounding the ludic dimensions of digital musicianship and the musical dimensions of digital play.

KEYWORDS: *Grime, identity, masculinities, sampling, gamer culture*

INTRODUCTION

A startling new form of bass music characterized by manic energy, angular futurism and seething machismo, grime emerged from the council estates of East London in the early 2000s (Hancox, 2013, p.7). Rooted in jungle, garage, hip-hop and Jamaican sound system culture, the genre also had another key influence: videogames. This article argues that attending to the traffic between grime music and gaming culture can help us to understand better how players integrate gaming into their routines, relationships, biographies, vocabularies and identities, and to account for the diverse cultural functions videogames perform for different audiences in different contexts. This argument is developed in relation to two case studies: veteran London MC D Double E's 2010 track "Street Fighter Riddim", which uses characters from Capcom's fighting game series as material for a playful musical self-portrait, and Senegalese-Kuwaiti musician

Fatima Al Qadiri's 2012 *Desert Strike* EP, a grime-inflected, videogame-referencing exploration of its creator's childhood experiences of the first Gulf War.

Treating games as a musical and cultural resource, grime artists affirm James Newman's (2008) argument that playing videogames is only one mode of playing *with* videogames. Newman, however, elaborates this claim in relation to the activities of "dedicated gamers" and "communities of fans" whose deep investments find expression in practices like fan-art, cosplay, speedrunning, glitch hunting and the production of online guides (ibid. p.13)[1]. Unlike these practices, grime engages with videogames without being exclusively or even primarily "about" gaming. Like the hip-hop stars discussed by Nassim Balestrini (2015), grime artists incorporate a diverse array of verbal, visual and sonic materials into "'hybrid… works" of "intermedial life writing"[2] in which self-presentation shades into "myth-making" (pp.226 and 237). While many have looked to games for sounds, aliases and imagery, their productions and performances also bear the stamp of many other influences. Grime is a spur to recognize that individuals who may not fit conceptions of a "typical gamer", and who would not necessarily see themselves as part of "gamer culture", also participate in forms of creative play with videogames. The genre's pioneers were mostly young black men living in some of the UK's most deprived boroughs, some first- or second-generation immigrants. Their engagements with videogames affirm the importance of interrogating "the male (white and middle-class) image of the digital game player" and of expanding our conception of "gamer culture" (Shaw 2014, p.viii). Beyond that, looking at gaming through the prism of grime provides a new perspective on questions that have long preoccupied game studies scholars. Like gaming culture, grime poses a challenge to conventional understandings of creativity and cultural value. Both have been characterized as insular, all-male scenes oriented around troublingly violent, bafflingly repetitious cultural artefacts rife with second-hand signifiers and abrasive digital textures that are an affront to refined aesthetic sensibilities. While such complaints are hardly without foundation, they fail to tell the whole story.

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This article attempts to offer a more even-handed account. The following section provides information on grime and its history while looking at how videogames have been incorporated into grime artists' lyrics and music. It proposes that the frequency with which MCs and producers have turned to videogames for similes and samples points to a profound connection between gaming and grime, both of which are founded on the live configuration of libraries of fragments. Highlighting stories of producers whose first experiments with musical composition happened on gaming hardware, I argue that

1. Cosplay ("costume play'") involves dressing up as favourite characters from games and other media (see Newman, 2008, pp. 83-8). Speedrunners compete and collaborate to find the quickest routes through games (see ibid, pp.123-48). Glitch hunters systematically comb gameworlds looking for errors, exploits and logical quirks (see ibid, pp.113-6, and Meades, 2013).

2. Life writing studies, despite its name, is interested not just in texts but in the myriad media practices through which "the self or personality" is constructed, expressed, performed and recorded (see Poletti & Rak, 2014, pp. 20-23). Whether or not grime is a vehicle for verifiable biographical information, it certainly constitutes life writing on these terms, and rewards analysis from this perspective.

grime's ongoing love affair with videogames brings both the ludic dimensions of digital musicianship and the musical dimensions of digital play into focus. This claim is developed in the next section through a close analysis of "Street Fighter Riddim"; serving as an example of how grime MCs articulate identities using videogame references, the track is also striking for what it suggests about the terms on which players can be said to identify with their avatars. The article concludes with a consideration of *Desert Strike*; drawing attention to the terms on which images, events, texts and styles circulate in an era of globalized markets and digital mediation, Al Qadiri's EP has sparked discussions of authenticity, appropriation and gatekeeping that are relevant not just for game studies but for our understanding of networked cultural identities more generally.

BACK IN THE DAY: GRIME, TRADITION AND NOSTALGIA

For Simon Reynolds (2007), grime represents a particular phase in the history of the "hardcore continuum"–a British rave music aesthetic encompassing forms like jungle, drum 'n' bass, UK garage, 2-step, grime, dubstep and UK funky (p.351). Writing in 2002 of the sound that would become known as grime, Reynolds reads it as a "drastic remasculinization" of UK break-beat and bass music, exchanging the "bump 'n' flex, the sexy swing" of 2-step garage for twitchy percussion, bludgeoning bass and furious rhymes (ibid. p.347). In emphasizing the role of MCs, grime continued a trend started by garage crews like Pay as U Go Cartel, from whose ranks grime lynchpins like Wiley, Flow Dan and DJ Slimzee emerged. But where garage lyrics were rife with aspirational hedonism (all fast cars, fur coats and freely flowing champagne) early grime tracks were altogether bleaker in tone, alternating between "alpha-male predatory" boasts and sketches of everyday struggle and stress (ibid.). Discussing poverty and crime while referencing soap operas, sitcoms and premiership football, early grime also witnessed gaming's role in day-to-day urban life. Just as mid-90s US hip-hop crews like the Wu-Tang Clan and the Three Six Mafia peppered their work with references to *wuxia* cinema, Marvel comics and video nasties, so grime MCs drew images and aliases from games, whether it be Fudaguy comparing himself to a "shadow demon" from *Shinobi* (Sega, 1987-2011), Tinchy Stryder cribbing his name from a Capcom game or Footsie asserting "They're not on it / They don't want it / Watch how I make a boy / Run like Sonic" (Newham Generals, 2006). Providing grist for threats and power fantasies, games also offered a way to evoke the past. In some tracks, referencing gaming history becomes a means of asserting seniority; witness Demon (2005) declaring himself "old school like a Commodore 64" or Wiley (2006) boasting he "had the first Sega" on "Crash Bandicoot Freestyle". In others, it is a means of conveying the nostalgia for "the idealised prelapsarian bliss of childhood" that Hancox (2013, p.26) sees as a key characteristic of grime. By incorporating verbal or aural references to cute characters (like Mario, Sonic, Spyro or Crash Bandicoot) into music full of rage and paranoia, grime artists create moments of

tonal dissonance and sonic anachronism, speaking to a sense of lost innocence by framing themselves as children whose circumstances forced them to grow up too fast. For a genre bent on presenting itself as sonically forward thinking (one of the club nights that hosted grime was called FWD>>), grime's gaming tastes can be strikingly retro, with producers remaining loyal to 8- and 16-bit sounds––see Royal-T's "1UP" (2009), D.O.K's "Chemical Planet" (2010) or Champion's "Bowser's Castle" (2013). Evocative of the 1980s and 1990s, when many of grime's first wave were still at school, these references also correspond to geographic and socioeconomic factors, from the European success of Sega's Mega Drive hardware (rebranded under the name Genesis in the US) to the tendency for "economically disadvantaged" gamers to play their games on consoles rather than PCs at this time (Taylor, 2012, p.130).

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Even when grime tracks do not directly sample videogames, the crude tools used to create those formative early beats, many of which are awash with sawtooth waveforms and synthetic timbres, give them a sonic texture that will feel familiar to gamers. For this reason, grime is often discussed in relation to "chipmusic"[3]. But where much chipmusic involves the recuperation of aspects of "geek" and/or "gamer" culture, which once carried negative associations of social ineptitude and sexual inadequacy, grime artists, by and large, are interested neither in challenging the idea of "nerds" as "losers and loners" nor in interrogating "the compulsory cool of black culture" (Newman, 2008, p.17; Eglash, 2002, p.58). The whole point of white nerdcore hip-hop artist Professor Shyguy's 2013 album of chiptune R'n' B covers is the ostensible incompatibility of the gamer stereotype with the ghetto lothario stereotype; for grime artists, though, there is nothing contradictory about incorporating videogame references into hypermasculine brags. When Skepta (2006) warns "I know skeng man in my postcode / That will sniff two lines and go into devilish mode / Shoot you in the face then skid round the corner like Yoshi and Toad" his yoking of cokeheads and killers to *Super Mario Kart*'s (Nintendo EAD, 1992) cartoon dinosaurs and anthropomorphic mushrooms is meant to affirm his status as a "badman" so blasé about murder that it might as well be a child's game. Which is not to say that this persona is any more or less of a performance than Shyguy's; as Hancox (2013) puts it, "even the youngest of grime fans" understand that most "skeng talk"[4] is just that: talk (p.28).

As this suggests, grime is more reflexive than it is sometimes given credit for. That said, it is also a culture founded on "clashes" that see rival MCs trading insults, threats and occasionally blows, and agonistic machismo is very much its stock in trade. It shouldn't surprise us, then, that grime is particularly fond of

3. Chipmusic is defined by Carlsson as "music composed by using, emulating or sampling old digital sound chips" (2008, p.153). See also James Newman on chipmusic in this special issue.

4."Skeng" (along with "mash", "tool", "leng" and many more) being grime slang for gun.

fighting games. On the first *Lord of the Mics* DVD (2004), a key window on early grime culture, head-to-head clashes are preceded by samples of *Street Fighter II*'s (Capcom, 1991) announcer yelling "FIGHT".In 2013, when Bless Beats started a trend for uploading "war dubs" aimed at rival producers to the audio streaming site Soundcloud, meanwhile, peers responded with tracks sampling *Mortal Kombat* (Midway, 1992), *Killer Instinct* (Rare, 1994) and *Tekken* (Namco, 1994), tipping their hats to classics like JME's (2005) "Baraka" and Dizzee Rascal's (2004) "'Street Fighter". Skepta and Smasher are among the many MCs to wax nostalgic about *Street Fighter* while, as discussed later, D Double E has oriented an entire track around *Super Street Fighter IV* (Capcom, 2010) similes. Perhaps most striking, though, is DJ Logan Sama's story. Having transitioned from pirate radio to nationwide broadcasters like Kiss FM and BBC 1Xtra, he has, in recent years, become increasingly involved with fighting game culture, appearing on streams and podcasts, presenting a documentary on *Street Fighter*'s history and hosting events for Capcom at which grime artists often compete. That the two scenes are compatible is neither particularly shocking nor necessarily flattering: both thrive on macho taunts and fierce competition, and if fighting game culture still has issues with inclusivity and abuse, grime is no less prone than dancehall or hip-hop to homophobia and misogyny (Harper, 2014, p.124-5). Without wishing to discount these cultural politics, though, I want to argue that this crossover speaks to other, arguably more profound, parallels between grime and gaming.

PERFECT COMBOS: PERFORMANCE AND EMERGENCE

Paul Ward (2002) observes that all videogames entail "the combination of pre-rendered animated fragments" from a "finite library" of possible selections (p.126). Expert play is about demonstrating one's mastery of this library by fluently stringing together fragments into sequences tailored to the situation at hand. Viewed as a configurative practice, gameplay betrays striking affinities with grime, affinities highlighted by stories of producers cutting their compositional teeth on games or gaming hardware: Ruff Sqwad's Dirty Danger ran Fruity Loops on a PC his dad gave him for gaming, brothers JME and Skepta began making music on games like *Mario Paint* (Nintendo, 1992) and *Music 2000* (Jester Interactive, 1999), and others have similar tales (Hancox, 2012; Twells, 2016). Even when grime producers weren't using these tools[5], they were building beats according to rigid compositional rules. Characterized by eight bar loops, a tempo of around 140 beats per minute and an emphasis on bass, grime's sound was shaped by the presets, patches and samples built into certain keyboards and software studios. Wiley's influential early tracks, for example, use the "Gliding Squares" preset found on the Korg Triton, the same keyboard hailed in the title of the 2015 *King Triton* LP by Slew Dem's JT the Goon. If grime tunes can sound formulaic and repetitious to the uninitiated, this is in part because each track has to play by these formal rules in order to suit the needs of DJs and MCs–MCs who, rather than fitting their lyrics to

5. There is a tendency for journalists, seduced by the romantic notion of grime artists crafting hits on PlayStations in teenage bedrooms, to overstate the importance of games like *Music 2000* to the scene; Braddock's (2004) hyperbolic assertion that *Music 2000* "is to today's music what the guitar was to the pop boom of the 1960s" represents an early example.

fit a particular track, will develop an arsenal of all-purpose rhymes ready to be deployed whenever the microphone comes their way, dividing their flows into 8- or 16-bar chunks. Like computer scientists, then, grime artists think in powers of two: "eights… sixteens, thirty-twos, sixty-fours" (Wiley, 2013). And, like game design, grime production is about constructing tightly circumscribed "possibility spaces" within which playful performances can occur (Salen & Zimmerman, 2004, p.390). Grime performers dexterously retrieve and recombine musical and lyrical fragments to create compelling new combos, competing for supremacy. While grime may be fiercely anti-authoritarian, it also understands that there can be no play without rules.

This playful attitude also informs grime artists' use of "canned" sounds and familiar samples. In many electronic music genres, producers try to transform off-the-shelf sounds beyond recognition, creating new effects and obfuscating their sources. For Tricia Rose (1994, p.73), it was hip-hop that first "inverted this logic" by using recognizable samples, a practice that Tara Rodgers (2003) reads as a means of weaving a "complex web of historical references" while also "contesting dominant systems of intellectual property and musical ownership" (p.314). It is not necessarily incorrect to see grime's use of ready-made sounds as betraying a lack of expertise, resources or patience–as Dizzee Rascal asks, "why spend a day on one tune when you can do four?" (Hancox, 2013, p.38). In the genre's early years, in particular, many producers were resourcefully making use of what they had to hand. XTC's 2004 track "Functions on the Low", now best known as the basis for Stormzy's UK top 10 hit "Shut Up" (StormzyTV, 2015), uses a stock Shakuhachi flute sample that has also featured in 1980s adult contemporary hits, Hollywood fantasy soundtracks and vaporwave satires (Howe, 2013). The demonic cackle that would become Terror Danjah's personal sonic signature, meanwhile, came from a jungle sample pack (Ryce, 2010). But convenience and lack of access to technology are not the only reasons for using generic or second-hand sounds. As we have seen in relation to their use of samples from games, grime producers often deploy familiar sonic fragments to mobilize the meanings and associations they carry. Beyond that, using the same palette as other producers enables grime artists to situate themselves within an evolving aesthetic tradition. In some cases, they might be paying tribute to a hero: Wiley's "eski click" effect (which fans speculate originated as a *Mario* sample) has spawned its own microgenre of "eski-beat" homages. In other cases, it can be a matter of contesting rival's claim to a sound: Wiley himself made "Morgue" (2003) after a falling out with Wonder, using the same sonic building blocks as Wonder's "What" (2003) in an attempt to beat his former crewmate at his own game. In both cases there is a lusory instinct in evidence, as producers compete to make familiar sounds their own, imbuing them with new resonance and significance.

One of the other elements that makes grime sound videogame-like is its use of sampled sound effects as melodic and percussive elements. Hearing produc-

ers Rapid and Dirty Danger weaving the same canned dog barks, gunshots, squealing tires, grunts and yells into new compositional patterns across the Ruff Sqwad compilation *White Label Classics* (2012) is not unlike watching, or listening to, a gamer working through a game's grammar of available "moves" (jump, grab, shoot etc.) as they figure out how to progress. While rhythm games like *Guitar Hero* (Harmonix, 2005) foreground the parallels between musical performance and digital play, Kirkpatrick (2011) has argued that digital games in general have less in common with film or literature than they do dance, music and visual art. For him games are first and foremost about the dexterous production of harmonious forms and the interplay of repetitious patterns, not storytelling or symbolism. Kirkpatrick also observes that forms like dance have traditionally been gendered feminine, and it is perhaps this that has inspired videogame designers to (over)compensate by cloaking the process of "dancing with [our] hands" in bombastically masculine trappings, as a matter of lone starship pilots saving the galaxy or crack soldiers slaughtering terrorists (ibid. pp.153-4)[6]. In grime, too, brilliant displays of dexterity, fluency and formal imagination often come wrapped up in violent, misogynistic and homophobic imagery, as MCs bid to "merk" (murder) the beat, the dance, their rivals. Such rhetoric confronts critics with a quandary familiar to game studies scholars: how do we talk about the value of cultural forms whose representational content might be juvenile, generic, alienating or otherwise offensive? In evaluating these products can we separate form from content, and if so should we? I will return to this question later, arguing that while we should not let questions of content blind us to what is happening at a formal and an affective level, nor should we turn a blind eye to the way that grime and gaming perpetuate toxic stereotypes. For now, though, I want to pursue the idea that gaming and grime share an interest in live performance as a driver of emergence, an occasion for the playful production of new and unexpected combinations from familiar sets of parts.

As videogame preservationists note, games make little sense until they are played (Guins, 2014, p.31). Similarly, it can be hard to appreciate individual grime instrumentals until we have heard how DJs and MCs integrate them into the pirate radio sets that are the scene's definitive documents. More than just a mode of dissemination, the limitations and affordances of pirate radio had a profound influence on grime's sound. No sponsors to thank meant space for long-form mixes, *liveness* increased the stakes for performers and allowed for a degree of listener interaction, while FM radio's poor sound quality fostered forms of sonic branding that ensured particular artists' voices and styles would cut through the static. For producers, this meant aural watermarks like Terror Danjah's cackling goblin; for MCs it meant developing and deploying catchphrases, nicknames and vocal tics that might be compared to fighting game "special moves"–not least when, christening himself the "E3 tiger" in a guttural growl that is part Southern rap, part *Street Fighter*'s Sagat performing a "tiger uppercut", Wiley threatens to "Kill 'em with the tiger / Triple-hit combos / 20-hit

6. Kirkpatrick's argument resonates with Springer's (1991) observation that at the very moment digital technologies seemed to be offering the prospect of transcending gendered embodiment, popular culture began to abound with "cyberbodies" made to "appear masculine or feminine to an exaggerated degree", as if to counteract or compensate for any destabilization of gender norms (p.309). My thanks to the editors for highlighting this parallel.

combos / Uppercuts, body blows" (Mak 10 *et al,* 2003). David Surman describes the special move as a "reward spectacle": pulling off a tricky command at just the right moment, the *Street Fighter* player experiences "the visceral pleasure of synchronicity between play and representation… player and… player-character" (2007, p.210). The power of such reward spectacles is captured in a YouTube video cited by Todd Harper, in which famed *Street Fighter* player Daigo Umehara snatches victory from the jaws of defeat by parrying his opponent's "super art" before responding with his own devastating combo to end the match (NightmareZer0, 2006). Conceding that "the video might be hard to understand if you don't know the intricacies of the [gameplay] system", Harper argues that "the crowd reaction… gives even the lay viewer a taste of just how incredible that moment was" (2014, p.2). Beyond that, it suggests how fighting games are engineered to generate emergent drama, and evokes those moments of synergy and serendipity that sometimes occur in grime sets as an MC spitting with dazzling pace and fluency deploys a particular bar just as the DJ is transitioning from one track into another. And, just as many fighting games feature replays, allowing players to review and savor the winning blow, grime has "rewinds"– a performative convention borrowed from the reggae sound system practice of abruptly breaking the flow of the mix and manually winding the record back to the start in recognition of a particular beat, bar or drop's impact. Grime can, then, be viewed as a rule-bound framework within which performers deploy sonic signature moves to create moments of confluence and emergence, moments that are somehow more than the sum of their constituent parts. Like the Twitch streamers[7], speedrunners, tournament competitors and professional gamers who wring catharsis, comedy and suspense from familiar rules, animations, joystick prompts and lines of code, grime artists compete to create definitive combos, staking a claim to owning a moment, a sound, a track.

"JUST LIKE DHALSIM", OR IDENTIFICATION AND ITS DISCONTENTS

In the pursuit of such peak moments, DJs and MCs sometimes impose additional constraints on themselves, akin to the "expansive gameplay" practices of gamers who devise new "house rules", game types or challenges (Parker, 2008). Such practices are attaining a higher profile within gaming culture, as online streamers seek to woo viewers with evermore demanding and outlandish displays of gaming skill; grime has long been using radio and YouTube in this way. For example, in a 2007 freestyle video, Tinchy Stryder spits as he drives (timandbarrytv, 2007), while on a 2008 Rinse FM show DJ Spyro (who repeatedly emphasizes that he is mixing without headphones) blends a snatch of *Sonic the Hedgehog 2*'s (Sega, 1992) soundtrack into the mix before dissolving into triumphant laughter (D.O.K would later sample the same track on 'Chemical Planet'). MCs achieve similar effects through what literary scholars would call "procedural or constrained writing" (Baetens, 2012, 115-116). For the avant-garde OuLiPo group this meant projects like George Perec's *La*

7.Twitch is a platform for broadcasting play, including speedruns. More popular streamers often reach audiences numbering in the tens of thousands.

Dispotion (1969), a novel in which the letter "e" never occurs; for a grime artist, "constrained writing" might entail composing verses that pun on multiple car marques or cigarette brands. So-called "alphabet bars", which must incorporate all twenty-six letter sounds in sequence, offer another popular format for rule-bound rhyme composition. Some MCs are more adept at such wordplay than others. JME is particularly fond of writing lyrics that depend on double meanings, extended metaphors and the slipperiness of slang for their impact. In "Deceived" (2006a), for example, he sketches what sounds like a scene of gang violence (frayed tempers, knives and "tools", blood) before revealing he's actually describing one of the least grimy scenarios imaginable: doing some home improvement as a birthday surprise for his mum. In "Deadout" (2006b), meanwhile, he tells us he's "mastered the levels" and that "all the other players want to look at my pad", before specifying that he's talking about notepads not joypads, "the music game" not "*Super Mario*".

If "Deadout" frames lyrical composition as a form of play, the parallels are still clearer in D Double E's "Street Fighter Riddim", which name-checks most of the male characters in *Super Street Fighter IV*. Using these figures as lyrical avatars, the track suggests how grime might help game studies to rethink the player/avatar relationship. This relationship has, long preoccupied scholars. Decades ago, Marsha Kinder observed that her children were picking characters in *Super Mario Bros. 2* (Nintendo R&D4, 1988) based not on how those characters looked or who they were diegetically, but on what they allowed the player to actually do in-game (1991, p.107). In recent years Adrienne Shaw (2014) has been particularly forthright in questioning "common sense logics of representation" and received ideas about identification (p.ix). For her,

> "players do not automatically take on the role of characters/avatars. Playing as a character that is ostensibly 'other' to you (in terms of gender, race, or sexuality) is not necessarily transgressive or perspective-altering. Playing as a character that is like you (in terms of demographic categories) does not necessarily engender identification" (Shaw 2012, p.12).

Calling for greater nuance in discussions of diversity and representation, Shaw suggests that scholars should treat media as "source material for what might be possible, how identities might be constructed", observing that she herself 'grew up taking what I could from media and my surroundings, even when they didn't represent me" (2014, pp.3, viii). Viewed as source material for identity work, *Street Fighter* is simultaneously rich and potentially treacherous; as Harper observes, its characters may be "colourful, brassy and unique", but they are also crude "cultural and ethnic stereotypes" (2014, pp.1 and 109––original spelling). With "Street Fighter Riddim" D Double E makes these caricatures his avatars in a game of comic myth-making that, for all its flippancy, raises some interesting questions about the terms on which players relate to in-game charac-

ters. When, for example Double, a dark-skinned Londoner, "nearly six feet tall, but weighing only 130 pounds" with "elegant cut-glass features that border on emaciated" (Reynolds, 2007, p.379), aligns himself with *Street Fighter*'s Rufus, an obese American martial artist with a blonde braid, it is clearly not on the basis of nationality, ethnicity or outward appearance. Instead he uses the character to figure hunger or drive, declaring he wants to get paid so he can have a "big belly like Rufus" in a simile all the more arresting for the traits they don't share. Throughout the lyric, and indeed the accompanying video (timandbarrytv, 2010), Double elicits laughter through dissonance, incongruity and bathos, foregrounding the ways in which he is both like and *un*like Capcom's world warriors. Ostensibly, the track is about the gap between reality and play, as Double affirms his authenticity by repeatedly declaring "it's not a game like *Street Fighter IV*". His lyrics, however, playfully breach this boundary while also defying demographic pigeonholes. Double might sound deadly serious when tells us he's a "soldier like Guile", but it's hard to keep a straight face when Guile's blocky wedge of blonde hair is transposed onto his head in the video; if Double's "eyes are red like Akuma", meanwhile, it's not because they're radiant with demonic energy but because he's such a heavy "weed consumer". Comedy often emerges from the gulf between grime's world of drugs, criminality and cockney slang and *Street Fighter*'s cartoonish universe. Double uses rhyme and repetition to bridge this gulf, declaring he's "shocking MCs like Blanka" before dubbing his rival "a wanker" and then threatening to "come through in a beat up Honda / And give man a hundred slaps like E. Honda". In other cases comparisons are underwritten by puns and slang––as a lyricist he's got "hooks like Balrog" (a boxer) and "spit[s] fire" like Dhalsim, a character whose special moves literally set his opponents alight. Double also finds room to showcase his command of gaming trivia: asserting "In the final fight / I'm the guy / Everyone wants to be my Cody", he shows he's aware that the characters Cody and Guy first appeared in Capcom's *Final Fight*(1989), sneaking geeky insider knowledge into music that otherwise paints him as the very embodiment of myths of ghetto masculinity.

These myths are no less reductive than the national stereotypes on which *Street Fighter II*'s character designers drew. And while Double's reiteration of well-worn tough guy tropes is knowing and often hilarious, "Street Fighter Riddim" ultimately does little to expand the claustrophobically narrow range of masculinities sanctioned in grime. The lyric does, however, have some intriguing implications for debates about avatars, identity and identification. Double uses Capcom's characters to portray himself as witty, dangerous, mercurial, tenacious, resourceful, canny and, most of all, protean. In so doing, he offers us material with which to challenge the still-pervasive assumption that onscreen characters need to have key demographic variables in common with the player/viewer in order to be relatable. True, Double ignores *Street Fighter*'s female characters, but he also ignores Dudley, a black Londoner. Whether or not this relates to Dudley's design (a dandified horticulturalist with an immaculately

waxed moustache, Dudley is hardly the grimiest character in the game's roster), it certainly suggests something other than classical "identification" is at work in "Street Fighter Riddim". That something, I would argue, is closer to Carol Vernallis' (2013, pp. 158-9) account of how music videos can foster rapport across ethnic and socioeconomic lines via "kinesthetic expansion and contraction, a dynamic sense of embodiment" that "through the process of entrainment" connects "my body, the performer's body, and the music coursing through both". Vernallis, here, echoes both Surman's description of the reward spectacle and Brian Moriarty's (2002) influential discussion of gaming and entrainment. Such texts suggest that while, in many cases, representation and narration play an important role in fostering player/avatar connections, these are neither the only, nor necessarily the primary, means through which such connections are forged. In other instances (and especially in the case of genres like the fighting game, where fast-paced action typically takes priority over storytelling and character development) it may be kinemes, contours, trajectories, cadences, rhythms or colors that do the lion's share of the work. As Surman argues, the act of executing a special move at just the right moment can evoke a profound sense of being connected to our onscreen character, however irrational or fleeting this sense may be—just as vocal idiosyncrasies and technical flourishes (like the stutters, gurgles, groans and coos with which Double decorates his bars) can engage listeners viscerally quite apart from questions of lyrical content. Also important here is the track's dependence on simile, the basic building block of grime lyricism. Where metaphor conflates tenor and vehicle, simile (often described as metaphor's "weaker" cousin) concedes that the things it invokes are different even as it proposes that they have certain characteristics in common. Describing correspondences that are provisional, partial or temporary, simile arguably provides a better model than metaphor for describing what it is like to engage with an avatar. It also gives a better sense of how subjects perform identities online by configuring cultural fragments into new compositions which speak to them and which they can speak through, if only for the moment. Less a searching autobiographical meditation than a succession of pithy comparisons, witty punchlines and bravura acts of impersonation, "Street Fighter Riddim" exemplifies the playful, integrally *intermedial* character of contemporary life writing.

"ARE YOU REALLY FROM THE ENDS?" CROSSING THE BORDERS OF GRIME AND GAMING

Senegalese-Kuwaiti artist Fatima Al Qadiri's 2012 EP *Desert Strike* also takes up questions of grime, gaming, autobiography and identification, albeit from another angle. There are no lyrics here, and no direct samples of the 1992 Electronic Arts shooter after which the record is titled. Rather, Al Qadiri describes this suite of instrumental tracks "inspired by grime" as a "soundtrack" for a traumatic passage in both her own life and the history of Kuwait (*Dummy* 2012). As the biographical sketch on her record label's site has it,

> "In 1992, ten-year-old Fatima Al Qadiri bought a copy of *Desert Strike: Return to the Gulf*, a top-down shooter game for Sega Megadrive based on Operation Desert Storm. A year prior, Kuwait's inhabitants had experienced the apocalyptic vision of aerial bombings, air raid sirens, and skies filled with smoke from black oil fires. Time collapsed, schools closed, Fatima and her sister, Monira, spent their entire time at play – and began an addiction to video games that lasted for several years" (Fade to Mind, 2012).

Desert Strike, then, is about appropriation: commemorating Saddam Hussein's murderous land-grab and the USA's military reprisal, it also references Electronic Arts' appropriation of this scenario as material for a game––and it does so by borrowing from grime, a genre that caught Al Qadiri's ear partly through its use of videogame samples. In interviews she describes grime as "the most macho genre of western music… martial! The most apocalyptic and the most childlike music", observing that, "as a child who'd lived through the apocalypse, it resonated with me" (Sandhu, 2014). She also notes that "as a videogame fan, I knew some of the earliest grime tracks were recorded using PlayStations", suggesting that by combining "video game FX" which sound "innocent in isolation" with "warring beats and bass" grime producers fashioned a uniquely potent mode of expressing of anger, dread and trauma (Sandhu, 2014; *Dummy*, 2012). Originally a vehicle for everyday experiences of crime and violence on London's estates, Al Qadiri found in grime a sonic vocabulary equally suited to conveying the experience of living in a literal warzone: "I don't think anyone has really encapsulated that sensation… in a more accurate way than those tunes from the early 2000s" (ibid.).

In discussing *Desert Strike,* Al Qadiri also reveals a keen awareness of globalized capital's cultural crosscurrents. Reminiscing about a childhood spent watching "Chinese and Japanese cartoons" alongside British sitcoms, she explains that "like the majority of middle-class Kuwaitis, I'd go to London every summer… go to Woolworths to buy candy and comic books". Indeed, she first learned of Kuwait's invasion when she "woke to watch a Japanese cartoon dubbed into Arabic" only to find a newsreel playing (ibid.; Sandhu 2014). Professing her love for the music of games like *Castlevania* (Konami, 1986), she describes *Desert Strike* (the game) as featuring "one of the ugliest video game soundtracks I've ever come across" (*Dummy*, 2012). It is this "ugliness" (the aesthetic ugliness of the game's "shrill, high-pitched, really unsettling" sonics and the ethical ugliness of its "disturbing" repackaging of a war she actually lived through) that seems to license Al Qadiri's appropriation of *Desert Strike*'s title for a record of her own music informed by her own memories of the conflict (ibid.).

Dummy's interviewer implicitly frames this act of appropriation as an instance of what postcolonial theorists have called "writing back", whereby colonized authors respond to and rework imperialist "pre-texts" to tell their own stories (*Dummy*, 2012; Thieme, 2001, pp. 2-3). When it comes to Al Qadiri's relation-

ship with Electronic Arts, this model makes sense. It has its limits as a framework for understanding her relationship with grime, however. For where writing back tends to be understood in terms of a disempowered colonial periphery and an empowered imperialist center, it is harder to discern who wields power when it comes to Al Qadiri's repurposing of musical conventions developed by pioneering grime artists. The same can be said of early grime's much-discussed fascination with "oriental" tunings and textures. To be sure, "sinogrime"[8] tracks like Jammer's "Thug" (2004) smack of "sonic colonialism, whereby aural fragments are used for perceived "exotic" effect, without investment in, or engagement with, the music culture from which the sample was gathered" (Rose, 2003, p.318). Equally, though, they might be said to signal an outward-looking "cosmopolitan disposition" akin to that of certain "Western players of Japanese videogames" (Consalvo, 2012, p.200). Sinogrime is hardly a matter of a colonizing center's cultural elite romanticizing a "primitive" subaltern tradition; Hancox (2013, pp. 29-30) interprets tracks like "Thug" as expressing grime's futurism and its "aspirational, acquisitional tendencies", evoking "Shanghai tower blocks and the millennial promise of the newest superpower" in order to express an "intuition about where the future lies, geopolitically" on the part of British subjects disillusioned with what post-imperial, post-industrial Britain has to offer them.

Grime's sonic evocations of "the mysterious East", in short, are every bit as complex as Al Qadiri's evocation of early 21st century East London, reflecting the vicissitudes of a globalized popular culture in which sorting centers from peripheries, the over- from the under-privileged is not so easy as it once might have been. A mixed-race woman, raised in a war-torn country, Al Qadiri is also a graduate of New York University, child of diplomats and artists. Does her engagement with grime express as a sense of solidarity or identification with black British teenagers on Blair-era council estates? Is it appropriative or exoticizing? How do we map the power differentials and the dynamics of identification in such a case?

CONCLUSION

In the beginning, "grime was not just local but microscopically local", an "intensely territorial" scene rooted in "postcode wars and inter-estate beefs", proliferating via acetate dubplates and white label records, FM broadcasts, cassette tapes and Nokia phones (Hancox, 2013, pp. 39-41; Reynolds, 2007, p. 380). Over time, file sharing, video streaming, and social media have brought the sound to audiences from other geographical locations and other cultural and socioeconomic "positions"––listeners like me, a white, middle-class British male who started downloading grime sets as a university student in the mid-2000s. Even as the internet has expanded and diversified grime's listenership, however, it has also enabled the kinds of abusive gatekeeping gestures to which Al Qadiri alludes: "internet trolls have told me that I don't make grime" (*Dummy*, 2012). Like gamergate's harassment of perceived threats to "gamer culture"[9], such ges-

8. "Sinogrime" is a term coined by DJ, producer and academic Steve "Kode9" Goodman to describe the large subset of grime tracks which incorporate Chinese or "oriental" sounds and instruments (Feola, 2016).

9. As Chess and Shaw (2015) recount, gamergate mutated from a "harassment campaign" directed at Zoe Quinn, designer of the game *Depression Quest* (2013), into a "sustained online movement" united by its belief that feminists and "social justice warriors" were "actively working to undermine the video game industry" (p.210). Along with defamation and "doxxing" (the publication of sensitive personal data online), as well as rape and death threats, Quinn faced insistence that *Depression Quest* was "not a 'real game'"(Berlatsky 2014), similar to Al Qadiri's encounters with "trolls" appointing themselves arbiters of what counts as "real" grime.

tures prove it is easier to bully scapegoats than to engage thoughtfully with the myriad forces shaping popular culture in our networked and globalized age.

But if I am dubious of bids to paint *Desert Strike* as ersatz or illegitimate to shore up an image of what grime used to be or ought to be, I am equally suspicious of another mode of narrating the relationship between the two––one that will ring bells with videogame scholars. For, implicit in some accounts of *Desert Strike* is a kind of redemption narrative, whereby a genre that was, in the hands of the young men first drawn to it, a violent, juvenile plaything, realizes its potential as a "serious" artform, the vehicle for an autobiographical trauma narrative that echoes scholarly critiques of the "military-entertainment complex" (De Peuter & Dyer-Witheford, 2009, p.101). This is the way that gamification and "serious games" are sometimes framed: as a matter of a medium considered trivial at best and pernicious at worst finally being turned to a worthwhile purpose. There are parallels, too, with the denigration of the tastes and habits of so-called "bro gamers" by middle-class gaming journalists (Baxter-Webb, 2016), and with the advent of what Felan Parker calls "prestige games", titles that purport to transcend "mere entertainment", often by subverting the conventions of familiar genres like the 2D platformer or the first-person shooter to expressive ends (Parker, 2015, p.2)[10].

The music of figures like D Double E and Al Qadiri resoundingly affirms that gamer culture was never the exclusive preserve of "nerdy" white middle-class males, while also underscoring the playfulness of electronic music and the musicality of digital play. In grime as in gaming culture, rule-bound frameworks and libraries of component parts become the basis for compelling acts of live, configurative performance, blurring the line between identity work and intermedial play.

One might use the term "prestige grime" to describe the recent spate of melancholy, meditative album-length deconstructions of grime by artists like Al Qadiri, Sd Laika, Logos or Visionist. Formally reflexive, conceptually sophisticated and tonally cogent, these works lend themselves more readily to critical analysis and exegesis than, say, D Double E's scattershot back catalogue––a back catalogue that, like the fighting games it occasionally references, is also rife with violent and, as anyone who has heard Newham Generals' 2009 "Bell Dem Slags" can attest, sexist imagery. As cultural critics, we should not ignore this, but nor should we use it as an excuse to dismiss forms like grime or fighting games out of hand, as an alibi for resorting to politically inert formalist analyses, or as a cue to focus only on works that bend popular forms into more prestigious, or less problematic, shapes. For while grime's relationship with gaming emphasizes how rife with tired myths of masculine potency both remain, this is not all it tells us. The music of figures like D Double E and Al Qadiri resoundingly affirms that gamer culture was never the exclusive preserve of "nerdy" white middle-class males, while also underscoring the playfulness of electronic music and the musicality of digital play. In grime as in gaming

10. Here it is instructive to compare *Bioshock* (2K Boston, 2007), Parker's quintessential prestige game, and *Quake III Arena* (id Software, 1999). Both are considered significant first-person shooters. It is, however, much easier within the framework that our dominant critical vocabularies offer, to make a case for the cultural import of *Bioshock* (with its allohistorical critique of Randian politics and its reflexive exploration of free will and the player/designer relationship) than it is *Quake*––an exquisitely tuned platform for competition, but also a violent, gleefully tasteless mélange of horror and sci-fi clichés with little by way of a plot.

culture, rule-bound frameworks and libraries of component parts become the basis for compelling acts of live, configurative performance, blurring the line between identity work and intermedial play.

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AUTHOR'S INFO

Rob Gallagher is a postdoctoral researcher with King's College London's Ego-Media project. His work addresses the role of digital technologies in fostering new conceptions of identity and forms of self-presentation. He is the author of Videogames, Identity and Digital Subjectivity (Routledge, 2017).

JAMES NEWMAN
Bath Spa University, FHEA
j.newman@bathspa.ac.uk

Driving the SID chip

Assembly Language, Composition, and Sound Design for the C64

ABSTRACT

The MOS6581, more commonly known as the Sound Interface Device, or SID chip, was the sonic heart of the Commodore 64 home computer. By considering the chip's development, specification, uses and creative abuses by composers and programmers, alongside its continuing legacy, this paper argues that, more than any other device, the SID chip is responsible for shaping the sound of videogame music. Compared with the brutal atonality of chips such as Atari's TIA, the SID chip offers a complex 3-channel synthesizer with dynamic waveform selection, per-channel ADSR envelopes, multi-mode filter, ring and cross modulation. However, while the specification is sophisticated, the exploitation of the vagaries and imperfections of the chip are just as significant to its sonic character. As such, the compositional, sound design and programming techniques developed by 1980s composer-coders like Rob Hubbard and Martin Galway are central in defining the distinctive sound of C64 gameplay. Exploring the affordances of the chip and the distinctive ways they were harnessed, the argument of this paper centers on the inexorable link between the technological and the musical. Crucially, composers like Hubbard et al. developed their own bespoke low-level drivers to interface with the SID chip to create pseudo-polyphony through rapid arpeggiation and channel sharing, drum synthesis through waveform manipulation, portamento, and even sample playback. This paper analyses the indivisibility of sound design, synthesis and composition in the birth of these musical forms and aesthetics, and assesses their impact on what would go on to be defined as chiptunes.

KEYWORDS:*SID chip; driver affordance; design potential: Rob Hubbard; Martin Galway*

INTRODUCTION

Released in 1982, the Commodore 64 (C64) would go on to sell approximately 17 million units, becoming "the best-selling single personal computer model of all time" (CHM, 2007). Among its catalogue of approximately 10,000 com-

mercial programs, games were prominent, and the C64 became a key gaming platform with magazines such as *Zzap!64* (UK, Newsfield Publishing, 1985-1994), offering reviews and features on the ever-expanding catalogue. As Barton and Loguidice (2007) note, the C64's impact on the nascent home gaming space was significant, and its low cost and inherent flexibility of application when compared with single-function gaming devices are often cited as contributory factors to the early 1980s US market "crash" (see Wolf, 2012). The provision of two joystick ports and high-resolution graphics modes ensured that the computer was well suited to gaming. As such, like the BBC Model B and Commodore's later Amiga series, although originally conceived as a general-purpose home computer, the C64 was and continues to sit alongside dedicated videogame consoles in popular and scholarly discourse (see Gazzard, 2016; Maher, 2012).

Sound was especially crucial to the platform's success and, as Collins (2006a) notes, C64 game music has a "unique aesthetic" that makes use of "screaming guitar-like square wave solos, full-length songs, [and] attempts to re-create traditional 'rock band' line-ups in its use of tone channels" (online). Such was the popularity of C64 soundtracks that, in addition to rating the music and effects of the titles under review, *Zzap!64* regularly featured interviews with composers including Rob Hubbard and Martin Galway who gained a celebrity equaling the designers of the games their music accompanied. The magazine even compiled monthly Top 10 lists of readers' favorite soundtracks. The popularity of this music remains today with archives such as the online *High Voltage SID Collection* (*HVSC*) gathering files for replay on emulators dedicated to the singular task of reproducing C64 music and sound (to the exclusion of graphics or gameplay).

The unique aesthetic of C64 music is partly a function of the system's sound chip. The *Sound Interface Device* (or "SID chip", as it is more commonly known) is widely celebrated in gaming, electronic music and general computing discourse (Laing, 2004; Byte, 1995). It is known for the sophistication of its design and for being the inaugural project of the designer who would go onto to found Ensoniq, a company which low-cost sampling keyboards proved commercially and technically impactful in the musical instrument space (Vail, 2014). As Viens (2012: 47) notes, "This chip really requires no introduction. It's by *far* the most famous of all music chips in the world. It is also by far the most complex analog/hybrid chip of the lot" (original italics). Some caution must be exercised, however. The comparative sophistication of the SID chip's specification perhaps encourages the adoption of a broadly technologically deterministic approach to conceiving of videogame music production, in which aesthetics and specification are not only related to one another but also are historically mapped in terms of identifiable generations:

> "As with the visual side, the history of video game music is highlighted by the type of technology available at that time. As a result, we have the 8-bit, 16-bit, 64-bit, and the 128-bit eras. The first video games lacked a sound component, included

> only a brief theme, a few sound effects or were limited to simple melodies by early sound synthesizer technology" (Marquez, 2014: 68).

Eschewing a simple linear timeline, some commentators point to the distinctiveness of specific hardware devices and platforms. For Joseph P Beuckman (2001), "(c)omputers have personalities, shapes and architectures like a canvas that influence what we make" (Beige 0036, 2001: online). If we are to appreciate the unique aesthetic of the C64 music, disentangling the specific contribution of the SID chip and the compositional and sound design techniques that harnessed it is essential. This is especially the case given the tendency of contemporary *chiptune* practitioners and fans to conflate such differences. As Altice (2015) notes:

> "The output of the GameBoy, NES and Commodore 64 are now subsumed under the chiptune moniker, but the sonic character of those machines are far more unique than the Xbox 360, PlayStation 3, or Nintendo Wii. Games ported across those platforms will exhibit visual differences, but their soundtracks will remain the same. There is no "sound" of the Xbox 360 any more than there is a "sound" of an Onkyo CD player" (Altice, 2015: 277).

Moreover, given the particular characteristics of these chips' programming interfaces, I argue that we must extend our analysis beyond silicon design and specification. To appreciate the distinctive forms and aesthetics of C64 music, we must consider the creation of the music player routine or "driver", because it is in the creation of this interpretative software layer that we see the interplay between musical inventiveness, sound design, and the hidden and revealed affordances of the SID chip.

Ultimately, I argue that the creation of the driver is both a response to, as well as an investigative revelation of, the SID chip's affordances. In considering the chip in terms of a suite of affordances rather than a definitive or stable specification, I draw on Gibson (1979) and, in particular, Norman's (1999) exploration of the relationship between the attributes of a (design) object and an actor using it. In part due to Norman's popularization of the concept, the concept of *affordances* has been widely adopted in Human Computer Interaction (HCI) research where it is used to refer to the functional properties of objects that allow particular uses (Murray, 2011). As such, my analysis is concerned with the capabilities of the chip, which are revealed by and codified in the production of specific software tools for creating music and sound, and which reflect particular technical and musical sensibilities and contexts. For instance, the SID chip's ability to replay samples is not part of its specification per se, given that it is not a feature intended or documented but, rather, a "hidden affordance", uncovered through experimentation and the exploitation of a "bug", or quirk, of the SID chip a few years after its initial release.

Accordingly, my focus on the production of the driver sees it as both a response to the perceived affordances of the SID chip and an exploration of its less obvious affordances. Through experimentation and targeted investigation, channeled via musical imagination, these hidden affordances (whether intended, or quirks of the design and manufacture) are made accessible and perceptible and become part of the chip's functional repertoire. The investigative work that is undertaken by composer-programmers bears many similarities to other hacking practices (see Marquez, 2014; Danet, 2001; Raymond, 1996), as well as to gameplay. As such, I position the exploration and revelation of the chip's affordances as a "configurative" ludic practice dedicated to "the manipulation of dynamic systems that develop in unpredictable or emergent ways" (Moulthrop, 2004, pp. 63-64).

The argument concludes by examining the contemporary availability of the SID chip to musicians in software or within a hardware system such as the Elektron SidStation or Twisted Electrons Therapsid. Although these instruments support integration into modern *Digital Audio Workstations* (DAWs) and performance-oriented workflows, their new interfaces disallow techniques available via 1980s drivers. The SID chip is, therefore, constructed as a different instrument, and the suite of affordances is materially altered.

SOUND INTERFACE DEVICE

In the early 1980s, computer and arcade game sound chips were typically uncomplicated affairs. As Collins notes, "PSGs [Programmable Sound Generators] offered little control over the timbre of a sound, usually limiting sounds to single (often square) waveforms, without much ability to manipulate that waveform" (Collins, 2006b). The Atari VCS' *Television Interface Adapter* (TIA) is a case in point. Handling both the system's visual and audio output, and extensively analyzed by Montfort and Bogost (2009), the TIA is a sound chip that employed a 5-bit frequency divider which generated a finite number of mathematically-related, but often musically unrelated, pitches. Although refreshing in their honesty, the opening lines of the *Atari 2600 Music And Sound Programming Guide* hardly instill confidence in the budding TIA musician. "It is difficult to do music on the Atari 2600 due to the limited pitch and two voices… many of the pitch values are not in-tune with others" (Slocum, 2003).

Indeed, much TIA music, such as the 1984 *Gyruss* soundtrack, is discordant almost to the point of comedy. However, as Driscoll and Diaz (2009) note, to compensate for the TIA's esoteric tuning, Garry Kitchen, the developer of Activision's 1983 *Pressure Cooker*, "determined a set of pitches that the Atari TIA could reliably reproduce. He then hired a professional jingle writer to compose theme music using only those available pitches" (par. 2.3). Excepting such inventive solutions, the majority of Atari's TIA-generated music has a decidedly atonal quality to it. Collin's (2006) analysis of Atari 2600 soundtracks notes an absence of harmony and an unusually high incidence of "flattened seconds" both of which are attributable to the TIA's unique tuning table and eschewing of equal

temperament. By contrast, Commodore hired Bob Yannes, an engineer with a musical background, to design the SID chip. As Yannes notes, "One of the reasons I was hired was my knowledge of music synthesis was deemed valuable for future MOS/Commodore products" (Yannes interviewed in Varga 1996).

As a musician, that Yannes was unimpressed with the state of computer PSGs might not surprise us. "I thought the sound chips on the market, including those in the Atari computers, were primitive and obviously had been designed by people who knew nothing about music" (Bagnall, 2011: 372). However, what is notable is that Yannes' ambition was not to make an incrementally better PSG than the TIA and comparable sound chips: "I really wanted to do a multi-track, polyphonic music synthesizer" (Bagnall, 2011: 373). This desire to create a different order of PSG that not only drew inspiration from the features and functionality of professional synthesizers but that also might be used to power a subsequent generation of such musical instruments, goes some way to explaining the sophistication of Yannes' design. As Charles Winterble, manager of MOS Technology (the company that manufactured SID), observed, "This thing is already 10 times better than anything else out there and 20 times better than it needs to be" (Bagnall, 2011: 374).

Fundamentally, the SID is built around a core of three discrete channels or "voices" that are combined prior to the final output stage for processing. Each voice is, in essence, an individually addressable monophonic, subtractive synthesizer offering flexible sound generation, modulation and shaping features. Where the TIA offered a series of tuning tables comprising of 32 often jarring pitches, SID's oscillators offered precise control over an eight-octave range (Vogel & Scrimshaw 1983: 5). Even the later *Nintendo Entertainment System* (NES) offered a limited palette of waveforms. Two of its four voices were hardwired to playback a variable pulse waveform, the third was limited to just a triangle, while the fourth offered noise. Typically, as with Koji Kondo's *Super Mario Bros.* soundtrack (Schartmann, 2015), these voices, and their waveforms, were assigned to particular musical duties with the two pulse waveforms handling melodic and harmonic lines, the triangle assigned to the bassline, and the noise channel used for percussion. As Troise (2015) observes, this "ensemble" form of composition has a history dating back many hundreds of years, although the "Famichord" (Akesson, 2011), with its omission of the dominant from a major or minor 7th chord, is a distinctive response to the voice architecture of the NES (or Famicom as the system was known in Japan).

Each of SID's oscillators offers four independently selectable waveforms: sawtooth, triangle, pulse and noise. Crucially, waveforms are not tied to channels and can be altered on a per-cycle basis as well as being used to cross-modulate one another giving rise to sync- and ring-modulation effects. The pulse waveform offers continuous duty cycle control, making possible the phasing, animated *Pulse Width Modulation* (PWM) effect familiar from analogue synthesizers and described by composer Chris Huelsbeck as "the holy grail of its [the

SID chip's] power" (Carr, 2001a). Further replicating the topologies of subtractive synthesizers, the three channels of harmonically rich waveforms pass into a multimode, state-variable resonant filter with dynamic cutoff control[1].

Additionally, SID offers per-channel ADSR (Attack-Decay-Sustain-Release) envelopes for controlling the volume contour of each voice. "The Commodore 64 sound generator allows us to control the rates at which the sound output will build up and die away, and by carefully manipulating these rates we can produce a wide range of instrument effects" (Money, 1984: 169). With attack times as short as a couple of milliseconds and release times approaching 30 seconds (see CBM 1983a), SID's envelopes, like its PWM and filter, directly reference the instruments Yannes took inspiration from and sought to contribute to with his design. By contrast, the NES's sound chip offers limited amplitude control over its pulse and noise channels, and no control at all over the amplitude of the triangle.

In the context of its contemporaries, SID is a sophisticated sound generator. The *Owner's Manual* for the recent Elektron SidStation (which puts an original 6581 chip under the control of a modern, digital musical interface) is more poetic: "SID is the classic synthesizer that never had a case built around it" (Elektron 1999: 5). In this article, I suggest that by producing bespoke software routines for sound design and composition that harness the perceived and revealed affordances, each composer-programmer effectively "encases" the SID chip. Each software driver constructs it as a specific instrument and music-making system, (de)privileging facets and codifying techniques that become inexorably entangled with the specification, capability and "sound" of the hardware.

This case offers a clear example of the interplay between perceived and hidden affordances and the exploratory work undertaken by composer-programmers. Delving deeper into Hubbard's driver, we find specific subroutines designed to facilitate the musical exploitation of the SID chip oscillators' precise pitch control.

THE DRIVER

While Yannes' design may have explicitly referenced musical instruments such as the Minimoog in its functionality and topology, it is important to note that the SID chip's interface was quite unlike any performance-oriented musical instrument. In common with chips of its era, the whole of the functional potential of SID was accessed through 29 8-bit registers. These could be read and manipulated either with BASIC PEEK and POKE commands or more directly through Assembly code. Where the Minimoog offered an inviting and accessible rotary potentiometer to control its filter's cutoff frequency and a piano-style keyboard with a pitch bend wheel for triggering and manipulating notes, the SID chip presents "FC Lo" and "FC Hi" registers for cutoff and "Freq Lo" and "Freq Hi" registers per voice for setting oscillator pitch all of which are set in Hexadecimal.

This is an interface squarely located in the world of code with none of the concessions to accessibility or musician-friendliness that inform the workflow and meticulous labeling of a Minimoog control panel (see Pinch & Trocco,

1. The design was flawed as Yannes observes. 'I knew it wouldn't work very well, but it was better than nothing and I didn't have time to make it better.' (Varga 1996). That the filter design was compromised was problematic but, as composer Ben Daglish notes, the performance variability between SID batches was a yet more frustrating issue, 'you never had ANY idea how it was gonna sound on another machine.' (Flat Four 2005; see also Collins 2008). Indeed, 'The game Beach-Head even allowed the user to change the filter settings, to try to compensate for this.' (Judd 1996).

2002). As Collins notes, "(t)his meant that most early games composers were in fact programmers working on other aspects of a game, or at best in rare cases, in-house programmer-musicians who had to work closely with programmers" (Collins, 2006b). As Rob Hubbard, whose compositions we will explore in detail below, notes:

> "There were no MIDI sequencers, no Trackers. We coded everything just in an Assembler. I used to load up a machine code monitor and literally display the bytes in real time. The music was all triggered on the raster interrupt and I would start changing the numbers in real time to alter the synth settings and musical notes. So, I would tend to work on four bar chunks that I would tend to repeat and I would sit on that Hex editor, changing things. I would sit and tweak all those numbers until I had the four bars pretty much the way that I wanted them to sound and that would let me continue on for another 16 bars…" (Hubbard, 2002).

There were consumer-facing products such as Commodore Music Maker (1982), which used standard notation and a musical keyboard overlay that sat atop the C64's QWERTY keyboard for note entry. The system was inventive but, as Carlsson (2008) notes, it was too inefficient for use in game development and the output too difficult to integrate. As composer Thomas Petersen (2006) notes, even tools such as Chris Huelsbeck's more professionally-oriented SoundMonitor program suffered from high memory usage and CPU spikes, making it less advantageous than using Assembly code.

In the absence of available or suitable tools, composer-programmers typically created custom "music players", or drivers, to control synthesis and sequencing. Being bespoke, the coverage of the driver might constitute a subset of the possible SID chip feature set as deemed significant to the composer or composition in question. As such, while the SID chip offers the affordance of PWM on each voice via six addressable registers, this feature need not be implemented in a driver routine. Similarly, the manner in which it is implemented is driver-specific and reflects compositional, sound design and aesthetic intentions.

McSweeney's (1993) investigation of a ripped (extracted) version of one of Hubbard's early SID drivers reveals the extent of the work performed by this comparatively small, but absolutely essential, software routine. Occupying just 900-1000 bytes of code, the driver controls every aspect of the sound from silencing and initializing the SID chip, through defining instrument settings such as waveform, envelope times and levels; gathering note durations and pitches; applying effects such as portamento, vibrato or arpeggiation; altering pulse-width depth and modulation time; to the selection of new sequences each comprising patterns of notes for playback. By separating a "song" into three "tracks", each comprising "pattern" numbers that refer to sequences of "notes", the structure of a given piece of music can be expressed. At the note level, the driver is separated into "notework" and "soundwork" routines governing

pitch and effect parameters. The main loop runs three times (once per voice). Clocked by the system counter (running at 50Hz on a European PAL machine and 60Hz in NTSC regions such as the US), the control of note and synthesis parameters has the precision of a single frame of raster time. The speed of these changes is of vital importance in generating some of the specific and distinctive sound design and compositional motifs found in the output of Hubbard, and of other C64 musicians. Importantly, we note already that timings are based on computational and audiovisual system contingencies rather than musical relevance. Hubbard (2005) recalls that:

> "I was writing my own assembly-language music routines. The music routines were basically controlling the chip, and whatever you could do with the software to get some more sounds, or anything more interesting… you would write the music to take advantage of that. The two basically went hand in hand… You would come up with an idea for something the software could do, you would write that, and then write the music to take advantage of it. In most cases the two things happened simultaneously. You can think of something to do with the software and you immediately know what the musical implication of that is gonna be" (Hubbard, 2005).

This case offers a clear example of the interplay between perceived and hidden affordances (Norman 1988) and the exploratory work undertaken by composer-programmers. Delving deeper into Hubbard's driver, we find specific subroutines designed to facilitate the musical exploitation of the SID chip oscillators' precise pitch control. "Instruments" (specific sounds such as the simulation of a bass guitar or piano) are set in an 8-byte data structure. Examining Byte 7, McSweeney (1993) notes that:

> "Bit#1 signals a 'skydive'. This is a slower frequency down, that I think sounds like somebody yelling as they fall out of a plane. […] Bit#2 signals an octave arpeggio. It's a very limited arpeggio routine in this song. Listen for the arpeggio and the skydive when combined, which is used alot (sic) in Hubbard songs" (McSweeney 1993).

Indeed, these effects are manifestly evident in Hubbard's *Monty on the Run* or *Crazy Comets* (Martech, 1985) soundtracks among others. As McSweeney notes, this combination of a smoothly descending pitch bend (the "skydive") with octave arpeggiation (alternating between the original pitch and +1 octave every 50 cycles) is a distinctive musical and sound design trait in Hubbard's output. And so, while this composite sonic effect is made possible by the stability of the SID chip's oscillators and the precision of the control over their pitch in their "hi" and "lo" registers, it is rendered musically executable through the coding of the driver. And, just as Galway incorporated PWM into a revised driver to provide greater synthesis sophistication and animation, so Hubbard's

updated routines add further pitch and sound design effects to their instrument definitions via the manipulation of different registers in different combinations.

In discussing the compositions of other composers he particularly revered, Galway's focus on Hubbard's work reveals his personal aesthetic preferences and speaks to the position that Hubbard held, and continues to hold, among his peers and fans. However, and more importantly, it also points to a contributing quality of the driver, as Galway points out to Carr (2001b):

> "[Neil Carr] *Is there a SID tune that wasn't your own that you would have liked to have composed yourself?*
> [Martin Galway] Absolutely, they're usually Rob's!!! But I suppose I was simply wanting to use his program to get all that percussion. I wouldn't have minded having a go with his software and doing music in my style with his percussion. Perhaps we should have swapped drivers for a game just to see what we could have come up with. Or perhaps, collaborated on the same tune, each other's driver contributing simultaneously" (Carr 2001b).

What we are reminded of here is that the driver is bespoke code that combines a particular understanding of the SID chip and its capabilities, a suite of distinctive musical and aesthetic priorities that both reflect and inflect the driver, and an approach to coding that sets out the musical and synthesis capabilities in exploitable configurations. Unsurprisingly, given their importance in constituting the SID as an instrument, drivers were continually developed and refined. Discussing *Monty on the Run*, Hubbard (n.d.) remarks that, "The middle section was an excuse to use the new pitch bend code that I wrote for this project" while Martin Galway, in-house composer at Ocean Software notes, "I didn't develop pulse-width modulation until the next project, which at the time was called *Cyclone*. It later came out as *Helikopter Jagd*. On *Roland's Ratrace* I guess you could say I was still mastering the C64" (Galway n.d.). However, the "personality" of the driver remained. As Chris Abbott, C64 remixer and owner of the C64audio.com website and record label, observes, "Rob Hubbard sounded very different from Martin Galway because they had to write their own synthesizer engine, as well as the music" (Flat Four, 2005). As Galway intimates, Hubbard's routine places emphasis on rhythmic elements, both explicitly in terms of drum and percussion instrument settings where his own routine focused more on waveform manipulation, ring modulation and PWM (although, ironically, the discovery of a means of performing sample playback would later transform Galway's driver and musical output, as noted below––see also Tognon, 2003).

Further related to the idea of driver "personality", it is important also to note that the early era of C64 composition is rather different from contemporary discourse of videogame music, which often focuses on: dynamic and adaptive aspects of audio and the explicit relationship between the auditory, visual and gameplay (see Fritsch, 2012; Collins, 2007b); the healing of the separation

between composition and instrument (Herber, 2008); procedurality and elements of randomization (Stevens & Raybould, 2016); and the articulation of affect through sound (see Horowitz & Looney, 2014). C64 soundtracks were not typically interactive but, rather, accompanied gameplay while being interrupted only by synchronized sound effects (indeed, Rob Hubbard's *Kentilla* soundtrack was originally intended to adapt to changes in gameplay environment, but the idea was scrapped due to its technical complexity––Zzap,164 1986: 74). Also, as Hubbard notes:

> "The sense of freedom that people had in those days was just extraordinary. You could branch out and do pretty much whatever you wanted to do… They [publishers and developers] were letting me write anything I wanted to write" (Hubbard, 2002, online).

Surveying collections such as *HVSC*, we find many examples of "samplers": compositions written on spec rather than in response to a specific commission. Designed to showcase the composer's work and to be available for purchase, many of Hubbard's critically acclaimed pieces (*One Man and His Droid*, for instance) began life this way and were written long before the game was even conceived and released in 1985).

With so much artistic and compositional freedom and the liberty to create original, experimental SID music rather than accompaniments to particular titles or sound in the service of specific experiences or gameplay mechanics, the driver is revealed as a key site for study. Hubbard's routine, like Galway's, is an expression of particular approaches and intentions––of specific musical predilections and influences, and born of a specific understanding and revelation of the affordances of the chip, both influenced by and sometimes exceeding, the extent of the documentation and design.

THE DRIVER AT PLAY: THE MUSIC OF ROB HUBBARD

For all the discussion of SID's synthesis sophistication, we should remember that it does not present unlimited opportunity. For instance, while Yannes' original plan had been to make use of "multiplexed" oscillators to provide up to 32 separate voices (notes), the final chip could play just three. So, while each voice offers flexibility in excess of the capabilities of contemporary sound chips, as composer Ben Daglish put it, SID still offered "limited polyphony, to say the least" (Carr, 2001c). To compound matters, as the sole sound-producing device in the C64, SID was responsible for delivering not only music but also sound effects.

To tackle the issue, a number of strategies were adopted. In some cases, such as *The Human Race*(Mastertronic 1985), Hubbard composed the music to use just two SID chip voices with the third dedicated to sound effects––or "interactive non-diegetic sound" as Collins (2007a, p. 212) puts it. In other instances, such as *Delta* (Thalamus, 1987), where the in-game composition utilizes all

three SID channels, a switch on the options screen allows the player to toggle between this music and the sound effects as the accompaniment to their gameplay. However, more common was for both music and sound effects to play concurrently resulting in "note-stealing" as one or more channels of music were temporarily silenced to make way for a spot sound effect. This is heard extensively in C64 soundtracks such as *Thing on a Spring* (Gremlin Graphics, 1985) and *Commando* (Elite, 1985), though it was no means limited to that system. Indeed, although it offered an additional voice, most NES in-game soundtracks exhibit similar interplay between music and sound effects. Koji Kondo's *Super Mario Bros.*(Nintendo, 1985) theme is a case in point and appears to "duck" in volume as Mario jumps, for instance.

Notwithstanding the deleterious and unpredictable impact of player-triggered spot effects, Hubbard et al. devised a series of compositional and sound design strategies to deal with the limited polyphony and enrich the complexity of their soundtracks. "Most of it was simply done by multiplexing the three channels. If the lead line has two beats rest, put a fill or some effect in there" (Hubbard, n.d.). Hubbard's use of the term *multiplexing* is interesting here and while it attempts to achieve something of the same audible effect it technically differs from Yannes' use in relation to sharing the SID's oscillator to generate a greater number of simultaneous voices. What Hubbard refers to here is a combination of compositional and sound design techniques that make use of a specific and distinctive affordance of SID's oscillators. Put simply, rather than assign a channel to a specific sound or musical part that plays throughout the piece (such as a bassline, lead guitar, and drums, as with the ensemble approach to writing on the NES), any given musical sound might be performed on any of the three channels depending on their "availability". As Troise (2015) observes, the composer "looks for 'gaps' in the melody in which to fill out the composition."

Accordingly, while the channels might primarily be dedicated to particular duties with drums and percussion predominantly performed on channel 3, for instance, additional drum fills and percussion flourishes might be added to channels 1 and 2 throughout the piece depending on their availability and the musical sense such additions would make. *Commando* is a case in point, with percussion spread, or multiplexed, across all three channels. Figure 1 shows a waveform display of the three SID channels with channel 1 (top) predominantly handling the lead melodic line, channel 2 (middle) performing pseudo-polyphonic chordal backing through rapid arpeggiation, and channel 3 (bottom) covering the bassline. As such, no single channel is responsible for the drums and percussion, which are a notable feature of the soundtrack's aesthetic. Instead, the rhythm track is performed across all three voices with noise and toms on channel 1, ring modulated percussion on channel 2, and a snare on the offbeat performed on channel 3. Notably, there is no kick drum on the downbeat and channel 3's bassline effectively covers this function alternating with the snare to provide the foundation of the rhythm section.

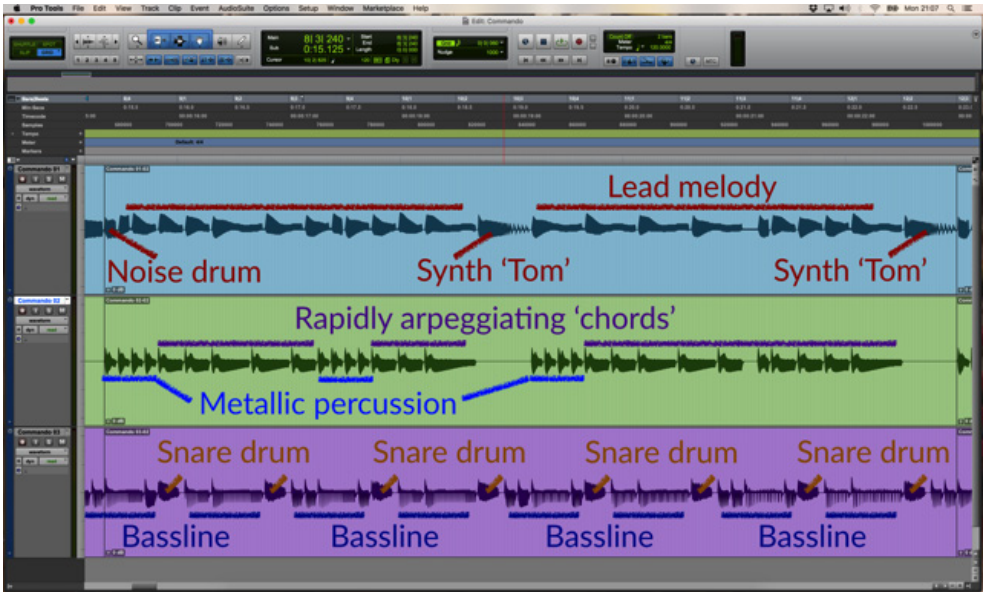

Figure 1: Multiplexing drums and percussion in Rob Hubbard‚Äôs Commando. Photo courtesy of the Author.

Examining *Commando* in this way, it is clear that there is very little sonic or compositional space remaining that speaks eloquently to the specificity of this as a composition for the SID chip, as well as reminds of the characteristic harmonic and rhythmic intensity of this chip music aesthetic. Drawing attention both to the specificity and historical continuity of these techniques, Guay and Arsenault (2012) note that chip composers often deploy the kinds of extreme ornamentation characteristic of the Baroque. As Akesson (2011) amusingly puts it, this is the compositional equivalent of a restless child who cannot sit still.

For Collins (2006a), the emphasis on building textures through the combination of rhythm elements is similarly characteristic of the C64 aesthetic. Certainly, it is not only in *Commando* that we find Hubbard's extensive use of pitched percussive instrumentation often using ring modulation and simultaneously performing rhythmic and contrapuntal duties. *The Last V8* (Mastertronic, 1985) and *Sanxion* (Thalamus, 1986), for instance, are both deeply complex, textural works. Heard in isolation, some of *Sanxion*'s heavily ring modulated lead and supporting lines sound utterly cacophonous; yet, in concert, they gel together reminding us of the novel, often transgressive character of game sound (Cheng, 2014) and of the integrated composition and sound design of these works as "SID music", rather than as transcribed pieces or even as "chip music".

The modulation of the SID chip's oscillators is found at work elsewhere albeit at an altogether different periodicity. Where the alternating bass-percussion patterns we have noted above allow for compositional multiplexing, accelerating the modulation of waveform output to the speed of the system clock allows for new sound design techniques and the creation of complex instrumentation. As we note in McSweeney's disassembly of Hubbard's driver, part of the Instrument setup is dedicated to create just this effect:

> "Bit#0 signals that this is a drum. Drums are made from a noise channel and also a fast frequency down, with fast decay. Bass drums use a square wave, and only the first 50th of a second is a noise channel. This is the tell-tale instrument that gives away a Rob Hubbard routine! Hihats (sic) and other drums use noise all the time" (McSweeney, 1993)

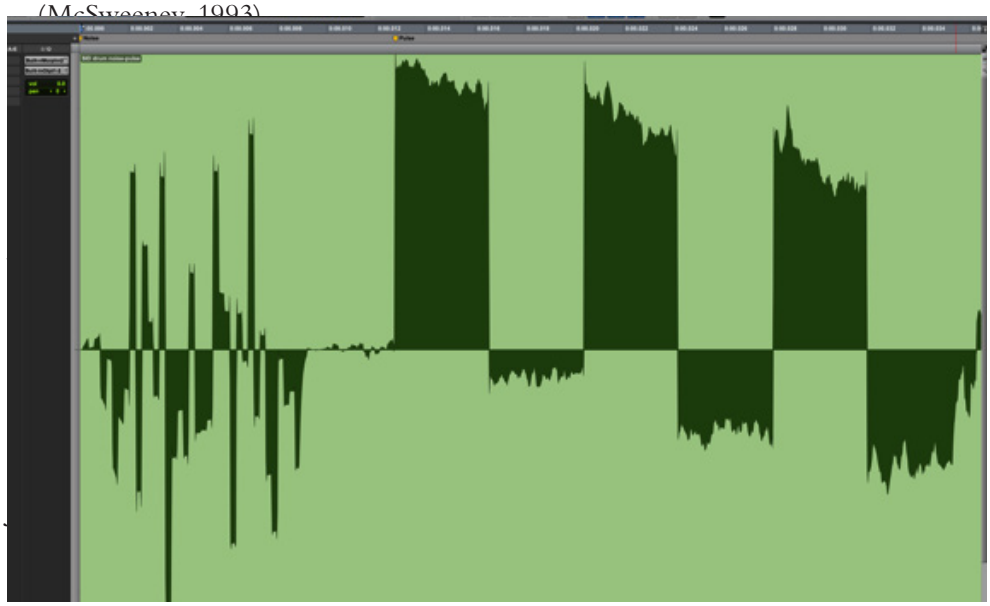

Figure 2: SID chip drum sound design showing dynamic waveform manipulation. Photo courtesy of the Author.

Analysing Hubbard's SID compositions, one can identify an extensive use of frame-accurate manipulation of waveforms. In addition to those sounds obviously present as discrete "drums", compositions such as *Crazy Comets* and *Sanxion* add a short (as little as 1/50th of a second) burst of noise to a number of their otherwise pitched instruments. The result of this is to add an additional percussive sound running concurrently with the pitched element. In *Sanxion*, channel 3's pulse wave bass instrument is augmented with digital noise in its attack. The 16th-note sequence thus appears to create both a synthetic bassline and a continuous shaker or hi-hat sound from a single channel.

Resonating with Hubbard's technique, Martin Galway notes: "I just tried to make sure all 3 channels were getting used. A couple of techniques allowed it to sound like more was going on, like fast arpeggios, and chorusing/echoes." (Galway n.d.) The provision of arpeggiation in Hubbard's driver as we noted above speaks to another commonly utilized technique designed to compensate for the SID chip's limited polyphony, but that also makes use of its ability to be clocked at high rates. Because using the three channels for chordal composition is inefficient, composers often deployed rapid arpeggios cycling around two or more notes at 50Hz to simulate the effect of multiple notes playing simultaneously. As Akesson (2011) notes, while the necessity for the chip music composer's use of the technique is different and derives from interaction between the execution of code and television standards and refresh rates, the simulation of polyphony

through rapid arpeggiation and large interval skips was known to Bach and evident in the final movement of the *Partita No. 2 in D Minor*, BWV 1004.

For the chip composer, the combination of rapid arpeggiation, along with other effects such as pulsewidth modulation, creates an effect that not only harmonically rounds out compositions, yet also adds dynamism and animation. The sonic effect of this technique is a chordal "warbling" that is, perhaps more than any other, characteristic of chip music. As with the drum sound design example above, it is crucial to remember that the rate of this arpeggiation is in no way musically derived but, rather, is a function of the C64's processor and screen-update interrupt-system, which is taken advantage of in the driver. As with the other examples of sound design and composition we have noted above, it is the singular interaction between musical intention and opportunity, and the technical capability of SID (as a discrete device but also part of a larger computing system) that collides in the driver and gives rise to the identifiable quality and personality.

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LET THERE BE (MORE) DRUMS

Although Hubbard's driver included sound design routines for synthesizing drum sounds, it was the discovery of a glitch in the SID chip that would transform the performance of percussion on the C64.

> "I figured out how samples were played by hacking into someone else's code… I had no equipment for editing samples though, so my program synthesized the drums as a series of farts and burps! Later I was able to acquire some proper drum samples and by "Game Over" it got quite sophisticated" (Galway n.d.).

The ability to replay samples exploits an inconsistency arising from the chip's design and fabrication which gives a *DC offset* between the channels. By rapidly manipulating the chip's amplitude registers, it is possible to generate otherwise undesirable audible clicks that when clocked at the right rate and with suitable data can create a form of *Pulse Code Modulation* (Collins, 2006a). Importantly, the "fourth" voice is actually a phantom that appears across at the SID's output stage as a result of the interaction of the other channels. As the exploitation of a glitch codified and transformed into process in the driver, it is perhaps the best example of the interplay between technical and creative exploration that, in this case, yields affordances not only hidden but unintended. Indeed, the subsequent "8580" revision of the SID removed the DC offset making sample playback all but inaudible on machines equipped with the newer sound chip. As such, the affordance was not simply re-hidden but eradicated altogether.

Hubbard's workflow reveals the tight integration of coding, arrangement, and composition. The process is not merely about transcribing musical ideas into Hexadecimal code. As Troise (2015) notes, it is the difference between "…trying to recreate externally composed music on the PSG [and] writing music *for* the PSG" (original italics). What we see in Hubbard's driver is not only writing directly *to* the silicon by manipulating the 8-bit registers but writing directly *for* the silicon––effectively constructing the SID as a synthesizer in a case. Commenting on the longer-term influence of these techniques, composer Neil Baldwin notes that:

> "Another old C64 trick I employed a lot in James Bond Jr (and continued to do so for almost all the other NES projects I worked on) was to simulate echo but just using a single voice. Instead of using two voices, one playing a melody and the second at a lower volume but slightly delayed, the single-voice method used slightly truncated note lengths and in the gaps in between notes, play the same notes shifted later in time, quickly dropping the voice volume (and then restoring it to play the next melody note)" (Baldwin, 2009).

Exploration, and the dialogue between musical intention and utility, and technical capability and exploitation were central to the development of the driver. This was partly because, according to Yannes, the documentation was written before the completion of SID prototypes let alone finished silicon, thereby rendering it unintentionally inaccurate (in Bagnall, 2011). However, experimentation was also rewarded because the SID's registers behaved in sometimes unpredictable ways modified in combination or in ways that musicians found more useful than the chip designers who had masked such combinations or left them undocumented. As Hubbard (2002) suggests, the search for a distinctive sound, effect or technique, remained an ongoing process and drove experimentation and the refinement of the driver.

> "We were always looking for ways to try to find something that the machine could do that it really wasn't designed to do. You'd look in the manual on the C64 and it would say things like… don't set this bit whatever you do and we'd say "OK, I don't care, I'm going to try setting the bit and see if it does anything". We were always looking for ways to squeeze more out of this thing by doing things in assembler and tweaking around" (Hubbard, 2002).

Indeed, even Commodore's own *Programmer's Reference Guide* appears to endorse an investigative strategy that perhaps belies the lack of a specification covering the full range of SID's capabilities. "Only through experimentation on your own will you fully appreciate the capabilities of your machine. The examples in this section of the Programmer's Reference Guide merely scratch the surface". (CBM, 1982: 208).

SID TODAY

The SID chip remains a popular device today with fan projects curating music files, databases and emulator applications to replay the work of Hubbard, Galway *et al*. The SID chip is also available to contemporary musicians in a number of forms and is a cornerstone of the contemporary chiptune scene or subculture (see Marquez, 2014; Bittanti, 2009; McLaren, 2003). Software emulations such as chipsounds and QuadraSID seek to replicate the chip's distinctive features either through sampling or circuit modeling (see Viens, 2012) while devices such as Therapsid and the SidStation eschew emulation and connect an original SID chip to a modern, tactile interface. Regardless of the approach, it is clear that each device whether software plugin or MIDI-equipped hardware, these modern SID implementations may be integrated into contemporary music production workflows in ways simply impossible in the 1980s. In one sense, Yannes' original vision for the SID chip as a more mainstream instrument is realized. However, while the accessibility of the chip is dramatically increased, other facets are diminished. Each new device attempts to replicate some of the features discussed above. The chipsounds plugin, for instance, incorporates a wavetable into each instrument patch. This allows per-cycle waveform and pitch variation thereby simulating the warbling chords so characteristic of C64 music and which may be triggered with a single key. However, with a fixed arpeggio per patch, and the contemporary DAW (Digital Audio Workstation) workflow's dissociation of the sound generation (plugin) from the compositional environment (the sequencer), the ability to continuously vary the groups of pitches over time becomes altogether more complex and comparatively impossible in the live performance contexts that these plugins and hardware repackagings also facilitate. Similarly, the ability to generate the virtual fourth channel is lost without the ability to manipulate the DC offset of the SID chip's output.

What we see in these modern interfaces to the SID chip is certainly a stylistic recovery of the fundamental oscillator sound, its routing and filter characteristic, combined with a degree of control over some key synthesis features, that integrates into contemporary workflows. However, […] there is far more to the SID chip. Its characteristic sound is also a product of the way it was harnessed (or in the terms of Elektron, "encased") by composer-programmers such as Hubbard and Galway

In light of such developments, while it is possible to find increasingly easy ways to access to the chip, they often offer a narrower set of the chip's capabilities than are available by directly writing to its data registers at 50Hz. In these accessible reworkings, certain features of the chip are necessarily curtailed, and many of its once revealed affordances become hidden again. What we see in these modern interfaces to the SID chip is certainly a stylistic recovery of the fundamental oscillator sound, its routing and filter characteristic, combined with a degree of control over some key synthesis features, that integrates into contemporary workflows. However, as important as the raw tonality of the

oscillators, the design of the envelopes, or the non-linear distortion characteristics of the filter, might be in fundamentally distinguishing the SID chip from other soundchips (as Altice rightly notes), the analysis above has demonstrated that there is far more to the SID chip. Its characteristic sound is also a product of the way it was harnessed (or in the terms of Elektron, "encased") by composer-programmers such as Hubbard and Galway. It is through the production of their bespoke driver software that the technical affordances are inexorably bound to the connected processes and principles of composition and synthesis. The driver is informed by both musical and sound design priorities along with a knowledge of the chip's affordances, as shown in the (imperfect) documentation and via the exploitation of its documented and undocumented capabilities, flaws and quirks. Controlled by Rob Hubbard's driver, the SID chip is constituted as a specific, bespoke compositional platform, related to, but different from its existence under the control of another driver or interface. By revealing and making musically usable what was designed (and, unintentionally, hidden) in the silicon and the 29 8-bit registers, the driver constitutes the SID chip as a complex suite of perceived affordances.

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AUTHOR'S INFO:

James Newman is Professor of Digital Media at Bath Spa University and a researcher and curator at the UK's National Videogame Arcade. He has published widely on videogames, game history and culture, and game preservation and has curated major exhibitions at the NVA. He is currently writing books on gameplay spectatorship and on early videogame sound and music.

KENNETH B. MCALPINE
Abertay University
k.mcalpine@abertay.ac.uk

The Sound of 1-bit:

Technical Constraint and Musical Creativity on the 48k Sinclair ZX Spectrum

ABSTRACT

This article explores constraint as a driver of creativity and innovation in early video game soundtracks. Using what was, perhaps, the most constrained platform of all, the 48k Sinclair ZX Spectrum, as a prism through which to examine the development of an early branch of video game music, the paper explores the creative approaches adopted by programmers to circumvent the Spectrum's technical limitations so as to coax the hardware into performing feats of musicality that it had never been designed to achieve. These solutions were not without computational or aural cost, however, and their application often imparted a unique characteristic to the sound, which over time came to define the aesthetic of the 8-bit computer soundtrack, a sound which has been developed since as part of the emerging *chiptune* scene. By discussing pivotal moments in the development of ZX Spectrum music, this article will show how the application of binary impulse trains, granular synthesis, and pulse-width modulation came to shape the sound of 1-bit music.

KEYWORDS: *1-bit game music; ZX Spectrum; technical constraint*

INTRODUCTION

For those who grew up gaming on the video game consoles and home computers of the early 1980s, the bleeps of the in-game music were as much a soundtrack to life as were Iron Maiden or Depeche Mode. Indeed, many teen gamers, myself included, spent much more time playing games and absorbing the sights and sounds of those games than we did spinning vinyl. Certainly, the familiar chirp of Rob Hubbard's theme from *Monty On the Run* (Harrap, 1985) on the Commodore 64 (C64) or Tim Follin's ZX Spectrum soundtrack for *Agent X* (Tatlock et al., 1986) has a definite nostalgic appeal, but the game music of that period is of more than just sentimental value, with a legacy that extends into the contemporary musical mainstream.

The early days of video game music are replete with tales of ingenuity and creativity[1], which were driven largely by the constraints of the sound hardware. Microcomputers like the C64, whose specifications offered a degree of audio hardware support used *Programmable Sound Generators* (*PSG*s), dedicated sound chips that provided their voice by synthesizing simple waveforms. Other machines, like the ZX Spectrum (Christie 2016), whose computer architecture was constrained by cost, offered no dedicated hardware support at all, and its motherboard-mounted speaker was controlled using a single-bit value on one of the processor's addressable memory ports.

Regardless of whether the sounds were generated by dedicated PSGs or directly by the *Central Processing Unit* (*CPU*), the computer hardware offered little in the way of musical expression. At most, PSGs offered only a few channels of polyphony and a prescriptive palette of simple waveforms, while the monophonic 1-bit Spectrum beeper was more restrictive still, providing just a single-channel square wave with no level control. In response, however, there arose from this digital frontier an explosive period of technical creativity as game programmers and musicians (they were often one and the same) coaxed the hardware into performing feats of musicality that it had never been designed to achieve. The methods that were adopted to broaden and expand the musical capabilities of the PSGs were not without cost, however, and their application often imparted a unique characteristic to the sound, which, over time, came to define the aesthetic, if not the style, of the 8-bit computer soundtrack. Here, 8-bit refers to the generation of microcomputers, of which the C64 and ZX Spectrum were part, which used 8-bit microprocessors at their core. This is distinct from the notion of 1-bit music, which uses only a single bit of information to encode volume level or speaker displacement.

The characteristic 8-bit sound that accompanied the video game soundtracks of the early- and mid-1980s has currency through a number of related contemporary subcultures, including the *retrocomputing scene*, a distributed community of enthusiasts who continue to drive development on obsolete computing platforms (Takhteyev & DuPont, 2013), the *demoscene*, a distributed technoculture focused on real-time computer art (Carlsson, 2009), and the *chipscene*, a vibrant lo-fi musical subculture that repurposes obsolete gaming hardware to make music (Paul, 2015). Appearances of that 8-bit style of music in movie soundtracks (see, for example Brian LeBarton's C64 arrangement of Sex Bob-Omb's *Threshold*, which features in the end credits of Edgar Wright's *Scott Pilgrim vs. the World*), television advertisements (Jonathan Dunn's hypnotic theme from the Gameboy version of Ocean's *Robocop* (1990) was used as the basis for Ariston's *And on… and on…*' campaign in the early 1990s), and major exhibitions, such as that at the Smithsonian in 2014 (Melissinos, 2014), suggest a growing acceptance of chip music, alongside 8-bit video game art and animation, as a legitimate form of artistic expression, while the adoption of elements of chiptune by major artists like Mark Ronson (Knowles, 2010) suggests the style is more than a niche crossover.

1. For an overview of the early period of video game music see, for example, Collins (2008), and Collins and Greening (2016)

Even Iron Maiden, those stalwarts of the 80s new wave of British heavy metal, have embraced the sound, launching their 2015 album *Book of Souls* with a NES-style game, which features an 8-bit arrangement of the band's "Speed of Light" (Dickenson & Smith, 2015) as the background track.

To understand and fully appreciate the evolution of that sound it is necessary to approach it from a number of different angles. Of course, we can examine the music itself to understand the stylistic influences that helped to shape the sound; however, stylistic analysis alone does not tell us very much about video game music as a media form. Sometimes, stylistic choices were driven by the narrative of the game, so that the music might provide context to game levels. However, as emerging from interviews carried out by the author with video game coders and composers from the early bit through to the -bit era young coders, many of them were keen to turn around their games quickly and with little appreciation or regard for copyrights and intellectual property. Often, composers just reached for the nearest sheet music to hand or arranged whatever vinyl was spinning in the background.

To really understand how video game music functions as media music we must also delve into the source code and the hardware, employing a platform approach to learn more about how the computer architectures and the games that were written for them shaped both the structure of video game music and how it was realized. It is by examining this broader structural context to video game music that we begin to appreciate the challenges facing early game designers, and see how those constraints functioned as a spur for creativity. This, in turn, can shed light on how the aesthetics of early video game music evolved.

> The physical design of musical instruments creates affordances and constraints that, to a great extent, shape the music that is written for them; this is as much the case for electronic instruments (including PSGs) as it is for more traditional acoustic instruments. Video game hardware shaped the sound of early video game music by way of the affordances they offered and the constraints that they imposed.

THE AESTHETICS OF CONSTRAINT?

Constraint has long been recognized as a powerful driver for musical creativity. Many cultures express ideas and expectations about how music ought to be performed, and arguably, it is the role of the professional musician both to satisfy and to challenge these expectations by exploring imaginative departures from the norm. Boden explores this idea (1995, p. 95), noting that, "(c)onstraints map out a territory of structural possibilities which can then be explored, and perhaps transformed". Such common understanding of what music is and how it should sound emerges primarily from the musical structures: the form, timbre, harmony, melody, and rhythm of performance, the grammar and vocabulary of which define the conventions of musical style, and the conventions of interpretation and performance that communicate these from com-

poser through performer to listener (see, for example, Ball 2010, for a detailed yet accessible discussion on this topic). It is from these conventions that there arises one of the most delightful aspects of music, an implicit guessing game between composers and their listeners. Composers provide sufficient structure and familiarity for their audiences to anticipate what is coming next at least some of the time, while providing enough novelty to maintain engagement with the listener (Huron, 2006, p 141). Without the shared notion of musical and performative norms that arises from the constraints of musical structures in particular audiences, this guessing game would often not be possible (there is little point or reward in guessing what is likely to follow if all eventualities are possible and equally likely) and it would often be difficult, in this light, to distinguish creative innovation from chance variation.

The constraints of musical form and grammar can be understood as cultural constructs, emerging by consensus and evolving as composers and performers experiment at the boundaries of style as public tastes and fashions change, but other externalities can impose constraints on musical expression, both implicitly and explicitly. For example, while it is more than just indulgent for a musician to write a sixty-four bar intro for the radio mix of a song, it is commercially reckless, since it limits the number of stations prepared to broadcast the track and the amount of airplay the song will receive. In particular, a commercially-aware musician will implicitly impose self-constraint to ensure that their compositions suit their chosen medium.

Perhaps more significantly, the physical design of musical instruments creates affordances and constraints that, to a great extent, shape the music that is written for them; this is as much the case for electronic instruments (including PSGs) as it is for more traditional acoustic instruments. In short, video game hardware shaped the sound of early video game music by way of the affordances they offered and the constraints that they imposed. Of these affordances, of importance was the complete top-down control provided to videogame composers by the sound hardware and its hosting computing platform (R. Hubbard, personal communication, June 9, 2017). This not only allowed detailed control over each and every aspect of the music and its performance (similar to that of Stockhausen's principle of 'total control'––White, 1968, p, 319), but it was also enabled the means by which the territory of structural possibilities could be explored, mapped out by the hardware's affordances, and transgressively pushed against and stepped beyond the boundaries imposed by its constraints.

THE ZX SPECTRUM: A MODEL OF TECHNICAL CONSTRAINT

A strong hobbyist community exists in the UK (see, for example, Kline, Dyer-Witheford & de Peuter 2003, pp. 84-108). Therefore it may be little surprise that the first home computers were sold in the UK as component kits that required considerable time and technical dexterity to assemble. It was against this backdrop that Science of Cambridge (later to become Sinclair Research Ltd.)

launched the Microcomputer Kit 14 (MK14) in February 1978 as a 'minimum cost computer' (Science of Cambridge 1978). Science of Cambridge launched the MK14 at a price point of £39.95, something Practical Electronics described as "a landmark of […] unassailable proportions" (Berk, 1979). While it was relatively cheap and accessible, the MK14 looked positively primitive alongside its contemporaries, the Commodore PET and the Apple II. Nevertheless, the MK14 sold well enough to justify a successor, named the ZX80 for its 3.25MHz Zilog Z80 processor, with an added X to denote a magical X-factor (Tomkins, 2011).

Following the broadcast of the *Mighty Micro* (1979), a groundbreaking documentary series about the developing computer revolution, the British Broadcasting Corporation's (BBC) Further Education Department began to take an interest in the burgeoning home computer market, and established the BBC Computer Literacy Project, a series of television and radio programs that would be based around a BBC-branded microcomputer. The project was initially scheduled for launch in the autumn of 1981, which left little time for the BBC to develop its microcomputer in-house. Instead, they collaborated with the Cambridge-based firm, Newbury Labs, to draw up a specification for the machine. This spec matched very closely that of Newbury's NewBrain, the intention being, presumably, that Newbury Labs would pick up the BBC contract. As the project developed, however, Newbury Labs pulled out of the agreement and did not tender a design. The BBC was forced to postpone the Computer Literacy Project and broaden their search for a partner. Sinclair pitched its new machine, the ZX81.

Sinclair lost out on the BBC contract to rivals Acorn, but the ZX81 was picked up and aggressively promoted by the national newsagent chain, WH-Smith, which had an exclusive contract to supply the machine for six months. It sold by the thousand. Growing support from the popular press and a thriving mail-order games network grew the market for the machine, so that when the ZX Spectrum launched the following year, Sinclair had an established user base and many developers selling through a national network of retail outlets.

Free to specify its own components and price point, Sinclair, designed the most compact and powerful computer that they could to a price, undercutting the Acorn-designed 32K BBC Model B by over £200 at launch (Smith, 2011). With the Computer Literacy project giving the machine free marketing by pushing the idea of the home computer as a tool for learning, thousands of parents bought into the idea, giving the cheaper ZX Spectrum a home.

As a consequence of being designed to a low price point, the ZX Spectrum was a very simple machine. Available in two guises, both models had 16K of ROM and either 16 or 48K of RAM. It was also, if one discounts the analogue cassette interface of the ZX81, which could be co-opted to output simple melodies by *POKE*-ing certain memory registers from BASIC[2], Sinclair's first machine to feature any kind of onboard sound interface, a motherboard-mounted 22mm, 40 Ohm "beeper" speaker, which provided just a single channel of 1-bit playback across a 10-octave range.

2. BASIC, or Beginners All-Purpose Symbolic Instruction Code, is a high-level interpreted programming language that provides simple English-like commands that allow the end-user control over certain aspects of the machine's hardware. POKE was one such Spectrum BASIC command, which allowed users to write data values directly into the machine's addressable memory registers. By addressing certain memory registers, the ZX81's tape interface, which used square wave tones to encode and save digital data to analogue cassette tape, could be made to play simple melodies.

To compound matters, the sound commands were managed directly by the main CPU (a Zilog Z80A processor running at 3.5MHz) and a custom Ferranti *Uncommitted Logic Array* (ULA) chip. Without the availability of dedicated sound hardware, calls to the speaker occupied the processor; therefore, while the Spectrum was beeping it was unable to do anything else.

IMPLIED POLYPHONY: A CHANNEL FOR FREE

It is perhaps not surprising then that few of the early Spectrum titles featured very much in the way of sound or music. Typically, games would feature a single-channel melody as a title tune, and only limited in-game sound effects to punctuate key elements of the gameplay. *Chuckie Egg* (Alderton, 1983) is typical of this model, featuring the melody from "Birdie Song (Birdie Dance)" by the Tweets (Rendall & Thomas, 1981), itself a cover of Werner Thomas's accordion tune, as its title music. Such repurposing of existing musical themes was not uncommon in the early days of gaming. This was as true of graphics and gameplay as it was of music: *Hungry Horace* (Tang, 1982), for example, one of Sinclair's launch titles, was essentially *PacMan* (Iwatani, 1980) in disguise, and Artic Computing's *ZX Galaxians* (Wray, 1982a) and *Invaders* (Wray, 1982b) unofficially recreated those arcade classics as closely as was possible on the Spectrum's hardware. Ben Daglish, a celebrated C64 musician, recalls:

> "I had no idea that copyright existed. Quite seriously […] I really didn't. When we wrote all the Jarre stuff and all that […] we had no real idea as a 14- or 15-year-old kid that you couldn't just take some music that you liked, whether it was Beethoven or whether it was Jean Michel Jarre. We'd just write it down and put it in a computer game" (Burton & Bowness, 2015).

It was one such act of creative appropriation that lay behind Perfection Software's *Fahrenheit 3000*(Jones & Williams, 1984), a 64-screen platform game. Perfection wanted a title theme that would make an impact as soon as the game loaded, and Peter Jones suggested using Johann Sebastian Bach's 18th-century composition *Toccata and Fugue in D minor* which he had heard opening the movie *Rollerball*(Jewison, 1975). Working from the sheet music of Sky's 1980 cover (rearranged by Kevin Peek), Jones coded a five-minute beeper arrangement in Sinclair BASIC, before Tim Williams converted it to machine code for the final game.

What makes the music in *Fahrenheit 3000* significant is not so much the arrangement, which doesn't quite stick faithfully to either the Bach or the Sky sources but, rather, the choice of musical material itself. The opening statement of Bach's fugue is a sequence of semiquavers, which alternate between the melody and an implied pedal point on A. The effect, particularly when played at speed, is to create a sense of two-voice polyphony by using the pedal note to continually reinforce the sense of the tonal center against the melody.

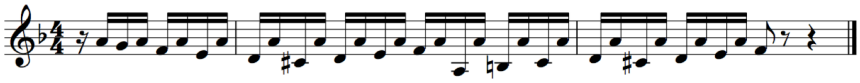

Figure 4: The opening section of J. S. Bach's Fugue in D minor creates a sense of two-voice polyphony by contrasting a repeated pedal note against a melody line.

Jet Set Willy (Smith, 1984) features a similar technique in its arrangement of Beethoven's *Piano Sonata no. 14, Moonlight*. Using a pattern of broken octaves, similar to the left-hand bass patterns of Boogie Woogie or Stride piano, the arrangement creates a sense of continuous movement between melody and accompaniment. The effect is striking, and it is easy to forget that there is nothing more complex here than a sequence of single-channel square wave tones.

Ben Daglish took the idea to its logical extreme with his soundtrack for Gremlin Graphics' *Arkanoid*clone, *Krakout* (Toone et al., 1987), providing an implied bass, accompaniment and melody, all played at breakneck speed. Importantly, he recalls that part of the joy of working on a Spectrum was the sense of challenge that it gave. It forced composers to look for ways to circumvent its limitations and find novel ways to introduce dynamic movement and musical interest, and often that involved harnessing the power of the computer itself:

> "Half the point of writing some of the music that I did, writing it on a computer, was that it meant that I could use notes that were never actually meant to be played by human beings. I could do really fast runs, scales and arpeggios" (Burton & Bowness, 2015).

His earlier port of *Thing Bounces Back* (Kerry et al, 1987) for the Spectrum used a similar approach, but alternates between a bluesy bass vamp in broken octaves and a bright blues melody. The effect works in much the same way a blues harpist will alternate between vamping and soloing to self-accompany, making use of the listener's aural memory and a strong sense of harmonic familiarity with the I-IV-V chord progression.

GRANULAR SYNTHESIS: PLAYERS CAN'T HELP ACTING ON IMPULSE

Artic's *Invaders* was an unofficial clone of Taito's *Space Invaders* (Nishikado, 1978) and features near-identical graphics and field of play to the original coin-op. The soundtrack also mimics the original, which uses a descending, four-note Dorian scale pattern that repeats and gradually speeds up, as the invaders are picked-off by the player.

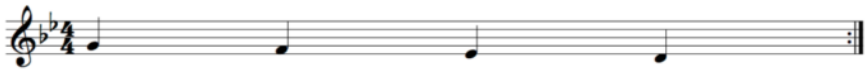

Figure 5: The descending Dorian scale pattern from Artic's 1982 game, Invaders.

The above descending scale sequence plays continuously throughout the game, marking the first use of a continuous non-diegetic soundtrack on the

Spectrum, being released around a year earlier than Bug Byte's *Manic Miner* (Smith, 1983b), whose rendition of Grieg's *In the Hall of the Mountain King* is often credited with this accolade. So how did *Invaders*, and indeed *Manic Miner*, achieve this feat? The solution was to think small.

Granular synthesis is an approach to sound synthesis and manipulation that was posed initially by the Greek composer Iannis Xenakis (1971), who created the composition *Analogique B* from hundreds of splices of tiny fragments of magnetic tape (Robindoré & Xenakis, 1996 pp. 11-12). Conceptually, the idea of treating sounds at times as continuous waves and at others as though they were composed of tiny sound quanta, or grains, opens up many interesting and creative ways of working. For example, two effects that have become commonplace in recent years are the time-stretch and the pitch-shift, which allow for the independent manipulation of tempo and pitch in recorded audio. Usually, these two parameters are inextricably linked: slow down the playback of a sound recording, and the pitch will drop proportionally. Granular synthesis enables the pitch and speed to be processed independently by applying the processing individually to sound grains, before recombining them to construct the final sound output.

Invaders uses granular synthesis as a technical strategy to create an in-game soundtrack that addresses the key limitations of the Spectrum's hardware. Recall that its speaker was controlled directly by the computer's main CPU and ULA, meaning that it was not normally possible to combine both gameplay and sound. Also, because the speaker was 1-bit, controlled via a single pin of the ULA, the speaker was either fully driven or at rest. No intermediate states were addressable, and consequently, there was no level control over the signal, which was a square wave by default. However, a 1-bit device can produce more than a square waveform. It was by recognizing this, and working directly within the software to manipulate the state of the ULA at a low-level, that author William Wray was able to create multiple independent channels of sound within the game.

A single cycle of a digital square wave is little more than a sequence of ones followed by an equal number of zeroes. Repeating this pattern over and over creates a continuous tone whose period, and therefore frequency, is determined by the number of ones and zeroes in each cycle. Increasing the number of ones and zeroes increases the period, and so lowers the pitch, and vice versa.
A Fourier analysis (Roads 1996, pp. 1084-1112) of the square wave reveals a well-defined and characteristic spectral signature:

$$\text{Relative magnitude of the } n^{th} \text{ harmonic} = \begin{cases} \frac{1}{n}, \text{ if } n \text{ is odd} \\ 0, \text{ otherwise} \end{cases}$$

Now suppose that, rather than outputting ones and zeroes in equal measure, one outputs a sequence of ones followed by three times as many zeroes. This is a pulse wave, an asymmetrical version of the square wave. In this case, 25% of the pulse is made from ones, and the rest from zeroes, and so the pulse

wave has a *duty cycle* of 25%. Its tonal characteristics are similar to those of the square wave, although a Fourier analysis reveals a different frequency spectrum, where *M* is the number of successive ones in the *N* sample points that represent a complete cycle of the wave:

$$\text{Relative magnitude of the } n^{th} \text{ harmonic} = \text{sinc}(n) = \frac{\sin(\frac{\pi n M}{N})}{\frac{\pi n M}{N}}$$

Continuing in this manner, the number of ones in each cycle of the wave can be reduced further to create smaller and smaller duty cycles, varying the frequency spectrum and tone of the sound, until the beeper is sent just a single positive bit followed by a stream of zeroes. This signal is a binary impulse, and its Fourier transform is a constant. In other words, an impulse contains all possible frequencies at equal magnitude.

It is not possible to hear an impulse on its own, but it is possible to hear its effect on a speaker, the so-called *impulse response*. Any speaker exhibits a degree of inertia, taking a short but finite time to move from rest to maximum displacement and back again, and it is this response that can be heard as a noticeable click. By sequencing a series of binary impulses together separated by short gaps, an *impulse train* emerges, a pitched tone, the frequency of which is determined by the period between successive impulses, and which contains all of the harmonics of the signal at equal strength, as shown in Figure 6.

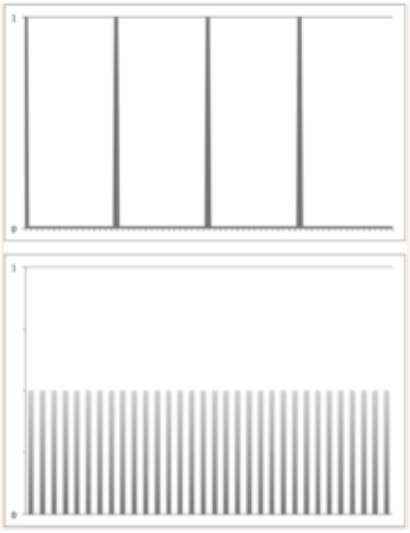

Figure 6 – Outputting an impulse train generates a signal whose frequency spectrum contains an equal amount of energy across all harmonics. The top plot here shows a time domain representation of the sound, showing a series of impulses separated by silence. The lower plot shows a frequency domain representation of the same sound, which has its energy distributed equally across all of its harmonics.

Invaders uses binary impulse train synthesis to create all of the sounds in the game, ensuring that the speaker is tied up for as short a period as possible while still allowing for continuous in-game sound, the game processing taking place in the fractions of a second between impulses. Moreover, the story does not end there. By using clever sequencing of the sounds, similar to that of the implied polyphony discussed in Section 4 above, *Invaders* manages to create multiple sound effects playing synchronously with the underscore.

The first, and most frequent of the game's sound effects is the alien explosion, which is cued whenever a player shot collides with one of the alien invaders. The explosion lasts for approximately 85ms, and is always triggered sequentially with the underscore. If an explosion sound coincides with one of the soundtrack tones, the sound that was triggered first, either the tone or the explosion effect, takes priority, and the subsequent sound is delayed until the first sound has completed. This results in a maximum delay for the explosion sound of around 25ms, which is barely perceptible in the context of the game. For the underscore, however, the worst-case situation could result in a delay of around 80-90 ms, which is enough to cause a degree of jerkiness to the underlying note sequence, although not so much as to cause it to break down.

The second effect is triggered by a bonus mystery ship, which travels across the top of the screen. Here, the sound effect plays continuously while the ship is onscreen, which takes approximately between 6 to 7 seconds, and is created by toggling the speaker on and off at 25ms intervals. During the mystery ship effect, when an underscore tone is due to be triggered, the game stops generating the mystery ship impulses and prioritizes the underscore grain, before picking up the mystery ship sound when the underscore tone has finished. The blip effectively masks the discontinuity in the mystery ship sound effect, creating an illusory continuity of tone in the latter. The final two effects are the player explosion and a level-start siren effect. These are played strictly sequentially, and cause the other elements of the soundtrack to stop playing.

Aside from the slight lumpiness to the underscore caused by the prioritized sequencing of the soundtrack elements, and the curious omission of sound effects for the player ship's laser fire, the game's soundtrack is very effective, not just referencing the original sound effects from the coin-op, but also in creating a real sense of continuous two- or three-channel sound, something that it achieves by the clever handling and sequencing of the short impulse trains.

Extending this idea further, it wasn't long before developers were using the technique to play two simultaneous musical lines by alternating between two or more grain pitches, and that grainy, bubbly quality became firmly established as part of the Spectrum sound. *Rockman* (Carter, 1985), for example, features an arrangement of the first movement of Mozart's *Eine Kleine Nachtmusik*, although the use of 50ms sound grains and lengthy inter-grain silences results in an unconvincing multi-voice effect, in the same way that a slowing a film sequence to below about 15 frames per second spoils the illusion of continuity

of motion, and the viewer becomes aware that they are seeing a series of time-sampled images. More successful was Imagine's port of the Konami coin-op, *Yie Ar Kung Fu* (Beuken & Thorpe, 1985), which uses the effect to play the main game stings in double-octaves, and *Dynamite Dan* (Bowkett, 1985), which uses alternating and arpeggiated grain pitches to recreate Mozart's *Rondo a la Turca*. Durell Software featured two-voice granular music tracks on two of their 1986 releases, *Thanatos*(Richardson, 1986a) and *Turbo Esprit* (Richardson, 1986b).

The music on Turbo Esprit is a fine example of the technique. Its Jan Hammer-styled melody complements perfectly the *Miami Vice*-like gameplay.

SINGING TO THE TUNE OF TWO

In 1983, Matthew Smith, a schoolboy from the seaside town of New Brighton in the North-West of England, was loaned a Spectrum by Liverpool-based publisher Bug Byte to develop three games. His first title, *Styx* (1983a), was a fairly simple action maze game based on a single, repeating screen that became progressively more difficult each time the player completed a level. It was his second game, *Manic Miner*, which became a runaway success, making Smith an unlikely superstar, and introduced the Spectrum's first truly iconic character, Miner Willy.

Manic Miner was based on *Miner 2049er* (Hogue 1982), a platform game that featured a Canadian Mountie, Bounty Bob, navigating his way through ten different screens and inspecting each area before his oxygen runs out. Several elements of *Miner 2049er* appear in *Manic Miner* (the underground setting and the oxygen-level as a timer, for example), but in creating Miner Willy, Smith injected a particularly British spin on the game, with an absurd humor to the level and character design, and a Pythonesque boot [3], which descends to squash Willy when the game is over.

On loading, the game displays a dynamic title screen showing the sun setting behind an idyllic cliff-top house, below which an animated keyboard plays, pianola-style, the notes of a delightfully-clangorous two-channel rendition of *The Beautiful Blue Danube* by Johann Strauss II. Although the music routine includes an algorithm that uses the note data to display the notes onscreen, the keyboard graphics show a shortened octave (C to E) to the left of middle C, making it almost impossible to use this as a visual point of reference for transcribing the music.

Smith (2014) notes that:

> "The game needed music, as I felt it was an integral part of the attraction. The title song, I had an old, simple piano arrangement [of *The Beautiful Blue Danube*] in sheet music so it was easy to transcribe. I did everything as quickly as possible, got the loop running as fast as possible, but I never got too prissy about exact timings".

3. "Pythonesque boot" is a reference to the surreal animation of a gigantic squashing boot that regularly appears in the television series of the British comedy sketch group, *Monty Python*, in order to segue various sketches

A RAM disassembly of Smith's code reveals that he used impulse trains as the basis of the title music routine. The music was stored in memory as a series of 95 groups, each containing three data bytes. Each triplet corresponds to a separate beat (or sub-beat) in the arrangement, and each is encoded as a duration and a pair of pitch values, or more accurately, as counter values, which are used to calculate the period between successive impulses using a technique known as *frequency divider*, or *divide down synthesis*(Roads 1996, p. 925).

This technique generates a waveform by counting the pulses of a master clock, and triggering an impulse when a chosen divisor (the counter limit) is reached. The counter is then reset and begins again. This generates a periodic impulse train at a frequency that can be calculated as follows:

$$\frac{sample\ frequency}{counter\ limit}.$$

By rearranging the equation, one can calculate the counter limit that corresponds to any given frequency. In the case of *Manic Miner*, the counter is updated on each cycle of the theme-music subroutine, and so the timing of each master clock tick is determined by two factors: the clock speed of the Z80 CPU, which runs at 3.5 MHz, and the length of time taken by the CPU to execute each of the machine instructions in the loop, which can be obtained experimentally. Smith was thus able to construct a frequency table that mapped the notes of the musical arrangement to a series of counter values, and it is these values that provide the note data for his routine.

Smith's music routine uses two counters to calculate two simultaneous impulse trains. The routine writes the two counter values stored in the data triplets into two memory registers, and calculates the period between successive impulses, effectively interleaving the two impulse trains on playback to create two channels of playback. For single melody notes, Smith encoded the pitch as a pair of counter values separated by 1 to create a phasing effect. Chords are encoded as two distinct frequency values. The phasing effect works well, creating a harmonically rich, time-varying tone on the single notes with a characteristic sweeping effect at the beat frequency. However, when the effect is used to trigger two simultaneous distinct pitches, the routine introduces a degree of pitch ambiguity that results from the relative amplitudes of the harmonics of the individual tones.

As noted above, single notes are encoded as pairs of counter values separated by a single unit, the effect of which is to create two binary impulse trains separated in frequency by only a few Hertz. This results in a frequency spectrum that is very close to a harmonic series, as illustrated in Figure 8.

Figure 8: A spectral plot of the two near-coincident impulse trains shows a pseudo-harmonic series, although the concordance between the harmonics of the lower tone, illustrated by the dark bands, and the upper tone, illustrated by the lighter bands, decreases with increasing frequency. This harmonic character makes it easy to identify a definite sense of pitch.

When two impulse trains are interleaved at distinct frequencies, this pseudo- harmonic spectrum breaks down, as shown in Figure 9 below. This spectral plot illustrates a major third interval. As before, the dark bands correspond to the harmonics of the lower tone in the interval, and the light bands to the harmonics of the upper tone. It can be seen immediately that there is no regular structure to these frequency components. The spacing between spectral components is variable, and includes a number of very closely clustered components, which introduces an unpleasant beating to the tone. Also, because each of the harmonics of each tone has equal magnitude, one of the key auditory cues that we normally use to locate and identify pitch, the fundamental, which is usually the strongest of these frequency components, is not evident. Every frequency component therefore arbitrarily becomes the dominant one as the ear focuses in on different regions, creating a very vague and indistinct sense of pitch. The overall effect is to create a sense in the listener of a rough, complex tone, rather than two discrete and distinct pitches.

Figure 9: A spectral plot of two non-coincident impulse trains shows a more complex relationship. There is variability in the spacing between components and some clustering, leading to beating. The uniform magnitude of the components makes it very difficult to identify discrete pitches.

Smith's approach, then, was innovative and, to an extent, very effective. He had managed to move beyond implying polyphony on a macro level, by manipulating the temporal arrangement of fairly large-scale sound grains, to implying it on a micro level by interleaving impulses, the smallest units of binary sound. This took ZX Spectrum music into similar territory to that which was explored by electronic music pioneers like Pete Samson, whose work with MIT's TX-0 and PDP-1 computer systems, explored similar methods some twenty years earlier (Levy, 2010, p 17-18), and suggested a direction for other developers to continue innovating.

PULSE-WIDTH MODULATION

In 1984, Quicksilva's *Zombie Zombie* (White & Sutherland, 1984) became the first spectrum game to address the failings of Manic Miner's two-channel routine and coax two completely independent channels of tunable square waves from the spectrum using *pulse-width modulation* (PWM). As discussed earlier, sending different sequences of ones and zeroes to the beeper allows the creation of a series of related wave shapes, from trains of binary impulses through to pulse waves of varying duty cycle. This idea can be taken one step further by returning to the idea of speaker inertia, which is the notion that a speaker cone cannot change its state discretely and instantaneously. When driven, it takes a short but finite time to reach maximum displacement and must move through all its intermediate states between fully off and fully on. The speaker behaves in a similar, though not identical way, as it returns to rest. Modulating the width of the signals (by varying the amount of time that the speaker is driven relative to the time that it is not) sent to the beeper, the speaker can be driven to intermediate points between off and on, thereby simulating the effect of a continuous analogue voltage. There are, as you might imagine, many ways to achieve this, but the most common method for the Spectrum was to use pre-calculated lookup tables to convert note frequencies to counter values which could be stored in memory and used to synthesize pulse trains in a similar way to the binary impulse trains discussed earlier. Using this form of PWM, the speaker cone could be made to dance in very elaborate ways to create very complex multi-voice tracks. This process tied up the CPU completely, though, meaning that the effect was only possible for the title screen and breaks in gameplay.

The sound routine in *Zombie Zombie* generates two-channels of sound without any volume or timbral control, and is based around an eighth note quantization scheme, with longer notes consisting of multiple eighth notes at the same pitch and triggered sequentially. The game features three main music sequences. The first is a triumphal, march-like setting of *Ten Green Bottles*, which morphs in bar 9 into an unsettling arrangement in parallel augmented 4ths, a reference to the common eighties horror soundtrack trope of the distended children's song or nursery rhyme. The game also features a simple, yet triumphal arrangement of Bizet's *March of the Toreadors* on completion of the

game, and a track that combines White's two-channel routine with the implied polyphony technique described in Section 4, combining bass and a simple arpeggiated accompaniment to create the suggestion of three simultaneous voices.

Having established PWM as a viable approach to music-making on the Spectrum, some games applied the technique with varying degrees of success, while Melbourne House's *Wham! The Music Box*(Alexander, 1985), a fairly sophisticated music sequencer and percussion synthesizer provided users with an easy-to-use graphical interface that would be familiar to users of most digital audio workstations today. The Spectrum's beeper, however, had yet more to give, and it was Tim Follin, a young programmer from St. Helens, in the northwest of England, who really embraced PWM, and took the Spectrum and its 1-bit voice to a whole new level. Follin developed his sound routine on his earliest titles, *Subterranean Stryker* (Follin, 1985), *Star Firebirds* (Follin et al, 1985a) and *Vectron* (Follin et al, 1985b), so that by 1986 with *Agent X*, both his signature sound and his technical implementation, which had reached a channel count of five, along with percussion, enveloping, portamento and phasing, were already very well developed. This did, however, come at the expense of audio fidelity.

In retrospect, Follin's earliest soundtracks showcase the incremental development of both his sound engine and his emerging musical style. The soundtrack for his first Spectrum game, *Subterranean Stryker*, is interesting only insofar as it demonstrates some of his engine's nascent capabilities. It features a single-channel melody line, which drifts stylistically and with little in the way of melodic coherence, the programming equivalent, perhaps, of a guitarist noodling on a fretboard. Beneath the notes, however, can be heard amplitude enveloping, a far-from-trivial task on a speaker that can only be either on or off, and a phasing effect, creating a dynamically-changing timbre, both features that Follin would continue to develop. For his next title, *Star Firebirds*, Follin introduced a portamento effect, creating quite dramatic Emersonian pitch glides in places, but it was *Vectron*, a 3D maze game inspired by the *Space Paranoids*sequence from Disney's *Tron* (Lisberger, 1982), where both the engine and Follin's musical style really begin to shine through. The soundtrack in *Vectron* manages three independent voices during playback and begins with a phased, enveloped synth leading into an electronic fanfare, before a fast blues-scale riff, not unlike the percussive organ lines of Keith Emerson and Rick Wakeman, begins. The score then breaks style, directly referencing Wendy Carlos's original score from *Tron*, before returning to a series of blues-scale sequences.

Follin published his three-channel music routine as a hexadecimal type-in program listing in *Your Sinclair* magazine (Follin, 1987), making it freely available for use in non-commercial programs. The listing contains just 167 lines of code, and the entire routine, complete with note data weighs in at just over 1K in size. The article noted that, at the time, Follin was working on a new 6-channel routine with chorus, bass, echo, portamento and full ADSR, all elements that would turn up in his later soundtracks as his commercial engine continued to develop.

In 1986, with the release of *Agent X*, Follin upped the channel count to 5, although this came at the expense of some audio fidelity. With the processor pushed to its limits, the music is very lo-fi, something Follin acknowledged in an interview with Eurogamer, noting that "It's hard to actually hear [the music in *Agent X*], I think I'd pushed the processor too far actually!". Follin's *Agent X* engine works by using five of the Z80's registers, sections of RAM inside the main CPU that can be used to store and rapidly operate on frequently-used data, prioritized areas of memory that allow for rapid access by the processor, in a loop, all of which count down from a series of predetermined values to zero. When each loop is complete, it generates a pulse, the width of which determines the speaker level. The constantly shifting pulse-widths affect both the level and timbre, adding noise in the sense that the changing harmonic content introduces an undesirable roughness to the sound and causes tuning problems as the channel count rises.

SUMMARY

That peculiar quality of sound of the ZX Spectrum, its quality of sound, the grungy fuzziness, came to define the sound of the Spectrum for a generation of gamers, becoming an important feature of the style, in much the same way that the warmth of tape saturation came to characterize the sound of recorded music throughout the 1960s and 70s to such an extent that modern developers now devote significant time and resource to create effects algorithms that degrade pristine digital recordings to simulate some of that analogue character.

It was a sound, however, that evolved gradually, through a series of logical steps, each of which is rooted elsewhere in the annals of electronic music history. Interestingly, however, my conversations with those early game music pioneers and game music historians, including Rob Hubbard, Ben Daglish, and Chris Abbott, suggest that these innovations happened independently. These were young, creative programmers looking for a way around a technical problem. In the same way that they weren't aware of copyrights, nor were they aware of Max Matthews' and Peter Samson's innovations in electronic music that had taken place in the preceding decades.

Following the demise of the Spectrum in 1992, 1-bit music continued to feature in many games, largely thanks to the PC speaker, which provided the default sound output for many early PC games. LucasArts' *The Secret of Monkey Island* (Gilbert, 1990) is a fine example of such early PC soundtracks, using a combination of the techniques outlined above to create an engaging title theme.

With the introduction of dedicated PC soundcards, Frequency Modulation and sample playback synthesis gradually replaced PSGs (Programmable Sound Generators) as the source of video game sound, and video game soundtracks became more cinematic, often increasingly relying on multiple channels with orchestral timbres, both in concept and in execution, and yet the chirpy 1-bit sound continued. Music trackers, such as the DOS-based *Monotone* (Leonard, 2008) and *Pulse Tracker* (Larsson, 2012), put these 1-bit music techniques in the

hands of musicians rather than programmers. Emulators and hacked code allowed a new generation of musicians to continue to push the capabilities of the Spectrum, and demoscene meets and *compos* (competitive events that encourage the creation of sophisticated real-time generative art and music using obsolete and limited hardware) continue to provide platforms for creative performance.

The growth in recent years of open development systems like the Raspberry PI, which was introduced to promote the teaching of basic computer science in schools, has kick-started the same sort of experimental approach to coding that happened during the first wave of the microcomputer revolution. With just a few lines of code and a small Mylar speaker wired to the digital output pin of an Arduino, a new generation of coders has been able to experiment with 1-bit music techniques.

Recent developments in music technology over the last 30 years have seen an explosion in the range and scope of music creation and production tools. Virtualization has taken esoteric studio hardware that previously would have been the preserve of international-class studios and converted them to code, allowing all-comers to build flexible virtual processing racks, driven by carefully designed presets that allow the devices easily to integrate into any production session. Classic synths have similarly been modeled and virtualized, and primed, both with sounds and loopable MIDI sequences, to allow their users to channel the sounds of, for example, Kraftwerk, the Prodigy, or Emerson, Lake and Palmer, with a few simple selections from a drop-down menu. Such is the democratizing effect of this technology that armed with a laptop, a suitable digital audio workstation (DAW) and a little time and enthusiasm, it is possible to create quite authentic-sounding electronic music tracks with relatively little effort. In many respects, this is a very positive development. It has provided a creative outlet for many and has made music making and production more accessible. This accessibility, however, comes at a cost.

> Constraint is what the lo-fi sound of the 8-bit microcomputer can provide. With simple, raw waveforms, limited polyphony and few options for dynamic articulation, chip musicians have no option but to go right back to the very basics and address the fundamentals that make music engaging and entertaining.

Historically, scholars such as Amabile, (1983) have argued that too much constraint on creative freedom decreases the intrinsic motivation to create. However, recent work has demonstrated a clear distinction between constraints that obstruct creativity (for example by encouraging conformity, as may be the case when composing new work from preconfigured musical patterns and presets), and those that promote it (see, for example, Stokes, 2005).In addition, recent research has suggested that the "Paradox of Choice" (Schwartz, 2004) can have similarly deleterious effects on intrinsic motivation (Iyengar Lepper, 2000) and originality (Chua Iyengar, 2008). While, on the one hand, it is won-

derfully liberating to have complex in-the-box software solutions that enable musicians to compose, arrange and produce, on the other hand, the tyranny of choice that is presented can be crippling, leading to creative procrastination as one searches for 'just the right sound', rather than ploughing on with the process of creation. It is just as Devo sang back in the 80s: "Freedom of choice is what you got; Freedom from choice is what you want," (Mothersbaugh, 1980).

Constraint is what the lo-fi sound of the 8-bit microcomputer can provide. With simple, raw waveforms, limited polyphony and few options for dynamic articulation, chip musicians have no option but to go right back to the very basics and address the fundamentals that make music engaging and entertaining. There is nowhere for half-formed ideas or weak arrangements to hide. It is electronic music in its most fundamental state; it is about simple ideas expressed well.

In 2003, Malcolm McLaren declared 8-bit to be the new punk (2003). It has that same, lo-fi DIY aesthetic and, just as punk raised a defiant middle finger to the worst excesses of prog rock and glam rock, so too 8-bit and the associated lo-fi subculture stands in stark contrast to the over-produced sound of much of current commercial music. The Spectrum embodies that spirit perfectly and, as a small but vibrant part of the retro computing scene, the demoscene and the chipscene suggest that there are, even now, many new musical chapters to be written in Z80 assembly.

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AUTHOR'S INFO

Kenneth McAlpine is a musician, author and academic at Abertay University, Dundee, Scotland, and is a Member of the Editorial Board of *The Computer Games Journal*. His research focus includes video game music and the role of technical constraint in the development of its aesthetic, and the implementation and analysis of real-time adaptive music used in interactive contexts.

F.PEÑATE DOMÍNGUEZ
Universidad Complutense
de Madrid
fpenate@ucm.es

"Heute gehört uns die Galaxie"

Music and Historical Credibility in Wolfenstein: The New Order's Nazi Dystopia

ABSTRACT

This article addresses the use of "Nazi rock 'n' roll" in *Wolfenstein: The New Order* (2014) as a strategy to reinforce a historically selective sense of verisimilitude of the game's dystopian setting. In *W:TNO*'s production, cover replicas of US popular music classics from the second half of the 20th century were composed in 'Nazi mode', with German themes and language, with the intent of creating a sense of stereotyped and mythicized knowledge of World War II that also imagined an outcome of the war in which the Nazis had won. The diegetic embedding of songs in this style could have supported the game's atmosphere in a way that is comparable to the use of licensed works in games such as *Grand Theft Auto*and *Fallout*. However, the soundtrack composition was constrained by controversies around the representation of the Third Reich in computer games, a factor that also limited the role of the songs within the game world. The narrative potential of the original score thus remained untapped, as the songs were used mostly for marketing purposes. This paper highlights how music partly contributed to the creation of a myth-historical alternate timeline of post-WW2, and how the use of these songs could have turned the game's story into a more complex and multifaceted discourse than what production allowed, contributing to a nuanced representation of Nazism, a theme that has remained controversial in the medium of the videogame.

KEYWORDS: *ludic-fictional worlds, historical video games, Nazism, myth, video game music, Wolfenstein.*

INTRODUCTION

The video game *Wolfenstein: The New Order* (MachineGames/Bethesda Softworks, 2014) (*W:TNO*) addresses one of the most trendy counterfactual questions in contemporary popular culture: what if Germany had won World War

II[1]? Despite the appeal of this hypothetical scenario, it is the first time veteran franchise *Wolfenstein*, known for its supernatural depictions of the conflict, explores this type of setting[2], taking the series' fictional universe to a whole new level. The sense of being trapped in a world where Hitler's ideals are enforced using violence and coercion is not only produced through the representation of massive buildings that scrape the skies of "Neu Berlin", or of the claustrophobic and labyrinthine sewers that members of the Resistance have turned into both their homes and headquarters; this sensation is also encouraged by the players' explorations of the game levels' visual and sonic features, as they discover more of *W:TNO*'s universe by reading newspapers clips that inform them about the capitulation of the globe before the *Führer*'s armies, or through the music that a new generation of "Germans" enjoy when listening to their futuristic record players. These seemingly secondary elements are key items in the credibility of a Nazi dystopia. As will be discussed, such elements act as remediators of popular narratives, especially about World War II[3], and are powerful tools in constructing specific understandings of the past. The discussion that follows will focus on the role that music plays in this process.

Besides an original soundtrack composed by Mick Gordon [4] that serves as the background music for the game, *W:TNO* features a tracklist made up from eleven songs edited and published by an imaginary, state-owned broadcast company called *Neumond Records* (New Moon Records). A list of the themes' names and performers is shown below:

Song name	Performer
"Berlin Boys and Stuttgart Girls"	Viktor and Die Volkalisten
"Toe the Line"	The Bunkers
"Mein Kleiner VW"	Hans
"Ich bin überall"	Schwarz-Rote Welle
"Weltraumsurfen"	The Comet Trails
"Zug nach Hamburg"	Die Schäferhunde
"Tapferer Kleiner Liebling"	Karl and Karla
"Mond, Mond, Ja, Ja"	Die Käfer
"House of the Rising Sun"	Wilbert Eckhart und seine Volksmusik Stars
"Boom! Boom!"	Ralph Becker
"Nowhere to run"	Die Partei Damen

Source: Wolfenstein Wikia: "Neumond Records" http://wolfenstein.wikia.com/wiki/Neumond_Records, consulted 20/02/2016)

The appeal of the soundtrack resides in the apparent contradiction between its styles and its lyrics. Every artist is a parody of an American band

1. From novels to videogames, TV-shows, music, and movies, cultural artifacts often deal with the theme of a Nazi-dominated world. Science fiction author Philip K. Dick (1928-1982) imagined a dystopian United States of America occupied by both the Third Reich and the Greater Japanese Empire; his novel *The Man in the High Castle*, written in 1962, has inspired a TV series produced by Amazon that aired in 2015. Also, within a film genre dedicated to Nazi-themed fiction, on occasion alternative pasts are explored where the Nazis fulfill their New Order projects. Additionally, some video games address this topic, for example *Turning Point: Fall of Liberty* (Spark Unlimited/ Codemasters, 2008).

2.*The New Order* is one of the latest games in a franchise that was born in 1981 and has become a cornerstone in the first-person shooter genre. Since, *W:TNO* has been followed by a brief prequel named *Wolfenstein: The Old Blood* (MachineGames/ Bethesda Softworks, 2015) and a sequel, *Wolfenstein: The New Colossus* (MachineGames/Bethesda Softworks, 2017).

3. Some noteworthy works on the issue of World War II in computer games are, for example, Gish (2010), Raupach (2014), Crabtree (2013), Baron (2010), Fisher (2011), and Rejack (2007).

4. Wikipedia: "Wolfenstein: The New Order Original Soundtrack" *https://en.wikipedia.org/wiki/Wolfenstein:_The_New_Order_Original_Game_Soundtrack _blank rel="noopener">https://en.wikipedia.org/wiki/Wolfenstein:_The_New_Order_Original_Game_Soundtrack (Consulted 16/07/2016).*

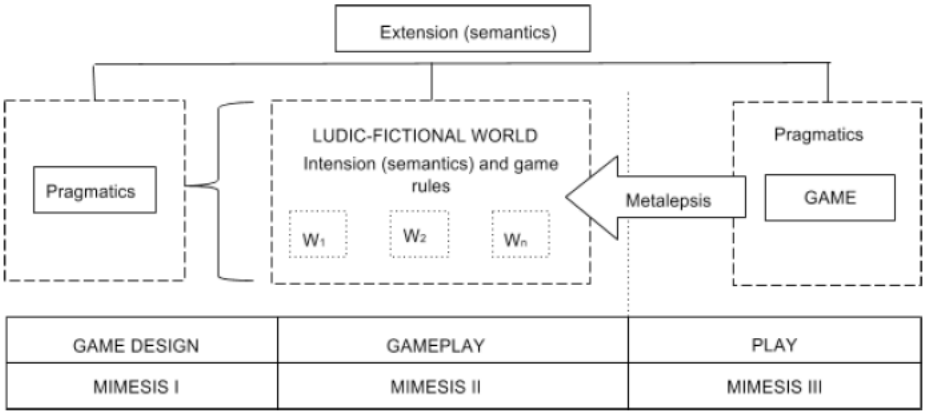
or rock star from the 1950s and 1960s, "Nazified" to fit the game world's dystopian atmosphere. For example, *Die Käfer* and *Karl und Karla* mimic *The Beatles* and *Sonny and Cher*, respectively. *The Comet Tails* with their song '*Weltraumsurfen'* are referencing the emblematic surf-rock quintet *The Beach Boys*. Likewise, the song '*Berlin Boys and Stuttgart Girls*' sounds awfully similar to the aforementioned band's '*California Girls*'. In a similar way, '*Zug nach Hamburg*', the greatest hit of the imaginary formation *Die Schäferhunde* is an almost direct reference to '*Last Train to Clarksville'*, by *The Monkees*. Finally, there are several licensed songs that have been modified to fit the game's atmosphere: '*Boom Boom*', by John Lee Hooker; '*Nowhere to Run*', by *Martha and the Vandellas*; and '*The House of the Rising Sun*', by *The Animals*. These hits work by adding an extra layer of authenticity and, at the same time, by generating a dissonance with sanctioned history intended to increase the appeal of the game world. However, in order to have a better insight of its ludic and fictional role in the game, we have to understand the process of creation and everything it implies: media conventions, potentials and culturally grounded limits. How does the soundtrack help build up the game's setting? How did social and cultural conventions about historical computer games affect the production process of the musical score and its outcome? Did those conventions contribute to the whitewashing of a mythologized fantasy about yesterday's Nazi-dominated tomorrow? The current paper aims to find answers to these questions through the use a specific methodological approach drawn from historical game studies, the contextualization of music in the game medium, and sanctioned discourses about World War II that are present in action games.

THEORY AND METHODOLOGY

A game like *W:TNO* (or any other) is not an open window through which we can observe the past (which is inaccessible), or even sneak through in order to experience former events, but an interactive tool that remediates current worldviews, including those about the past, in its own unique way through all its elements: graphics, rules, narratives, and sound[5]. Game scholar Antonio J. Planells de la Maza defines electronic entertainment products as "…complex fictional worlds that, as cultural artifacts, take part in a set of relationships inside current social, economic and political frames" (2015: 11). These worlds each have their own independent ontological status, which means that any of its elements are true unless they defy the inner logic and cohesion of said world (Planells de la Maza, 2015: 56-67). Although this definition attempts to surpass the classical, analytical theory of fictional worlds being just mimetic versions of our own reality, fictional worlds are constructed in the broader context of the real world. Thus, Planells (2015, p. 96) proposes a model to understand videogames that is very much influenced by Aristotle's theory of mimesis[6], called the *semantic-pragmatic model of the ludic-fictional worlds*.

5. For a general overview of the remediation of the past in videogames see, for example, Chapman (2016), Winnerling & Kerschbaumer (2014), Elliott & Kapell (2013), Mol/Ariese-Vandemeulebroucke/Boom/Politopoulos (2017), Uricchio (2005), Kline (2014), and McCall (2011).

6. Paul Ricoeur has proposed an interpretative model by which Aristotle's concept of mimesis – inherited from Plato's idea of a fraudulent copy of reality, without its derogatory connotation – can be divided in three stages. The process begins with mimesis I or pre-configuration, when the creator fashions the fiction; and it ends with mimesis III or re-configuration when audiences decode the message: positioned between these stages, lies mimesis II or the formal work of fiction (Planells de la Maza, 2015: 36-38, 53-54).



Planells de la Maza, A. J. (2015): Videojuegos y mundos de ficción: de Super Mario a Portal, Cátedra Signo e Imagen, p. 96. Translation by the Author.

According to Planells' diagram, the creation and understanding of a game's fictional world encompass three phases. While the first (game design) and third (play) are highly influenced by the context of the designer and player (pragmatics), the second one (gameplay) belongs to the realm of semantics[7]. However, the three of them are connected by the extensional semantic, thus being related to each other and, ultimately, with their context (Planells de la Maza, 2015: 95-104). This sets a bridge between reality and fiction, which allows audiences to understand the imaginary world by filling the gaps with the logic and knowledge of their own world: this is called the *principle of minimal departure* by Ryan (1991: 48-60) and *encyclopedic knowledge* by Eco (1993: 38).

This principle allows authors and game designers, whether unconsciously or not, to avoid explaining general issues that are included in fiction, such as the composition of the human body or the law of gravity. More complex are the translations of specific personalities, groups, or elements with a strong and unique identity within the fictional text. In these cases, they are considered *fictional particulars* that are connected to their real references through an *inter-world identity*. A *fictional particular*, also known as *replica* and *version*, is the translation of a real particular (often a person) in a specific fictional world. Take, for example, Napoleon––the Corsican who lived between the 18th and 19th centuries is the real particular of the one featuring in *War and Peace* (Tolstoi, 1869) and also of the one Arno Dorian meets in *Assassin's Creed: Unity* (Ubisoft, 2014). Replicas can share a number of properties with their originals, elements that make them recognizable by the audience and ultimately define their *inter-world identity*. However, these identities are flexible and malleable. According to non-existentialist semantics, the author has freedom in choosing to change the properties of the *replica*, altering its *inter-world identity*(Dolezel, 1999: 35-40). This is possible thanks to the ontological autonomy of the fictional world, which allows particulars within it to exist as long as they do not violate the world's semantic logic. The same goes for the game I will examine in the following pages. Its music acts like a twisted replica of the sounds popularly identified as symbols

7. I believe this is similar to historical discourses, the elaborate work of an author based on the sources and a bibliography. Here, the first phase would consist in the gathering of the historical evidence, its analysis and the revision of literature, and the third being the reception of the work and the debate of the author's methods, hypothesis, and conclusions

of a particular era (the 1960s) that, despite the differences they present to their originals, still retain an identifiable inter-world identity.

Nevertheless, current research on historical fiction shows that replicas of historical categories need to share some particular elements with their originals to be credible. This makes their *inter-world identity*more rigid, to resonate better with audiences and become authentic. But what does it mean to a replica to be *authentic*? Elliott and Kapell believe that *authenticity* pursues fulfilling the audience's historical knowledge and expectations, regardless of the empirical correctness of the *replica*. Seeking to create an *inter-world identity* based on real-world facts and data is not usually the aim of historical fiction, as an "accurate" translation of the past into the possible world (Elliott and Kapell, 2013: 359-361). Instead, the game's historical signifiers are emptied and become loaded by *myth*[8].

Myth naturalizes and de-politicizes historical explanations; however, these narratives need to refer the past in order to be read as history. Video games achieve this through the strategies of *selective authenticity*, "…a form of narrative license, in which an interactive experience of the past blends historical representation with generic conventions and audience expectations" (Salvati & Bullinger, 2013: 154), often creating characteristic "brands" for each historical period [9]. For example, authors focus on videogames set in World War II in order to identify the elements that, blended with genre conventions (in this case, *first person shooters*), configure *BrandWW2*. Accordingly, a game that features accurate representations of weapons and uniforms, manila folders, newsreel documentary and scenes inspired in movies and TV shows about the war is going to be accepted as a realistic historical simulation, regardless of the nature of its historical statements (Salvati and Bullinger, 2013: 157-164). This happens because the *authentic feel* of the fictional world strongly *resonates* with the player.

A *historical resonance* is the "recognition by the player of the game as 'sufficiently' real and related to a local context (shared history)" (Chapman, 2013: 35). These resonances come in multiple forms: image, text, narrative and sound, including music. The remediation of the past in a fictional world or a historiographical text (Chapman's 'global context') can create both resonances and dissonances with the reader's historical knowledge and background (the "local context"). While resonances are produced when the global context matches the local one, dissonances rise up as the consequence of the contradiction between both contexts. When the latter happens in a videogame without the player purposely and actively seeking the dissonance, they can explore the dissonant, fictional world through an act of *passive counter-history* (Chapman, 2013: 32-37; Chapman, 2016: 42-46). While these dissonances allegedly defy authenticity, they effectively combine with resonant elements to create more complex and interesting fictional worlds based on historical knowledge. I will argue that, despite the initial dissonances associated with "Nazi rock 'n' roll", when contextualized in the wider fictional world of *W:TNO,* and combined with an imagined target audience, it becomes a tool that enables the game's historical verisimilitude.

8. A critical approach to mythologies was developed by Roland Barthes (1957). Within this semiotic approach, language (understood as any form of representation, such as text, image, sound) is regarded as a system of signs that implicitly connote myth, a veiled ideological discourse that reinforces and naturalizes specific power relations. The historians' work may therefore be regarded as a narrative practice informed by both fact and myth. This results in a narrative form we could call 'mythistory', popular among both historians and game designers. Despite basing their credibility on factual sources, their explanations rest on a particular ideology and the use persuasive strategies to reinforce their claims (see McNeill 1986).

9. Following a Barthesian approach, we could say that selective authenticity works on the signifier, providing the representation with an aesthetic that produces an imagined past.

MUSIC AND AUTHENTICITY

Aided with the aforementioned methodological framework, I will explore how music stands as a structural element in the creation of a pseudo-historical world of fiction such as the one presented in *W:TNO*. What really stands out when listening to songs licensed by the imaginary corporation *Neumond Records* is not that they try to duplicate some of the most memorable post-war US greatest hits of the 1950s and 1960s, but that their lyrics are in German. Most of them do not make explicit or serious references to Aryan supremacy and militaristic jargon, two of the main features of early Nazi music (Zeman, 1973: 37-61; Bergmeier & Lotz, 1997: 136-177); however, presenting the lyrics in German seemed sufficient to evoke Nazism. The cultural background of the game medium allowed the publisher to take that shortcut. In videogames, German language is often associated with a particular historical event: World War II. Along with Salvati and Bullinger's *BrandWW2*, author Eva Kingsepp argues that games usually focus on transmitting a Nazi atmosphere to feel authentic rather than trying to mediate the past accurately. This sense of "Naziness" is often achieved by introducing certain elements popular culture has associated with the Third Reich: symbols such as swastikas and iron crosses, certain types of paintings, locations such as European villages and Medieval castles, and even artifacts often associated with occultism due to the interest certain Nazi officials showed to the supernatural (Kingsepp, 2002, 2012). Language and sound are also powerful elements of selective authenticity in this kind of games. The soundscapes of World War II-based games not only transmit a sense of immediacy through the shouting of orders and the sound of gunfire and explosions, but they also carry particular meanings: one of them is that the German language is always the voice of the foe. Due to the overrepresentation of Wehrmacht ("Defense Force") soldiers as opponents, a short word or sentence shouted out in German indicates to the average player that the enemy is nearby and needs to be found and shot down (Kingsepp, 2006: 75-77). This way, even the most ordinary expression or conversation becomes a morally charged signifier in the context of a war game, turning the whole language (and its culture) as an indicator of evil and animosity (Kingsepp, 2006: 81).

The tendencies mentioned above are not entirely applicable to *W:TNO*. Surprisingly, the game content features a lot of eugenic terminologies [10], especially when the main antagonists enter the scene. However, despite recently being elevated to the status of cultural products, games have become problematic tools of representation because of their playfulness. This fact has made the representation of controversial themes and issues in the game medium a thorny subject. Linderoth and Chapman have found Goffman's frame theory very useful to explain the process of adapting sensitive issues to the game form. Through this process, themes are *ludically framed*, this is, they acquire a playful meaning that works as an additional layer of meaning that adds to the ones already given to that theme by culture and society. The new meaning produced

10. This is the racial jargon used by Nazism to describe the characteristics and mechanisms that put what they believed was the Aryan "race" above any other. The scene where Blazkowicz meets Frau Irene Engel serves as a good example, since she states that he has "very nice Aryan features" while her subordinate, Bubi, points out that he also fancies Blazkowicz's blue eyes.

by placing the issue into the ludic frame is often perceived as having trivializing properties, a trait called *upkeying*. For example, airsoft players know that they are engaging in a trivial activity despite fighting each other with accurate replicas of real weapons, and they are very strict in the rules applied to the game and in the language they use––for example, players are not "killed" but "eliminated". In the reverse case, games are also seen as *downkeying* artifacts, this is, the actions seen or performed by the player are translated ultimately to the user's everyday activities. In this case, a concerned father could ban her daughter from playing videogames after witnessing her overrunning pedestrians in *Grand Theft Auto* and thus believing she will emulate the game as soon as she gets her driving license. Both processes have restricted the appearance of many controversial issues in games, turning them into "value thermometers" that reveal social and cultural norms and acceptable narratives. Therefore, most games must engage in strict culturally sanctioned rules of representation to be acceptable. Regarding Nazism and World War II, developers tend to be over-cautious to dodge potential criticism and accusations of being anti-democratic, homophobic and racist on the basis of sensitive content (Chapman & Linderoth, 2015: 140-143). Thereby, thorny episodes such as the Holocaust or the dropping of the atomic bombs tend to be excluded from digital environments of play, and Nazi symbols and emblems erased from virtual uniforms in games where users can play as a German combatant. Such extreme selectiveness, which apparently contradicts *BrandWW2*, allows games to avoid being at the center of controversy and social panics but also selectively cleanses the history of Nazism and World War II in the process, making this narratively and aesthetically more acceptable (Chapman & Linderoth, 2015: 149-153).

W:TNO stands as a noteworthy exception to the tendency to use discursive strategies that avoid the problematization of controversial topics or the lack of representation of these particular issues[11]––it even features a concentration camp. In this context though, efforts were made to keep the lyrics of *Neumond* songs ideologically aseptic. I believe that the cause of this decision lies in the apparent contradiction that results of the *downkeying* attributes of music, which is itself a medium, mediated in a videogame or associated with it. Music has a long-standing tradition of being the carrier of ideological messages. One of the most obvious examples is the anthem, used to transmit certain dogmas ranging from a nation-state world system to liberal or socialist and fascist ideologies, in a subtle and trivialized way (Billig, 1995: 93-127). This explains the cautious stance Jason Menkes, executive producer of *Copilot Music + Sound,* adopted when he claimed that:

> "…no one wanted to create propaganda or create something that could be used for propaganda. If you translate the lyrics, they're pretty benign: they're just love songs, or fun pop songs (…) We hired as many non-Aryans as I could for this project. A lot of our artists were Jewish or black or gay"[12].

11. In World War II ludonarratives, such tendencies often privilege binary interpretations of the conflict and avoid showing its most complex aspects.

12. The Wall Street Journal: "'Wolfenstein: The New Order' Marketing Team Created Fictional Record Label For Promo Campaign", http://blogs.wsj.com/speakeasy/2014/04/04/wolfenstein-the-new-order-marketing-team-created-fictional-record-label-for-promo-campaign/ _blank rel="noopener">http://blogs.wsj.com/speakeasy/2014/04/04/wolfenstein-the-new-order-marketing-team-created-fictional-record-label-for-promo-campaign/ (consulted 18/07/2016).

In order to make the former statement clearer, I will make use of the translated lyrics of "Mond, Mond, Ja, Ja", a Nazi rock hit by the imaginary band Die Käfer:

German (original)	English translation
Drei, Zwo, Eins, Start	Three, two, one, start
Der Mond schaut uns an und wir zurück.	The moon looks at us and we look back.
Der Mond ist über uns, wird uns gehören.	The moon is above us, will be ours.
Gestern die Welt und heute der Himmel,	Yesterday the world and today the sky,
Denn uns gehört er und die Freiheit fliegt.	For it belongs to us and the Freedom Flies.
Mond, Mond, Ja, Ja.	Moon, Moon, Yes, Yes
Vereint wir sind unter dem großen	United we are under the great researchers.
Forscher.	Moon, Moon, Yes, Yes
Mond, Mond, Ja, Ja.	Today the galaxy belongs to us.
Heute gehört uns die Galaxie.	Forward brothers, our moon is red.
	We will conquer the small rock.
Vorwärts Brüder unser Mond ist rot.	We are those who have mastered the skies,
Wir werden den kleinen Fels erobern.	For we are the greatest in the universe.
Wir sind die jenen, die den Himmel be-	(3x)
herrschen,	Moon, Moon, Yes, Yes
Denn wir sind die Größten im Universum.	United we are under the great researchers.
	Moon, Moon, Yes, Yes
(3x)	Today the galaxy belongs to us.
Mond, Mond, Ja, Ja	
Vereint wir sind unter dem großen	
Forscher.	
Mond, Mond, Ja, Ja	
Heute gehört uns die Galaxie.	

Source: Wolfenstein Wikia: "Neumond Records": http://wolfenstein.wikia.com/wiki/Neumond_Records (Consulted 16/07/2016).

This song tells us about conquest and might – components of the fascist discourse –, but in such an innocuous way that, combined with the catchy pop-rock melody, becomes silly. From the perspective of the *selective authenticity* framed in a ludic and musical medium, the allusion to the Nazi willingness to expand their *Lebensraum* is softened by the lack of reference to any nations, territories and ethnicities. Furthermore, the fact that they are singing about the conquest of the Moon, which was far beyond humanity's reach during the 1930s and 40s, serves as a parody of the Third Reich's expansionist policies. In addition, the "researchers" mentioned in the chorus refer to Nazi scientists, another cliché of Nazism in pop culture and myth. Finally, the song features in

the fictional album *'Das blaue U-Boot'* (a parody of the 'Yellow Submarine'), the cover art of which features four silhouettes walking over a pedestrian crossing in a sassy reference to the album cover of The Beatles' *Abbey Road*.

Another example worth mentioning is the song *'Tapferer Kleiner Lieblieng*', from the male-and-female duo *'Karl und Karla*', apparently specialized in romantic ballads. Here, *'Karl und Karla',* the German counterparts of Sonny and Cher, sing a cheesy love ballad with silly lyrics that blend corny expressions about love with stereotypes and commonplaces of the German culture and geography. However, the creative process of this particular song is noteworthy. Initially, it was entitled '*Blue Eyes Forever'*, but the supremacist innuendo implied in the sentence finally had it discarded[13]. In this context, "Tapferer Kleiner Liebling" ("Brave Little Darling") seemed a wiser option. Furthermore, the tone in which the German language is used in the medium is also important: in the game's cut-scenes Nazi language is associated with evil and dehumanized foes, while the ironic and parodic mood of the aforementioned songs would have made its lyrics' meanings easily misunderstood. Finally, due to the political uses of music, any serious reference to the Third Reich and its dogmas could have been interpreted as an apologetic message.

A MYTH-HISTORY OF NAZI AND ROCK 'N' ROLL MUSIC:

I next wish to argue that the original score of *W:TNO's* is a good example of the tensions between myth and "accurate" historical knowledge in computer games, and also talk about the aesthetic remediation of a particular past by a commercial product in the context of global capitalism. First of all, in order to understand how these particular strategies of song composition work as selective authenticators that link *Wolfenstein's* Nazi dystopia with historical commonplaces, it is convenient to explore the history and myths of its two referential themes: The music scene in the Third Reich and the phenomenon of American rock 'n' roll in the 1960s. I believe that, in the process, the former is oversimplified while the latter is privileged. This is because post-war American hits became known worldwide and have been elevated to a mythical status, while the musical landscape during the Third Reich had been narrowed to just tools of Nazi propaganda.

I will focus on the former first. Despite attempts by Hitler's administration, through the Ministry of Propaganda and its different sections, to brainwash the German population with racist and nationalistic ideology, and to influence their cultural tastes (Zeman, 1973: 37-61; Bergmeier and Lotz, 1997: 136-177), the NSDAP changed its approach to music and propaganda as they reached the levers of power. Therefore, the relationship between Nazism and popular music was a thorny one. Germany, especially Berlin, had been the cultural capital of Europe during the 1920s (Bergmeier & Lotz, 1997: 137), which popularized modern music such as jazz and swing popular in Germany. The *Partei* had a problem with this because Nazis associated these styles with non-"Aryans" who they believed to be *Untermenschen*. At first, the Regime tried to wipe out *danz-*

13. Get in the Media – "Brave Little Leiblings: The Alternate Reality of Music in 'Wolfenstein: The New Order'" http://blogs.wsj.com/speakeasy/2014/04/04/wolfenstein-the-new-order-marketing-team-created-fictional-record-label-for-promo-campaign/ _blank rel="noopener">http://getinmedia.com/articles/game-careers/brave-little-leiblings-alternate-reality-music-wolfenstein-new-order (Consulted 18/07/2016).

musik[14] through a number of bans; however, due to jazz's popular acclaim, the Nazis tried new strategies such as giving bands a more 'Aryan' aesthetic and promoting similar but more 'Aryan' styles (Pitner, 2014: 149-156). Nevertheless, this mythified understanding of the relationship between Nazism and popular music has been contested recently. Truth is that Hitler's totalitarian rule did not break with the social uses of music during the Weimar years completely: this is, as a mechanism of distraction and escapism free from propaganda. This is the case of the *Schlager* or 'hit song', an umbrella term initially used to designate commercially successful songs regardless of their style, which could be eclectic but eventually was reduced to sing-along songs. These melodies, whose popularity was usually ephemeral, were used in advertisements and marketing, and their catchy tunes often reached the rest of the world (Currid, 2006: 65-80).

Furthermore, during the Nazi regime, many Germans kept listening to jazz, swing and blues despite the Government's efforts to eliminate these styles from German popular culture. Many clubs in Berlin and other major cities hosted jazz performances, at the cost of often being often raided by the Gestapo. The allowance of 'borderline cases' of jazz music by the authorities didn't stop the police to strictly (and violently) enforce the law. However, the most audacious and rebel members of the young generations continued to listen to foreign broadcasts that played outlawed music. These youngsters called themselves *Hot Boys, Lotter Boys, Jazzkatzen* and *Swing Boys/Girls/Babies* and even had their own bands, such as the *Edelweisspiraten* and *Totenkopfpfadfinder*. Unfortunately, many of these rebels were captured by the Gestapo and ended imprisoned in labor camps, some even in Auschwitz (Pitner, 2014: 152-154). After being aware of this obscure chapter in history, we can say that *W:TNO's* unintentionally omits the problematic status of popular music in the Third Reich as both a clumsy strategy of domesticity by the authorities and as an active resistance strategy by those opposed to the totalitarian regime. This is because current popular culture tends to associate the sounds of Nazi Germany with certain soundscapes and uses, which resonate with the audiences. Surprisingly, this impression of music in the Third Reich is also framed by American popular music, especially rock 'n' roll:

> "The sound of liberation is the sound of American popular music, a sound that, for these well-trained ears, is absolutely distinct from sounds that might have come before – while the 'sound' of the Nazi period serves to metonymize mass evil, the sound of American popular music serves as a stand-in for a culture of thrillingly liberated, but doomed decadence" (Currid, 2006: 2).

Another cause of this apparently strange association is the ubiquity of Nazi imagery, and even ideology, in later manifestations of popular music. Bands and singers whose fame reaches the corners of the world (David Bowie, *The Rolling Stones*, Chuck Berry, *Ramones*, etc.) have flirted with National-Socialism, both aesthetically and politically. Furthermore, certain bands have remediated

14. An umbrella term that Nazis coined to gather jazz, blues and other styles considered inferior and impure

Nazism and its darkest episodes in a satirical tone, while others have tried to empty these symbols of any political meaning (Gonzalo, 2016). These examples illustrate that signifiers of Nazism were appropriated by capitalism, merging with mass media product while reinforcing its mythical status and appeal. Furthermore, the existence of this precedent has the potential to make audiences more receptive to the strategies of authenticity of *Newmond Records'* songs and its creators might have thought the same, too. Nazism blends in even further through combination with American popular music of the 1950s and 1960s, yet another mythologized historical phenomenon. Its current status is the outcome of the creation of certain narratives by professional rock critics (who were also witnesses of the historical process) who uncritically associated the "Nazi style" with certain values of youth culture (Walser, 1998: 365). Through this process rock music became an ideological construct, while part of its identity was given by its use as a marketing label (Walser, 1998: 347; Blake, 2004: 490). Additionally, later approaches to the study of the subject have contributed to strengthen the mythical aura of rock and other genres from the era, arguably due to lack of methodological rigor (Santelli, 1999: 238)[15].

By the 1960s involved a radical change in American rock music, which became a channel to denounce social and political issues, thus recovering the tone of protest that characterized many of the 1930s musical compositions. Musicians like Bob Dylan, and Simon and Garfunkel set the precedent of the East Coast protest-based music, while in the West Coast the musical aspect of counterculture adopted a more individualistic tone, with constant references to universal love, personal freedom and the use of drugs as a way of expanding the conscience (Stilwell, 2004: 438-440). This opened the path to the apparition of psychedelic rock and its contestation of traditional moral values and behaviors (Walser, 1998: 361-363), and radical activism against the war and on race, class, gender issues (Stilwell, 2004: 441). Due to its connection to the Civil Rights movement, 1960s rock 'n' roll has also been associated in more politicized contexts with civil rights movements like Black Power (Walser, 1998: 360). Although this particular interpretation is not crossed by certain hegemonic strategies, such as the whitewashing processes discussed here, it is still affected by the capitalist process of mythification and appropriation. We can find evidence of this process in how, more than half a century later, these symbols are marketed and thereby de-politicized.

In the arrangement of *Neumond Records'* hits, Copilot combined some of the myths mentioned above. Every artist they made up has a clear historical reference, therefore using the hagiographic characteristics of rock to create a pseudo-authentic experience. The musical compositions, based on the most popular songs of these bands, serve as the *inter-world identity* that connects the *fictional particulars* with their real but mythified sources. Besides, the use of German lyrics in a playful context establishes a connection between a mythified label of popular music and the traditional enemy of the historical first-person shooter.

15. Nowadays, rock 'n' roll has lost its musical peculiarity and is marketed through a combination of nostalgia and pastiche-like recovery of the past, as the recurrent compilations and re-edition trends show. Indeed, legendary singers and bands are one of the most important foundations of the myth. (Stilwell, 2004: 442). However, legends are usually white and male. The American music industry, especially since the end of the 1950s, systematically whitewashed both its roots and its image through the appropriation of black artists' works, which were performed by Caucasian musicians. See, for example, Stilwell (2004), Walser (1998), Kotarba & Vannini (2009).

All these elements resonate with the average videogame player, who is transported to a peculiar dystopia that feels like history.

MUSIC IN THE GAME EXPERIENCE

As indicated in the above discussion, Nazi rock 'n' roll anchors the fictional world of *W:TNO* to particular moments in history, acting as a carrier of authenticity. However, the question of how this element fits *ludically* and narratively in the game stays unresolved. In order to answer this question, we must understand the multiple roles music plays in ludofictional worlds. Music in games is often underestimated by designers and left to the final stages of development (Rogers, 2014: 427; Schell, 2008: 351-352), despite being a crucial component in game design and an integral part of the game experience (Perry & DeMaria, 2009: 502; Cerrati, 2006: 297-303). One of the key roles of music in games is setting a theme, which informs the atmosphere of the virtual experience. An effective soundtrack is one that resonates with the player's expectations of the game's theme (Schell, 2008: 48-54). For example, a videogame set in the Wild West would probably have a soundtrack inspired by Ennio Morricone's arrangements for the movies under the label "spaghetti western" because Sergio Leone's films have shaped the way the conquest of the West is remembered. Furthermore, using certain instruments, melodies, rhythms, and tones help to evoke specific periods of time and geographical areas (Perry & DeMaria, 2009: 506). However, the effects of resonance are amplified when game music is used diegetically, in other words, when the source of the sound is located within the fictional world. For example, a song emanating from a radio in a room that the player can explore is diegetic. The effectiveness of diegetic sound lies in its ontological status in the fictional world since it is the music its inhabitants listen to (Stevens & Raybould, 2011: 164).

In *W:TNO*, Nazi rock 'n' roll is diegetic. It emanates from loudspeakers, radio devices, and stereo sets. For example, at the beginning of Chapter 4 in the game, the player infiltrates the office of a Nazi officer who is listening to *Karl und Karla*'s '*Tapferer Kleiner Liebling'* through a gramophone; besides, at the end of Chapter 8, the radio of the vehicle Blazkowicz (the player's avatar) uses to escape Camp Belica is playing the aforementioned *'Mond, Mond, Ja, Ja'*. As the sound comes from these particular physical sources, the authenticity of the virtual world is enhanced; the 1960s witnessed the commercialization of singles and albums and the proliferation of radio devices that displaced printed music as the main form of distribution (Stilwell, 2004: 423-424, 428). Also, some *Neumond* LPs are scattered through the game, acting as collectibles that serve as rewards for the players that spent time exploring the game's locations. Still, players can only obtain three of the songs, and the interaction is limited to listening to them through the journal, a submenu, and by appreciating the art of their covers.

In this sense, the role the songs play in the games' overall narrative is very restricted, especially when confronted with other games, for example *Grand Theft Auto* (Rockstar Games, 2001-2016) and *Fallout*(Bethesda Softworks, 2008-2016). In both, music is used in an ironical way: in the former, as a way to explore the contradictions of contemporary American society and the socially and culturally constructed identities of the different ethnicities that coexist (Miller, 2007, 2008), in the latter, the selected hits from the 1950s, with its lyrics full of glee and joy, make a noteworthy contrast with the post-apocalyptic Wasteland where the action takes place (November, 2014; Cutterham, 2014). Licensed music has been used in videogames since the early 1980s as a marketing strategy and a form of revenue for both music and video-ludic industries, a phenomenon that has been improved along with the development of digital technology (Cerrati, 2006: 298-316). Nowadays, licensing music is an appealing choice for game designers, due to the boost of publicity that popular songs allow; it is also a risky choice because the most well-known songs can demand exorbitant prices (Rogers, 2014: 428). However, as *Fallout* and *Grand Theft Auto* exemplify, licensed music can also fulfill ludic-narrative roles. One of the most original uses of a licensed soundtrack in a game is *BioShock* (2k Boston/2k Games/Take-Two Interactive, 2007). There, music used in a diegetic way is played in certain moments of the story, creating a disturbance due to the clear dissonance between the song's lyrics and composition and the events of the game, thus transmitting a powerful message (Gibbons, 2011).

However, *W:TNO* fails where the games discussed above succeed. The original score does not reach its full potential due to its under-representation and limited use within the fictional world. Instead, *Bethesda Softworks* focused on using the soundtrack almost exclusively in the game's marketing campaign. This strategy has proven not to be very effective, as the figures of visits to *Neumond*'s Youtube and Soundcloud accounts show[16]. The songs are also available for purchase at the iTunes store, despite the company's unwillingness to turn the music into a secondary source of revenue. Instead, Pete Hines (vice-president of public relations and marketing at *Bethesda Softworks*) explains that they wanted music just to give more depth to *W:TNO*'s universe[17]. Therefore, Hines is in the same line of thought as those game designers like the aforementioned Jessie Schell, who believes music is a key factor in a game world's credibility and mood.

Reaching beyond *Neumond Records,* one finds that music, specifically rock, nevertheless plays a minor but relevant role in the game's narrative. In contrast to the music enjoyed by Nazi characters, *W:TNO*features a member of the resistance called "J.". This secondary character, a skinny African-American musician who left his home after the United States surrendered to the Third Reich, personifies the mythical image of the counterculture of the 1960s and, by extension, its soundscapes. "J." can only be found at the Resistance headquarters, where he is always performing majestic electric guitar solos. In the beginning, his presence seems to be only decorative, but at a certain point in the game a cinematic be-

16. 35,000 and 25,000 views/plays, respectively. Source: Get in the Media: "Brave Little Leiblings: The Alternate Reality of Music in 'Wolfenstein: The New Order'" http://getinmedia.com/articles/game-careers/brave-little-leiblings-alternate-reality-music-wolfenstein-new-order _blank rel="noopener">http://getinmedia.com/articles/game-careers/brave-little-leiblings-alternate-reality-music-wolfenstein-new-order (Consulted 18/07/2016).

17. Get in the Media: "Brave Little Leiblings: The Alternate Reality of Music in 'Wolfenstein: The New Order'" http://getinmedia.com/articles/game-careers/brave-little-leiblings-alternate-reality-music-wolfenstein-new-order _blank rel="noopener">http://getinmedia.com/articles/game-careers/brave-little-leiblings-alternate-reality-music-wolfenstein-new-order (Consulted 18/07/2016).

tween Blazkowicz and "J." can be triggered. The protagonist touching without permission the guitarist's precious instrument starts an argument in which "J." criticizes the former US Government and, by extension, Blazkowicz's ideals. He verbally attacks the segregation African-Americans suffered in their very homeland, a politics of discrimination that never ended – we have to bear in mind that, in the dystopian universe of *W:TNO*, the Civil Rights Movement never took place -. In one of the sharpest critics of the United States' racial segregation history ever seen in a (pseudo)historical videogame, "J." bluntly states the following:

> "I was little, and my mother wanted to take me to the picture show, but we had to go through the fucking colored entrance. I wanted a hot dog and a lemonade, but the sign says: 'We don't serve negroes in this establishment'. You're a patriot? Blue-eyed jarhead motherfucking Nazi-killing patriot that you are, you're still a fucking puppet to the man. You're exactly the kind of guy they ordered in come lynching time. You don't get it, do you? Before all this, before the Germans, before the war. Back home, man, you were the Nazis" (MachineGames/Bethesda Softworks, 2014).

This is a very controversial subject to address in a game, especially one in which Good and Evil are so clearly defined. It proves that *W:TNO's* writers were brave enough to tackle some of the thorniest issues regarding racial politics in the first half of the 20th century to the point of even comparing the US and the Third Reich, two powers that play very rigid roles in the aforementioned popular narratives of World War II. However, "J." is allowed to express his opinion and avoids controversy because he is authorized by the values he symbolizes. In effect, his race, social background, skills and role allow us to read him as the *fictional particular* of rock-guitar star Jimmy Hendrix. His *inter-world identity* is defined by his aesthetics, abilities and the social and cultural tradition he symbolizes. Furthermore, the game highlights this referentiality in "J."'s last moments. Surrounded by Nazi soldiers, the musician decides that his death will be as loud as possible. Therefore, he plugs his electric guitar into a huge set of amps and starts playing the American national anthem in the same way the historical Hendrix did at Woodstock Festival in 1969. Shortly after that, a group of soldiers storm the room and shoot him dead. The dialog between the German riflemen before opening fire is remarkable:

- *What is that?*
- *Some kind of weapon!*
- *Shoot him!* (MachineGames/Bethesda Softworks, 2014).

Here, music is given tremendous symbolic power, even though the wielder of the melodic weapon ends up dead before his foes. "J."'s last musical offensive represents the attack of counterculture and its musical manifestations against traditional American values and politics. The Nazi soldiers and the music they consume, *Neumond Records*' hits, are the video-ludic counterparts of the situation of popular music in the 1950s: monopolized by a few corporations and

censored by the American government, the Anglo-American music industry popularized white male singers and teen idols while hampering the way for black and Latino artists, thus presenting a passive, patriarchal and racist scene with products that were marketed to white audiences (Walser, 1998: 358).

CONCLUSIONS

Wolfenstein: The New Order invites the player to explore a world both historical and fantastical. Therefore, in order to become a credible reinterpretation of history that resonates with the user's historical knowledge, it includes some elements that anchor the fantasy to the historically sanctioned past. Music is one of these elements, but here, it is a replica of the modern music that sprung in the United States at the dawn of the second half of the 20th century. The inter-world identity of this soundtrack was built by mimicking some of the emblematic bands and artists of that era, by selecting their most popular songs, deconstructing them and re-arranging all the elements creating a new musical product that, however, maintains strong similarities with the originals. Once the sound record was composed, it could be used as an element of authenticity that legitimized the historical status of the game's world, even though as a twisted version of the past. In *W:TNO*, music has served as an additional element of the process of selective authenticity. As a consequence of the constant re-mediation of certain musical hits, audiences have associated some examples of mainstream music to specific moments of history. This mediated remembrance of the past has shaped the assumed audience's cultural memory, making them more sensitive to certain messages and signifiers. This has allowed particular narratives to resonate with the audience's understanding of reality and, by extension, the past (even though not necessarily the most accurately reconstructed past).

In *W:TNO*, music was made to work as the link between an imagined historical narrative and the 'real', sanctioned image of our very past. It has been inserted in a mythical narrative, a narrative that naturalizes a particular interpretation of the past. Musicians like *The Beatles*, *The Animals* and *The Beach Boys*, to mention a few, have become emblematic, acting as symbols of the cultural scene from a glorified era. The idealization of music and the social and cultural movements associated with the era has influenced the way we perceive that fragment of our past to a grade that nowadays it is sometimes difficult to separate reality from its mythical narrative. Another mythified parcel of history is World War II. The grand narratives that explain the conflict, both in academic writing and popular history, usually define the conflict in terms of the fight between Good and Evil. The use of German culture, especially the language, as one of the most easily recognizable features of Nazism in contrast with the heroic Americans who speak English is another manifestation of the the particular perspectives and narratives that have become historically dominant and are privileged in the medium. *W:TNO*'s German rock 'n' roll follows this tradition and perpetuates certain stereotypes and cultural *clichés*, but it also reinforces the player's sense

of being trapped in a world where Nazis have conquered even popular music. Within an Anglo-American popular gamer mindset, if something sounds like German, it may be labeled as "Nazi". Moreover, employing a humorous tone has proven to be an effective solution to safeguard the product from the critics.

The question remains if and how this strategy whitewashes the representation of the Third Reich and a more nuanced representation of history. Music in Nazi Germany was not only a tool for propaganda, but also a cultural form that contributed to the distraction and entertainment of its listeners. Understood this way, it is easy to imagine that rock 'n' roll would have occurred even if the outcome of World War II had been reversed. However, such an interpretation of a counterfactual course of history is problematic, because it implies the legitimation of a certain historical narrative in which capitalism is naturalized as the historical force that shapes the second half of the 20th century. Besides, even if this metanarrative is contested by the inclusion of an African-American virtuoso of the guitar who fights, in his own style, the yoke of a totalitarian regime and the musical corporations that act as accomplices, the deterministic interpretation of history is still sanctioned. This is because this representation of the past does not get over the myth but, instead, adds another layer to the perception of a past full of ideological traces. That a Jimmy Hendrix-like figure is shown as the embodiment of freedom and progress in a musical language paints history with American hegemonic colors, while also erasing a history of racial inequality. In so doing, it reinforces the myth that the United States and its musicians, black or white, led the way to a cultural, political, social and sexual revolution that confronted a number of traditions and politics that were seen, paraphrasing J., as the Nazis of the era.

The sound record of *W:TNO*, due to its mythical nature, would have been a very interesting tool to explore a hypothetical Nazi future. Although its narrative use is somehow stereotypical and conservative, it strongly resonates with the local contexts of players. The audience is assumed to recognize the songs as familiar but also to notice their intentionality as a parody. The consequence of this process is a seemingly non-problematic version of rock 'n' roll, and a humorous one. Furthermore, the narrative potential was lost somewhere along the development of the game. The decision of using the original score mainly for marketing purposes placed the creative potential inside the boundaries of the sanctioned representations of a consumer society's demand within a ludic frame––despite its minor role in the game, these songs are still related to a ludic artifact, a game. *Neumond Records'* greatest hits could have been more present within the game's fictional world, while also playing a more subversive part and thus adding another layer of depth. They could have blended with other game elements, such as mechanics, graphics and landscapes, to create a richer narrative, which could have been achieved thanks to the inclusion of J. Developers could have merged the Nazi rock with J's struggle and thus improve one of the faces of the polyhedral universe of *Wolfenstein*. Unfortunately, both elements

went separate ways, missing the chance of providing a ludic experience similar to *BioShock* or *Fallout*. I believe that the tricky inclusion of elements and discourses related to Nazism both in ludic and musical frames played a role in this decision, leaving a very original music recording almost exclusively as a part of a humorous marketing campaign. Nowadays, more game developers are aware of the important role music plays in the creation of a best-selling product. However, the representation of Nazism in games is tricky and still obeys strict implicit policies of representation. Therefore, in *Bethesda's* decision on what kind of use to give to *Neumond Records*, the possibility of target audiences responding negatively to Nazi rock 'n' roll may have outweighed the narrative potential derived from giving the songs a more important role in the game world. In the AAA video game industry, miscalculations like the aforesaid trend to be responsible for low sales figures, an outcome that big companies like Bethesda try their best to avoid. To wrap it up, the case of W:TNO stands as emblematic for the affordances, opportunities, and issues arising from the representation of history in games, and it highlights the importance of the sonic dimension to build both historical and mythical worlds.

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AUTHOR'S INFO:

Fede Peñate Domínguez holds an Undergraduate degree in History from Universidad de Las Palmas de Gran Canaria and a Ma. degree in Contemporary History from Universidad Complutense de Madrid, where he is now a PhD student. His research focuses on the remediation of the Spanish Conquest of the Americas in computer games. He is a member of the research project "Collapsed Empires, Post-colonial Nations and the Construction of Historical Consciousness. Infrastructures of Memory after 1917" (HAR2015-64155-P, FEDER). His research is funded by Spain's Ministry of Education, Culture and Sport (FPU15/00414).

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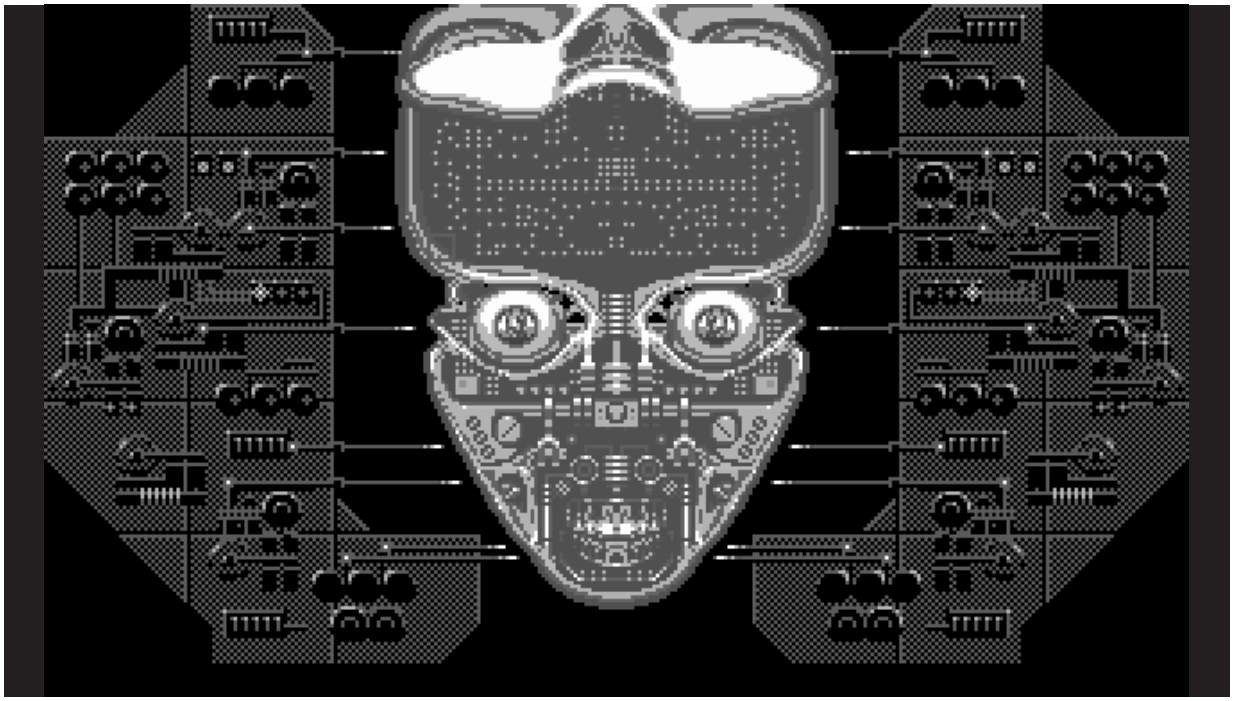
Music and Game Design: Interplays and Perspectives

Edited by H. C. Rietveld & M. B. Carbone



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Music and Game Design: Interplays and Perspectives

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ISSUE 6, 2017: VOLUME 2 – CRITICAL NOTES (NON-PEER REVIEWED)

CRITICAL NOTES

KAREN COLLINS
University of Waterloo, Canada
collinsk@uwaterloo.ca

Desert Island Diskettes

A Journey through Video Game Sound History

THE CHALLENGE OF MAKING A PLAYLIST FOR GAME SOUND

The sounds of video games have changed tremendously over their history, from about 1971 until now. Having been born approximately when commercial video games were first created and then growing up alongside the games as they evolved, the history of video games is very much a history of my own soundscape as it changed over the years. I had a *Pong* clone (a Telstar Alpha, made by Coleco) in the late 1970s, an IBM PC (the 5150, released in 1983), an Atari 2600, and then later Nintendo NES, Sega Genesis, PlayStation, and so on. What consoles I didn't own, my neighbors usually had (the Apple II, Colecovision, Intellivision, and so on), or my school (the Commodore 64), and I spent many hours of my childhood playing these games.

> the games listed below are the games that stuck in my head over the decades of playing games myself, and became important to me personally through the hours I spent with them. Some have admittedly "terrible" sound by today's standards, but to me, that's part of their charm, and growing up with these games means they hold a special nostalgia that I believe is best captured in their sound, even more than their graphics.

Being asked to make a playlist for game sound has always been a challenge for me. I have stayed away from lists as much as possible in the past, in the interests of not developing a canon for video game music. To me, there are far too many games deserving of our scholarly attention, and yet we in the field already seem to be focusing on just a few games, and a few genres of games, at the expense of others. Despite my long-time interest and expertise in the field, I also don't feel that I am qualified to decide which games are particularly important, or which are especially worth listening to or highlighting. My list below, then, isn't a "most important" or even "particularly notable" games when it comes to their sound and music. The list doesn't cover all of the consoles by any means, and anyone looking for a "best of" is sure to be disappointed by some of my inclusions and omissions. I take the title of my article from "Desert Island Discs",

a radio show created in 1942 by Roy Plomley for BBC Radio 4, which would bring a celebrity guest onto the program and ask them to choose eight recordings to take with them if they were cast away on a desert island. They were not meant to be bests of anything, only personal picks that held some meaning, which the guest would explain.

Therefore, the games listed below are the games that stuck in my head over the decades of playing games myself, and became important to me personally through the hours I spent with them. Some have admittedly "terrible" sound by today's standards, but to me, that's part of their charm, and growing up with these games means they hold a special nostalgia that I believe is best captured in their sound, even more than their graphics. Some were games whose composers I have since met, befriended and/or interviewed and are now of interest to me for that reason. Some indeed are usually in top ten lists or were the "first to do something" games, but are chosen here simply for their place in my heart, not for their place in history.

The list is supplemented by interview material I gathered during a year of filming interviews for the *Beep* documentary film (Ehtonal 2016). This documentary is a history of game sound from the penny arcades to today, and involved over 80 interviews with composers, sound designers, voice actors, and others involved in game sound from around the world (shot in UK, Canada, US and Japan, but also including interviews with composers from Germany, Spain, France and the Netherlands). Each full interview is released as an independent webisode, as well as in my two-volume book series *Beep* (Ehtonal 2016). The clips described here have also been assembled into one video that can be streamed or downloaded from our Vimeo website.

1 – *THE TELSTAR PONG* CLONE: (COLECO 1976): ORIGINAL *PONG* SOUNDS BY AL ALCORN AT ATARI

Pong was originally developed in 1972, and was the first commercially successful video game. The home version was sold through Sears starting in mid-1975, but it was one of Coleco's Telstar models that my Uncle purchased one Christmas in the late 1970s that was my first foray into video gaming. The game had no music, and only made simple analogue beeping sounds of different frequencies for the four games (all simple variations on *Pong*) built into the system, but to us children at the time, being able to control something on the television set cannot be overestimated in importance. The game was captivating, and we spent many hours listening to the beeps. Compared to the Magnavox Odyssey, which was also available as a home console at the time, the *Pong* clones were a huge leap forward for the simple fact that they had sound at all. There isn't a whole lot of interest here sonically, but I can still remember hearing those sounds in my head a long time after the game was set aside.

2 – *FLOPPY FRENZY* FOR THE PC BEEPER (WINDMILL SOFTWARE1982): UNKNOWN COMPOSER

Floppy Frenzy was a little-known game that must have been one of the very first educational video games. My father brought the game home with the computer, to teach us children not to put the 5¼-inch floppy disks near magnets or dust. Movement triggers the soundtrack: stop the diskette from moving, and the sound stops. Move, and the sound continues its monotonous, never-ending beeping—a trait also found in *DigDug* (Namco) that came out the same year. It's unlikely that the games were created in the knowledge of what each other was doing, since Windmill was Canadian and Namco based in Japan, so the idea of tying game sound to the action of the main character (very much Mickey-Mousing the sound) may have been independently created, simultaneously. The game also had little bonus, high score and death jingles. It's the death song that sticks with me more than anything (heard at approximately 9:45 into this video): not only did players use to spend a lot of time "dying" in early video games but to me, today, the song epitomizes my experience of audio on the IBM PC: a single monophonic channel playing simple on/off square wave sounds in very short melodies. This was PC sound before soundcards: monophonic, without sound envelope generators, and dreadfully annoying, which is probably where the original option to turn the sound off in games (still present in most current games) came from.

3 – *TAPEWORM* FOR THE ATARI 2600 (SPECTRAVISION 1982): UNKNOWN COMPOSER

Tapeworm still fascinates me. Its atonal melody that introduced the characters of the game at the start was a wonderful representation of the limitations of the Atari 2600 TIA soundchip. Sounds on the Atari chip were created by dividing the system clock into 32 notes. These notes didn't align with just tuning, and the selection of each original note and waveform determined the division of frequencies of the other 32. This meant that each tuning was completely different depending on the first note selection, and for the most part completely atonal, resulting in some bizarre musical creations. I believe that the many hours of my childhood spent in front of the machine were a strong influence on my later musical tastes and even on the development of electronic music in the 1980s general (see Collins 2006).

Beep video clip: The first clip in the video features several of our interviewees talking about the infamous TIA soundchip and its difficulties. First is Brendan Becker, a chiptune composer known as "Inverse Phase", famous for his Nine Inch Nails 8-bit cover album, *Pretty Eight Machine*. This interview was recorded at the annual MAGFest (Music and Games Festival) in January 2015 in Maryland. The second clip is pinball/game composer David Thiel, recorded at his home studio in Seattle in May 2015. The third is founder of music software company Plogue Art et Technologie, David Viens. Plogue makes the popular soundchip

emulator software called *chipsounds*, and the clip was recorded in Montreal in June 2015. It's easy to see that all of these folks have a love-hate relationship to the TIA chip: part of its appeal was its mix of very awkward tuning and rich waveforms.

4 – *MONTY ON THE RUN* FOR THE COMMODORE 64 (GREMLIN GRAPHICS 1985): ROB HUBBARD

The Commodore 64 had a much more advanced sound chip than its competitors. I didn't have a C64 at my house, but we had one at school and were allowed to play games at lunch time and during breaks. I remember playing *Where in the World is Carmen Sandiego?* (Brøderbund 1985) a lot, but not *Monty* in those days. However, when I began research for my book *Game Sound* (2008), I played just about every game ever released for the C64, and *Monty*'s theme was one of the songs that stood out for me amongst the lot. Created by Rob Hubbard, the theme uses Hubbard's module format, a way of maximizing the amount of music that could fit into a game by using loops, instrument changes (selections of sounds by picking waveforms and using envelope generators) and transpositions. Because the size of media and RAM was limited, there was a limited amount of space allocated to music. Through simple transposition statements, the same blocks of code could be re-used without the music sounding so repetitive.

Beep video clip: In this clip, German game composer Chris Huelsbeck talks about the Commodore 64 soundchip, followed by Charles Deenen, who explains some of the RAM issues. Both interviews were recorded in San Francisco in March 2015.

5 – *METROID* FOR THE NES (NINTENDO 1986): HIROKAZU "HIP" TANAKA

Metroid, along with *Super Metroid* on the SNES was, and still is one of my favourite games. The *Metroid* soundtrack was so different to nearly everything else that came out on the Nintendo. It used the NES soundchip to full advantage, but more than that, it didn't have the poppy "chippy" sound of so much of the music. The bass channel creates pedal tones that the melody rests on for the Brinstar level, but it's the Ridley and Kraid stages, with its sparse ambience, that captivated me as a young gamer. Not only did the music inspire in me a love of game audio, it's also one of those game soundtracks that inspired others to become game composers, such as Alexander Brandon (who composed for *Deus Ex*, *Unreal* and more).

Beep video clip: In this clip, recorded March 2015 in San Francisco, game composer Alexander Brandon talks about the importance of *Metroid* to his career.

6 – *SHADOW OF THE BEAST* FOR SEGA GENESIS (PSYGNOSIS 1989) DAVID WHITTAKER

The Shadow of the Beast game bears some resemblance to *Metroid*, which is probably why I really liked the game and its music when it first came out for the Sega Genesis. You'll notice we're still in the era of "wall-to-wall" music: non-stop

looping background music. The repetition of the really happy chip music of the time tended to grate on me (and most other people in the vicinity at the time), but the more moody, slightly prog-rock styling of Psygnosis games in particular were a wonderful change from that style. Music on the Genesis (or MegaDrive as it was known in Europe and Japan) was created using a combination of FM synthesis as well as the more primitive waveforms of a programmable sound generator (the chip type used up to that time). It was the newer digital FM synthesis chip, which allowed for more realistic instrument sounds that could be programmed in by the composer individually, which defined the Genesis sound.

7 – *MONKEY ISLAND 2*: LECHUCK'S REVENGE FOR THE PC (LUCASARTS 1991): MICHAEL LAND, CLINT BAJAKIAN/PETER MCCONNELL

Monkey Island 2 was the first game to use LucasFilm Games' new (at the time) software engine, iMUSE, or Interactive Music Streaming Engine. iMUSE enabled the game's parameters to control what was happening in the music—if a player was winning a battle, the music could jump to a different cue, and if a player was moving around a space, the music could adjust to the location. The infamous Woodtick scene, for instance, changes music depending on which building the player enters. Although the techniques had been used previously in games, iMUSE made it easier for composers to have control over how music played back in the game.

Beep video clip: In this clip, the three creators of the iMUSE engine—Clint Bajakian, Michael Land and Peter McConnell—discuss iMUSE and the difficulties of the Woodtick scene and interactive music as a whole. All interviews were recorded in San Francisco in March 2015.

8 – *TOMB RAIDER* FOR PSX (EIDOS 1996): NATHAN MCCREE

Tomb Raider was the reason I bought a PlayStation. Not only did the game have a female protagonist, but the wall-to-wall music of the past was suddenly replaced by the game's more careful attention to ambience and using music more sparsely only to highlight key points in the narrative while showing a cinematic approach to the score. In an interview with Nathan McCree, he explained his choices about abandoning the wall-to-wall music in favor of ambience. In part, this shift was influenced by the switch to Redbook (CD-ROM)-based games, which allowed for higher production values, but reduced the amount of interactivity possible in the music. For a time, the concepts of interactive music dream of iMUSE was abandoned in favor of linear tracks, as composers adapted to the new format. McCree explained to me that he had no say in the implementation, which had been done on the last possible day before the game was shipped, and in some cases music was put into the wrong place or not as he had intended, but fans of the game never seemed to notice.

Beep video clip: Composer Nathan McCree talks about the change in the move to CD-ROM with the PlayStation and how that influenced the music and sound of *Tomb Raider.* The clip was recorded in London in February 2015.

9 – *WILD ARMS* FOR PSX (MEDIAVISION/SONY 1996): MICHIKO NARUKE

I'm a fan of Ennio Morricone's music for Sergio Leone's "Spaghetti Westerns", and so *Wild Arms* was a personal favorite not so much for the game, but for the heavily Morricone inspired music. The driving rhythms and some of the themes are close to being lifted directly from Morricone themes, but Naruke puts her own spin on them, and the nature of the role-playing game being set in a cross between the American West and medieval Europe meant a combination of Western themes and more traditional Japanese RPG musical elements.

Beep video clip: Michiko Naruke discusses Morricone's influence on her music for the Wild Arms series. The clip was recorded in Tokyo in May 2015. My interpreter was Alwyn Spies.

10 – *LEGEND OF ZELDA OCARINA OF TIME* FOR NINTENDO 64 (NINTENDO 1998): KOJI KONDO

No list of my favorite game music would be complete without some Koji Kondo somewhere. The composer for *Super Mario Bros* and the *Zelda* series is without doubt many people's favorite. Along with frequently being listed in the Top Ten Games of all time, *The Ocarina of Time*'s music is also among many top 10 lists. The music is carefully integrated into the game, drawing on past themes established in earlier *Zelda* games, but adding new music and allowing player interaction with the music in the form of an ocarina. I'm convinced that the game inspired sales of ocarinas the world over––indeed, there are many Zelda-themed ocarinas for sale. For me, the theme-driven nature of Kondo's music, combined with the careful integration of the music into the game itself, represents some of the best that game music has to offer.

11 – *GRIM FANDANGO* FOR PC (LUCASARTS 1998) PETER MCCONNELL

I first wrote about *Grim Fandango* in my 2008 book *Game Sound.* At the time I researched and wrote the book, the game had been out for a few years, and hadn't really had a huge following or notable public interest, but was near the top of my list straight away. The game has since become a cult favourite, particularly amongst music fans. Peter McConnell's delightful orchestral music fits the game so well—a mixture of the dark underworld Día de los Muertos (Day of the Dead) and mariachi. To me, Peter McConnell is the Danny Elfman of the game music world—he writes playful, humorous music with highly memorable themes, and the *Grim* music is no exception.

Beep video clip: The music was re-recorded and re-orchestrated for the remake of the game in 2015, and I spoke with both Peter McConnell and the recording engineer, Jory Prum, about the work that went into the remake.

They both talked about the difficulties with recovering the original files to remake the music. Jory's interview was recorded in his studio in Fairfax, California, and Peter's clip was recorded in San Francisco in March, 2015. Jory passed away suddenly in April of 2016, and thousands of people flooded the internet to express how much his work meant to them, despite his being very much a "behind the scenes" person in game audio.

12 – *CASTLEVANIA: HARMONY OF DISSONANCE* FOR GAME BOY ADVANCE (KONAMI 2002): SOSHIRO HOKKAI AND MICHIRU YAMANE

The soundtrack for *Harmony of Dissonance* was much maligned by the press, largely for its 8-bit aesthetic, but also for its dense layers and morose themes. I've always enjoyed the *Castlevania* games and their music, but to me, the nature of the music as more complex, fitting the game well, and its 8-bit sound are precisely why I like this soundtrack. The music always heads in unexpected directions, and although it has fewer immediately recognizable themes or melodies, it offers a lot of sonic interest despite having being created on the Game Boy Advance's crunchy speaker and four-tone (plus sample channel) synthesizer chip.

13 – *MARIO AND LUIGI: PARTNERS IN TIME* FOR NINTENDO DS (NINTENDO 2005): YOKO SHIMOMURA

Yoko Shimomura tops my list of favorite game composers, and although her more famous work lies in *Street Fighter 2* and the *Kingdom Hearts* series, it's the *Mario and Luigi* role-playing games that I find most endearing. Shimomura had to take the well-known and well-loved *Mario* musical style and make it her own for the games, a difficult task, but she manages to give each game its own characteristic style and memorable themes. It's worth noting that playing games on the Nintendo DS are always better heard with headphones rather than the limited speakers present in the DS.

Beep video clip: Yoko Shimomura talks about writing the music for the series and balancing adaptations of the original *Mario* tunes with her own style. The interview was recorded in Tokyo in May 2015, and my interpreter was Alwyn Spies.

14 – *BIOSHOCK* FOR XBOX 360 (2K GAMES, 2007): GARRY SCHYMAN

BioShock was the first game music that left me absolutely speechless. I first became aware of the music when I heard Schyman give a talk about it at the Game Developers' Conference in 2007. *BioShock*'s dramatic orchestration and sound design blew away everyone's expectations of what game music was, and what it could be, inspired by 20th Century modernism. I'm also a big fan of Schyman's other music, which ranges from Bernard Hermann-esque *Destroy All Humans* to the beautiful *Dante's Inferno*.

Beep video clip: Here, Garry Schyman talks about the direction he received from audio director Emily Ridgway for the *BioShock* game. The interview was recorded in Los Angeles in October, 2014.

15 – *PEGGLE 2* FOR XBOX ONE (XBLA: POPCAP 2014): GUY WHITMORE

Another soundtrack to blow away everyone's expectations of game music was *Peggle 2*. A casual game created by PopCap, the first game *Peggle* originally established the theme of playing Beethoven's *Ode to Joy* upon each level's success in a game that combines elements of pachinko and pinball. For *Peggle 2*, Whitmore plays on this idea, bringing classical themes with a modern twist to each character, or "master" that the player chooses. My favorite, though, abandons classical music and aims for a bizarre, chaotic dubstep track for character Jimmy Lightning. More remarkable than the music itself is the careful integration of the music into the game—with each peg being a note that harmonizes with the theme for the level.

Beep video clip: Guy Whitmore tells us all about the musical choices in selecting and creating the music for *Peggle 2*. The interview was recorded in Vancouver in August 2015.

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AUTHOR'S INFO

Karen Collins is Associate Professor in the Digital Arts Communication program at the University of Waterloo, Canada. She has published five books on game sound, including *Game Sound* (MIT Press 2008), *From Pac-Man to Pop Music* (Ashgate 2008), *The Oxford Handbook of Interactive Audio* (Oxford 2013), *Playing With Sound* (MIT Press 2013) and the 2-volume *Beep Book* (Ehtonal 2016). She is also the director of the award-winning game audio documentary *Beep: A Documentary History of Game Sound* (Beepmovie.com).

ZANDER HULME
Queensland University of Technology
zanhulme@gmail.com

Killing-off the Crossfade

Achieving Seamless Transitions With Imbricate Audio

ABSTRACT

This paper examines common approaches to implementing adaptive musical scores in video games using pre-rendered music that make heavy use of the crossfade transition and are used in the production of both AAA and Indie titles (Phillips, 2014a; Sweet, 2014; Collins, 2008; Collins, Kapralos and Tessler, 2014). The aim of this paper is to critique shortcomings of the crossfade and to propose a way to address some of these shortcomings using existing technology. This is achieved through a new composing, recording, and implementation process, provisionally called "imbricate audio", the viability of which is tested through the creation of an original composition. Where crossfades create "conspicuous game soundtrack signifiers" (Houge, 2012 p. 1), imbricate audio aims to deliver modulations that sound close to those found in live performance or the linear scores of cinema, potentially increasing the ability of composers to immerse players in gameplay with adaptive music.

KEYWORDS: *Adaptive Audio, Composing, Game Music, Immersion, Recorded Music, Pre-rendered Audio, Music Systems*

INTRODUCTION

Like many of history's great inventions, adaptive audio was discovered by accident. When working on Taito's 1978 game *Space Invaders*, the game's designer, Tomohiro Nishikado, found a rather interesting bug: destroying on-screen "invaders" freed up processing power and caused the game to run faster (Paul, 2012, p. 71). According to Karen Collins (2005, p. 2), although the music in *Space Invaders* is only a simple four-note loop, this was the first instance of a game featuring continuous background music (previous titles containing either no music or only brief musical stingers heard at key moments). When Nishikado noticed the game increase in speed, he also heard the music increase in tempo. By intentionally exaggerating this effect, he was able to add tension as

the game progressed (Paul, 2012, p. 71) – in fact, the music was responding emotionally to the gameplay.

Audio quality in game music has come a long way since the monophonic 8-bit synthesis chips used in *Space Invaders* cabinets. The technological evolution of arcades, consoles, and home computers has seen the introduction of sophisticated polyphonic synthesis, digital samplers, and fully recorded scores. Since the release of Sony's PlayStation 3 in 2006, home gaming consoles and PCs are capable of greater-than-CD-quality recorded music in 7.1 surround sound (Collins, 2008, p. 71). However, the ability to put a full orchestra into a game has come with a compromise in versatility: a simple musical function such as Nishikado's adaptive tempo increase in *Space Invaders* would be a challenge for a game with a fully-recorded score.

> Improvements in adaptive audio implementation such as imbricate audio may well have the potential to improve the gaming experience as a whole.

Cinema has long made use of changes in music to assist narrative, responding to every nuance of the on-screen action and story. According to Belinkie (1999, p. 1), now that games too can have cinematic-style scores––some of which are even written by renowned film composers (Copeland, 2012, p. 14). Players may in some cases expect the same fluid musical response as they would hear in a film. Liam Byrne explains: "We're used to constant soundtracks in [our] entertainment. The more exactly the video game soundtrack matches your experience, the more involving that experience is going to be" (cited in Belinkie, 1999, online). It is worth noting that the video game medium has its own precedents and narrative devices and that making games more film-like is not necessarily an improvement, but one cannot ignore that many of our expectations of scored music for visual media are derived from decades of cinema. However, a defining characteristic of game music is its nonlinearity, the "ability of the game's music to respond to things happening in the game [that] makes video game music unlike other genres of music" (Lerner, 2014, p. 1). The music matches action in films as both film and music are linear media, and as such the two can be meticulously interwoven. Without a linear form to which the music can be matched, a game score requires "complex relations of sounds and music that continue to respond to a player throughout a game" (Collins, 2008, p. 211). Game music that fails to meet these expectations of fluidity can adversely affect player immersion.

Immersion is a mental state, which Winifred Phillips describes as the "ultimate goal" of game development (2014a, p. 52). When experiencing immersion, players "forget that they are playing a game. For a short while, these gamers have surrendered themselves to the fictional world of the game developers, entering the flow state that allows them to relinquish awareness of themselves and suspend their disbelief in favor of the plausible truths that the game presents to them" (Phillips, 2014a, p. 54).

Laurie N. Taylor (2002) distinguishes immersion from the experience of being "engrossed in a video game just as a reader would become engrossed in a novel, or a viewer in a film," stating that video games can cause "intra-diegetic immersion, which allows the player to become deeply involved in the game as an experiential space" (p. 12). Research on this effect indicates that adaptive game music significantly increases a player's sense of immersion (Gasselseder, 2014, p. 3) and that a game's level of interactivity is related to the level of immersion that players can experience (Reiter, 2011, p. 161). The conclusion that one can draw from this research is that improvements in adaptive audio implementation may well have the potential to improve the gaming experience as a whole.

PROBLEM

The numerous inventive approaches to implementing adaptive game music fall largely into two camps: sequenced audio and pre-rendered audio. Sequenced audio includes the use of synthesizers, samplers, and sophisticated virtual instruments (which blend aspects of both). Sequenced music is produced in real-time during gameplay, and in the hands of a talented audio programmer can transform in almost any way desired. However, the characteristics of current tools constrain sequenced audio to "electronic-sounding" soundtracks. Highly developed modern virtual instruments may be capable of sounding sufficiently realistic to fool the listener into thinking that they are hearing a live recording (Tommasini & Siedlaczek, 2016), but such instruments have too high a memory and processing cost to run during gameplay, as current gaming consoles are already being pushed to their limits to deliver cutting-edge graphics (Sweet, 2014, p. 205).

The alternative, pre-rendered audio can consist of recorded musicians, sequenced music that has been "printed" into fixed audio files, or a mixture of the two. Adaptive implementation can be achieved in code, but various tools for implementing pre-rendered audio in games (known as middleware) have arisen to make the task of creating adaptive pre-rendered soundtracks much easier (Firelight Technologies, 2016). This technology allows for real-time mixing of parallel vertical stems, horizontal resequencing of independent musical sections, and many other complex interactions that are based largely on combining the former two techniques. While these processes are too complicated to cover in depth in this paper, for the interested reader, Winifred Phillips gives an excellent introduction to these concepts on her blog (2014b and 2014c).

One of the limiting factors that prevents pre-rendered video game music from achieving the seamless flow of film music is the use of fade transitions. When games have cinematic-sounding music, players expect game scores to behave like movie scores (Stevens & Raybould, 2014, p.149), but fade-ins, fade-outs, and crossfades are transitions that composer Ben Houge refers to as "conspicuous game soundtrack signifiers" (2012, p. 1), which rarely appear in film. A notable exception is the modular score, which opts for independent sections of music, the end of each section fitting neatly into the start of every other

section. This has the benefit of seamless changes without using fades, though the system has to wait for the current section to end before a change can be made, which can result in short periods of inappropriate music (Stevens & Raybould, 2014 p. 150). A good example of an expertly crafted modular score is the soundtrack to *Monkey Island 2: LeChuck's Revenge* (LucasArts, 1991), which made use of the iMUSE system (Collins, 2008, p. 56). Watching a video capture of the game, one can see that the Guybrush (the player character) traverses different areas of the town of Woodtick, a distinct musical theme can be heard in each area (as discussed in Silk, 2010).

When the iMUSE system is triggered to change themes, by Guybrush crossing into a new area, a brief musical transition is selected depending on the playback position in the score. While these transitions create excellent seamless segues between the various themes of Woodtick, they can also take time to respond while iMUSE waits for an appropriate point in the music to transition from, then the whole transition must be played before the new theme can begin (Collins, 2008, p. 53). In the case of the video capture above, the longest response time was just over 7 seconds, counting from when Guybrush leaves the bar just after 1:40 in the video. 7 seconds may not be a significant amount of time in point-and-click adventure games like the *Monkey Island* series, but in faster-moving genres, it can feel like a long period for inappropriate music to be playing.

The Woodtick scene relies on sequenced virtual instruments to grant the moments of transition a seamless fluidity. The remastered *Monkey Island 2: Special Edition* (LucasArts, 2010) features a fully pre-rendered score with many recorded instruments, and unlike the original (which featured no crossfades) the fading used to facilitate these same transitions in the *Special Edition* can be clearly heard––though some pre-rendered modular scores can use clever edits to avoid using crossfades altogether.

The biggest issue with using fades in pre-rendered scores is the way in which the listener anticipates certain familiar instruments (especially acoustic instruments) to sound. Specifically, fades can critically change the start, end, or reverb tails of notes––something that would be odd and jarring to hear at a live performance. Reverb tails can be thought of as the expected natural ringing-out of an instrument. They are the result of a combination of an instrument's decay sound and the reverb of the space (or artificial reverb effect) in which the instrument is played. Human ears are "remarkably sensitive to fine details in audio content, and … sense the subtle artificiality that would occur when the reverb we've come to expect is momentarily absent" (Phillips, 2014a, p. 172). The start of a recording containing the reverb tails of previous notes also produces an unpleasant effect when played out of context (p. 173).

An important musical property that cannot be easily modulated during gameplay is music dynamic. Because manipulating the dynamic with crossfades interferes with reverb tails, and sounds unnatural, I chose this challenge as the first test of an imbricate audio system. The distinction between music dynamic

levels and volume is an important one, so let us take a moment to examine their differences. Volume is a measurement of loudness, whereas dynamic is a measurement of performance intensity. Playing violin soft or hard has an enormous effect on the timbral qualities of the instrument––an effect that cannot be achieved by simply increasing the volume of a recording (Gauldin, 2004, pp. A2-A3). Below I use the terms *piano, mezzo piano, mezzo forte, forte, and fortissimo* to express dynamic levels in order of increasing intensity, as these are the terms traditionally used in music manuscripts.

Imbricate audio consists of recording a score with regular pauses to capture the reverb tails of every branching point. Once all desired variations have been recorded, the tracks are divided into chunks, which are queued in the music system. No cut or fade would be audible.

PROPOSED SOLUTION

The solution I propose to this problem is ”imbricate audio”––a process that results in a densely modular matrix of musical “chunks” which can change states quickly while still preserving the integrity of the instrument sounds used (an example video of this is included below on page 9). The aim of creating such a process is to bring some of the flexibility of sequenced music to pre-rendered scores featuring recorded musicians, and/or virtual instruments that imitate recorded instrumentalists. Imbricate audio is an extension of the concept of a standard modular score, but with two important differences: firstly, instead of dividing the score into musical phrases, it is much more densely modular, with divisions every bar. Secondly, the reverb tails are preserved, eliminating the need for a crossfade to smooth out the transition. Together, these modifications grant many of the benefits of modular scores, but with a much quicker response time.

Imbricate audio consists of recording a score with regular pauses to capture the reverb tails of every branching point. Once all desired variations have been recorded, the tracks are divided into chunks, which are queued in the music system (the same can be achieved by creating sequenced music tracks and dividing them into chunks before they are rendered). The chunks are then played back in order, such that the lingering reverb-tail of each overlaps with the beginning of the following chunk. Without any input from the gameplay, the music will play in a linear or looping fashion without any audible signs that it is actually a collection of chunks and not a single, long recording. When the music system receives a cue or trigger from the game, the queuing is reordered.

In the case of Figure 1 (below), after receiving a trigger from the gameplay, the queued mezzo piano version of the following bar (Bar 4) is swapped out for a mezzo forte version of the same bar. Shortly after this starts playing, another instruction is received, and the mezzo forte version of Bar 5 is replaced with a forte recording.

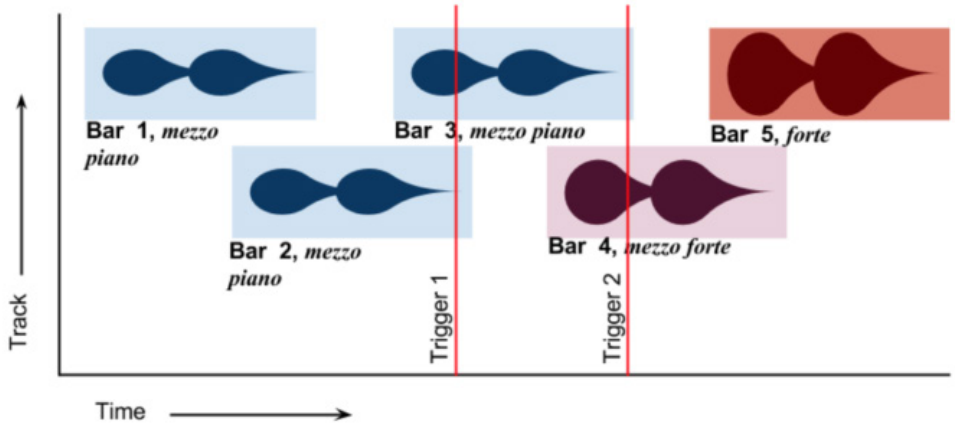

Figure 1 – Imbricate audio in action. Image courtesy of the Author.

From the listener's perspective, the musicians in the recording would be perceived as starting to perform with more intensity in response to an event in the game. No cut or fade would be audible, bringing the adaptive music experience closer to the linear experience of cinema without the distraction of the hallmark fades of game music (Houge, 2012, p. 1).

This is the simplest transition in an imbricate audio system: a trigger is received and the new music state is queued-up for the next branching point. In many contexts this may feel abrupt and sudden, so an intermediate transition chunk can be used. Consider if, in the above example, we ignored *Trigger 2* for the time being. *Instead of Bar 4* being from the mezzo forte music state, we would have a transitional music state, which is positioned between mezzo piano and mezzo forte. Every chunk in this transitional music state would consist of a crescendo from mezzo piano to mezzo forte, and the playback order would now be: *Bar 3, mezzo piano; Bar 4, mp-mf crescendo; Bar 5, mezzo forte.* Although including transitional music states would require considerably greater effort, it could be used for quite complex modulations between different dynamics, keys, tempi, timbres, meters, etc.

EXPERIMENTAL RESULTS

As a test case, I set out to create an adaptive score with the simple one-step process, which would be able to change the musical dynamic less than one second after receiving instruction from the game. For this reason, I composed a score in a 2/4 time signature at a tempo of 130bpm, resulting in each bar being less than one second in duration. I wrote the score to be recorded in its totality at five levels of dynamic intensity, ranging from piano through to fortissimo. Figure 2, below, shows a brief excerpt of the score I gave to the performers, and Figure 3 outlines the performance instructions I gave for each pass of the recordings.

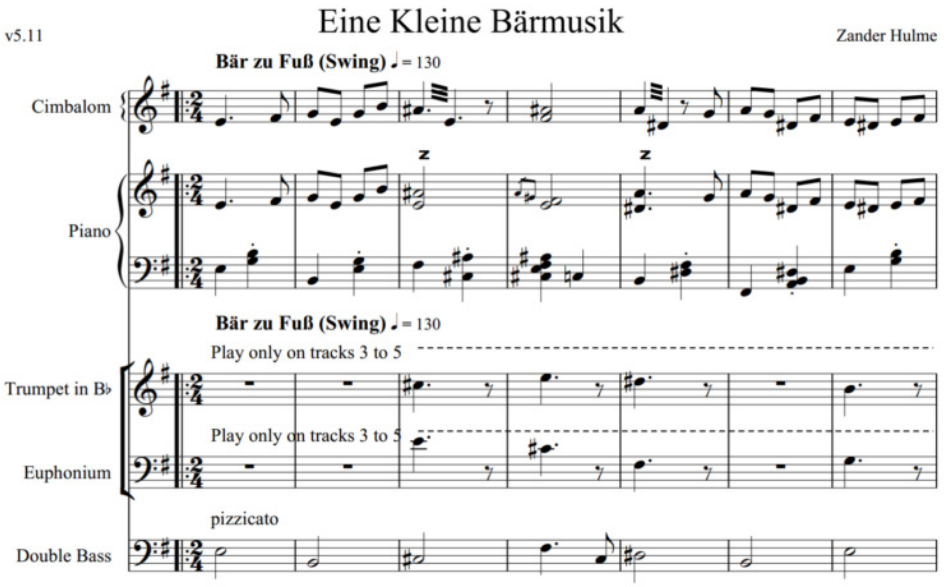

Figure 2 – Excerpt from adaptive score for Eine Kleine Bärmusik (Hulme, 2015). Image courtesy of the Author.

	Track 1	Track 2	Track 3	Track 4	Track 5
Dynamic level	*piano*	*mezzo piano*	*mezzo forte*	*forte*	*fortissimo*
Brass and piano articulation	*legato*	*portato*	*tenuto*	*staccato*	*staccatissimo*
Bass bowing	*pizzicato*	*pizzicato*	*pizzicato*	*arco*	*arco*
Piano tremolo	*no tremolo*	*no tremolo*	*no tremolo*	*tremolo at (**z**) markings*	*tremolo on all right-hand simultaneous intervals*
Brass tacet	*tacet where marked*	*tacet where marked*	*mezzo piano where marked*	*mezzo forte where marked*	*fortissimo with growl where marked*

Figure 3 – Performance instructions for recording Eine Kleine Bärmusik.

In the context of "designing a game for music", Richard Stevens and Dave Raybould (2014) discuss the limitations of modular scores (such as the *Monkey Island* example above). They mention the possibility of a process similar to imbricate audio, but quickly dismiss it as "time consuming and unnatural" (p. 152). Having now performed this process, I can attest that it can be "natural-sounding" and the recording process is not much more time-consuming than that of recording a regular modular score. I concede that splitting, rendering, and naming each of the chunks manually was tedious, but the process is simple enough

that it would be possible to automate. Additional rehearsals were also required for the musicians to become accustomed to the unusual performance technique.

In contrast to vertical remixing and horizontal resequencing approaches, the composing process for imbricate audio does require a consideration of the outcome of a transition from the end of each and every bar. It also imposes some limitations on the arrangement. For example, particularly long notes that span many bars may cause unintended dissonance. However, imbricate audio's quick responsiveness and lack of audible crossfades make it highly appropriate for some use cases.

An example of imbricate audio can be found in my brief demonstration of *Eine Kleine Bärmusik* attached to a set of buttons and run by a simple C# script in the Unity game engine (Hulme, 2016):

The dynamic intensity of the music is being modulated entirely by software, and although there are some distinct, sudden changes in timbre, these can be attributed to recording or performance mistakes. None of the many cuts in this example are themselves audible, as the natural decay of each chunk overlaps with the next. After 1:45 in the video, the system is instructed to start and stop so that individual chunks can be heard, reverb tails included. This piece is far from perfect, but it serves to demonstrate that imbricate audio is indeed feasible.

To efficiently record these chunks in a way that felt most familiar to the performers, I asked them to play only the odd-numbered bars of the score, treating the even-numbered bars as rests. When this was completed, they were able to listen to their performance of the odd-numbered bars and fill in the gaps by playing only the even-numbered bars. This method also had the unexpected benefit of cutting down on the number of full takes required, as when mistakes were made, a new take could begin only seconds before the error. This process was then repeated for each of the five music dynamic levels. I managed to record the entirety of the piece (5 instrumentalists playing 10 minutes of music each), during one day in the recording studio.

Like Stevens and Raybould (2014), I too had fears that the finished product would sound "unnatural" (p. 152), but I was relieved to discover that it performed seamlessly and adapted to instructions in less than one second as planned. An additional boon was the low processing overhead required to run this system: the simple C# script driving the queue runs in the Unity game engine so efficiently that it is even able to run in the background of mobile games. I have already shipped three games for iOS and Android that run this system, which both play smoothly even on low-end devices.

Fadeless modulations in music dynamics and smooth, fadeless modular score transitions are largely the domain of sequenced music systems, but imbricate audio can bring some of these features to fully-recorded, pre-rendered scores,

bringing us one step closer to creating game scores that are indistinguishable from a live ensemble.

CONCLUSION

Imbricate audio can be used to imitate vertical remixing, horizontal resequencing, and other systems by creating a densely modular score made of short chunks. It would be presumptuous to assert that it can serve as a replacement for these approaches in every case, but when it can, it eliminates the need for "conspicuous" crossfades. Imbricate audio may not solve all the challenges that face adaptive game music today, but I hope that the introduction of this system will be of use to composers who want to make innovative adaptive scores. I am still developing imbricate audio, and currently it is the core of a procedural music system that I am designing for an upcoming console title. I hope that other composers will make use of this tool, and combined with the immaculate sound quality now available on consoles and PCs, the power to transition between different music states quickly and smoothly should improve composers' ability to engross the player in the game world. Fadeless modulations in music dynamics (as in the example of *Eine Kleine Bärmusik*) and smooth, fadeless modular score transitions (as in the *Monkey Island 2* scene) are largely the domain of sequenced music systems, but imbricate audio can bring some of these features to fully-recorded, pre-rendered scores. By maintaining reverb tails (and thus the musical integrity of the instruments used), it may even become easier to achieve the elusive goal of player immersion––bringing us one step closer to creating game scores that are indistinguishable from a live ensemble, playing just for you.

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AUTHOR'S INFO

Zander Hulme is a freelance game audio designer based in Brisbane, Australia. Specialising in dynamic music systems and mobile games, he is best known for his work on *Steppy Pants*. His film scores have also won awards and screened at renowned international festivals such as Festival de Cannes and Bristol Encounters Short Film Festival.

TOM LANGHORST
Fontys University of Applied Science
t.langhorst@fontys.nl

The Sound of a Serve Toss

An Informational View on the Gameworld Interface as Sonic Interface Design

ABSTRACT

In this article, Jørgensen's three-layer model of the gameworld interface is used to analyze the practice of game sound design and to describe the informational role of game audio design, from the perspective of *Sonic Interface Design* (SID). First the relationship between visual and audio realism is discussed. Then three layers in Jørgensen's model (controllers, WIMPs elements, and gameworlds) are explored in relation to the semiotic analytical model of C. S. Peirce. By addressing the sound of the serve toss in games such as *Pong* (1972) and *Wii Sports Tennis* (2006), the article investigates how sound design can support realism, hypermediacy, and immediacy in varying contexts. Approaching game sound design from an information-based concept (the SID) as well as a holistic model (as gameworld interface), the aim here is to improve an understanding of the creative potential and extent of game audio design.

KEYWORDS: *Game Sound Design, Sonic Interface Design, Informational Spaces, Music Cognition, Semiotics, Persuasive Design*

INTRODUCTION

Kristine Jørgensen (2013a, 2013b) provides a fresh view on gameworlds by conceptualizing games as informational spaces working through three layers of an interface: the game controller, the WIMP elements (windows, icons, menus, and pointers) and the gameworld. Here this model is used to consider game sound design defined as *Sonic Interface Design* (SID) which "explores ways in which sound can be used to convey information, meaning, aesthetic and emotional qualities in interactive contexts." (Serafin et al. 2011, p.87). *As Collins notes* (2008), in the game *Pac-Man* (1980, Namco, Japan), "(t)ypically the music only played when there was no game action, since any action required all of the system's available memory" (p. 9). Considering aspects of immersion, it may seem like a disadvan-

tage when, in early video games, it was not possible to combine sound effects and music because of limitations in available memory space; however, the omission helped players to understand the mechanics of the game better. The examples of *Pac-Man*'s "bite" and *Pong*'s serve toss sound can be considered to understand how different audiences may have different expectations of what a "realistic", "believable", or "appropriate" sound effect may be in a game.

When we look at one of the core mechanics of *Pac-Man* ("eat blocks"), neither the sound of taking bites nor the animation can be regarded as realistic. The concept of the mechanic is suggested by the up and down movement of *Pac-Man*'s mouth and a sound effect that vaguely resembles the sound of a bite. The perception of the sound effect as "bite" is, like all game audio (Jørgensen 2008), highly contextual. Furthermore, following the semiotic approach of C.S. Peirce (see, for example, Zalta, 2010)[1], a sound effect may be regarded as an iconic sign, a representation that resembles qualitative features of the object. Peirce introduced ten types of signs of which three types of object-sign relations, commonly called "modes", are applied to this discussion: iconic, indexical and symbolic. When the sign has an analog physical connection between the signifier and its object, then the sign is an indexical sign. And if the sign utilizes arbitrary convention, habit, or social rule or law according to which the signifier indicates the object, it is a symbolic sign Even though there is some allusion to a ping pong ball, the sound effects of *Pong* (1972) is even less realistic than *Pac-Man*'s. Even more, the visual design of *Pong*'s ball, a square set of low-resolution pixels, undermines the concept "ball" in the iconic mode (one expects a real ball to be round), but as a symbolic sign, it works: players do not seem to mind a lack of realism, as long as it functions as a type of ball in the game. As the gameplay of the ball-game is preserved, the minimalism of both sonic and visual representations balance each other without disturbing the understanding of the game mechanics.

> Awareness of aspects of sonic design in relation to the gameworld and players' expectations can help make the production process of game sound design methodical and effective, but it also implies a more holistic approach to game sound design than what the one that dominates current game studies and game development.

Modes of representation differ according to the demands of context and game. If we were to use Pong's sound effects in the sound design of the much more realistic *Wii Sports Tennis* (2006), the balance would be disturbed. Each year when I introduce my students to game sound design and show them a gameplay movie of *Wii Sports* with the sound effects of *Pong* they are amused by the disturbance of their expectations of a more realistic sound (Huron 2006). Indeed, the relatively more sophisticated realism of *Wii Sports* shapes different expectations in the player than *Pong*'s sound effects.

There is, however, one exceptional sound in *Wii Sports Tennis* that outbalances its visual and sound realism: the serve toss.

This sound seems to have escaped from a cartoon soundtrack and sneaked its way into the *Wii Sports Tennis* game. The question is: why? The movement

1. Within Peirce's analytical approach, a sign consists of three inter-related elements: a sign (signifier), an object (signified), and an interpretant who makes sense of a sign. In the context of sound design, we can say that the sound itself is the sign element (signifier), whereas the object is what the sound stands for; so, in the Pac-Man example, the object can be described as "bite". The interpretant is best thought of as the understanding that the listener has of the sign-object relation. The process of game sound design can be related to these three elements when we consider its resulting product, the sound, as the sign which is based on the designer's applied theoretical and practical knowledge of sound design in terms of the sign's object and user test-based validation of the sound as the interpretant. Therefore, developing game sound design knowledge implies a focus on describing design patterns that can be deducted from knowledge of the relationship between the signifier and its object.

of a ball in the air (serve toss) can theoretically be considered but not practically be perceived as a sound for psychoacoustical reasons. Therefore, the serve toss sound can be regarded as a symbolic sign based solely on conventions. The upwards glissando (raise in pitch over time) represents the upward movement of the ball. Here, the sound of the serve toss is a good example of sonification, "the technique of rendering sound in response to data and interactions.' (Hermann et al. 2011, p.1). Sonification of movement in a game mechanic is not limited to this example alone.

The jump of Mario in *Super Mario Bros.* (1985) is another illustration of the same kind of sonification.

Such aspects impact on the gameworld as an informational space. Again, the player's interaction with a game can be described as a three-layer interface consisting of the game controller, WIMP (Windows-Icons-Menus-Pointers) and gameworld (Jørgensen 2013a, 2013b). According to Jørgensen, a gameworld as interface can be designed between the two opposing approaches of superimposing and integrating media, representing either a hypermediacy style of visual representation, the goal of which is "to remind the viewer of the medium", or an immediacy style of visual representation, which aims to "make the viewer forget the presence of the medium" (Bolter & Grusin 1998: pp. 272-273). Implementing the serve toss as a more or less "realistic" sound, while considering the affordances of context, is part of this strategy. Jørgensen explicitly includes audio as an important element of the gameworld as interface. The following part of this paper discusses how sound design can support these layers and design approaches in varying semiotic modes.

THE WIMP LAYER

The WIMP layer can be situated in the game's (graphical) user interface, or (2D) Head-Up Display, typically using windows, menus and the gameworld when (3D) pointers and icons are added inside the world. The main purpose of the WIMP layer is to provide the player with game system information (Jørgensen 2013b). In the WIMP layer, sound effects are most commonly used in the iconic mode when they support click actions related to the WIMP elements. In this case, the sound effect resembles the real-world sounds of our interaction with, for example, switches, buttons, and paper turns.

The click action in the WIMP layer can also be supported by sound effects that "look ahead" or "summarize" the (next) game state by representing the meaning of the state as a symbolic sign. In the app version of the game Risk, the WIMP layer sound effects contain elements of "arming riffles", "steps of army boots", and the "soundscape of a battlefield" to represent (part of) the meaning of the game states.

When the WIMP layer is used to indicate the outcome of our gameplay, for example when we score in Pong, the sound effects can be used to evaluate the gameplay. In that case, the design principle or design pattern of the evaluated

sound effect is important to establish its semiotic mode. Comparing the evaluative audio signs (success and failure) of *Pong* and *Wii Sports Tennis* we can say that *Pong*'s sound effects are symbolic, based on conventions, while the sound effects of *Wii Sports Tennis* are iconic since they resemble the sound of a crowd[2]. Nevertheless, such effects can also be considered as indexical signs, signs (in this case the sound recordings) that result from, are analogous to, something that happens in the real world This explains why such sound effects are so successful in communicating the meaning of success and failure (Langhorst 2014).

THE GAMEWORLD LAYER

In the gameworld layer of Jørgensen's model, a sound effect may exist in all three semiotic modes, iconic, symbolic and indexical, and can shift from one mode to another, and appear in combination. The *Wii Sports Tennis* serve toss sound is symbolic as a sign representing the event of a ball thrown in the air[3]. It is, however an index sign in relation to the data it represents (the change in the height of the ball). This is crucial for the concept of sonification where the sound must represent data in a one to one relationship to provide the player with accurate information.

Jørgensen (2013b) notices a semiotic mode shift in the gameworld that is caused by learning: "(w)hen we have played the game enough to learn how it works, however, signs that were formerly mysterious change character and become familiar and recognizable. Now the signs become representative of specific events in the gameworld" (p. 79). When it comes to sounds that hold a strong first/third person relationship between game and player, such as footsteps, the idea of internalized signs shifting from the iconic mode into the indexical mode is substantiated by arguments from recent neuropsychological research that "consistently suggested that the brain processes the sounds of actions made by an agent differently from other sounds" (Serafin et al. 2011, p. 89).

The indexical mode-shift of audio-signs can be compared with the acceptance of the (unedited) photographic image as an indexical sign (Barthes 1977) and explained as the perception of realism. An improved understanding of perception, combined with improved technology to create virtual worlds, makes it possible to convert the unreal, or the virtual, into perceived reality, *or modality*. The latter concept "refers to the degree of truth assigned to a given sound event" (van Leeuwen, 1999, p. 180). In short, the codes and conventions of game audio, sound effects, and game music, interact with other dimensions of the game to produce a believable, immersive experience for the player.

AUDIO EVENT DISTRIBUTION

The function of sound events in games is to provide the player with important information to understand the game and its game mechanics through detailed sound design; sounds can do so in either an integrated or superimposed manner. Sonic interface design provides the possibility to create highly informative game-

2. The evaluating sound effects of *Wii Sports Tennis* have become part of the gameworld layer but nevertheless provide the player with game system information. Game sound design can help to integrate game system information into the gameworld layer.

worlds, revealing game system information in an integrated manner, whereas dominance of visual information tends to lead to additional superimposed media.

Gameworlds with integrated audio events are alike our real-life environment and listening to this informational space can, therefore, be described as "(e)veryday listening [, which] is the experience of hearing events in the world rather than sounds per se" (Gaver 1993, p. 285). Gaver's framework explains how we perceive nonmusical sounds as a distribution of events and describe them not by their physical characteristics but by their source; for example, we describe a sound as "the siren of a passing police car" rather than that we summarize the physical specifications of the Doppler effect. Furthermore, Gaver shows how tolerant we are regarding the physical accuracy of a sound we hear: we have no problem recognizing footsteps regardless whether they sound on the street or in a large church despite that this significantly changes the physical characteristics of the sound. Game sound design can benefit from this tolerance to shift sound from accuracy to immersive experience. Summers' (2016) analysis of five different game types within the race game genre shows they each have their own specific relationship with how immersion serves realism, not only by facing the challenge of combining music and the dynamical sound of a racecar but also by the need to balance sound design in regard of realism, genre, and immersion.

Not only everyday sounds but also music can be perceived as "events" (Buxton et al. 1994). While listening to music involves a significant amount of cognitive processing within a complex auditory system, prediction seems to be an important aspect of this process (Huron 2006, Zatorre and Salimpoora 2013). Game music has been a topic of research quite some time, which seems to imply that interacting with game music is different than listening to music in general (Collins 2013). For example, *dynamic audio* "reacts both to changes in the gameplay environment, and/or to actions taken by the player" (Collins 2008, p. 4), which is essential for game audio and for the immersive function of game music (Phillips, 2014), In relation to game music, this is often referred to as *adaptive music*. In a game with adaptive music, the game system's logic needs to evaluate the gameplay and accordingly change the game state resulting in a change in the music. This process implies two different levels of cognitive processing for the player, initiated by unpredictable event-based decisions of the game system's logic. This causes an additional demand on the cognitive process during listening to music. Firstly, in terms of perception––at the first level the musical composition will change according to the characteristics of the new game state. Typically, this involves changes in the perceivable emotions and/or referential changes in the music such as the use of themes, *leitmotiv*, and the *idée fixe*, to support the game's narrative (Phillips, 2014). Secondly, concerning decoding––at the second level the player needs to decode the "argument" that initiated the game state change to perform in line with the adjusted level challenges and goals. In an ideal informational space, the design characteristics and design patterns of the music matches the argument of the game system's logic state change. Thus, for

3. The relationship between the upward moving sound and ball is much more complex than one might think at first. Since pitch is perceived logarithmically and is therefore described as pitchΔtime = log2 freqΔtime , the linear frequency rise from 200Hz to 600Hz of the SFX will be perceived as a logarithmic pitch change from approx. G to d''. The position of the ball is a parabolic function that can be describes as positionΔtime = (V0*ΔT) + (1/2A* ΔT2) , where ΔT is delta time, A is the world's gravity (- 9.8m/s2) assuming that the Wii sports world behaves like ours, and V0 is the initial speed of the ball. As the ball in Wii Sports tennis rises until its velocity becomes 0 and the ball reaches its highest position (the optimum to hit it!), the curve of the logarithmic pitch function and the parabolic ball position function are very much alike. This is due to the characteristic of the two functions but also due to the variable values (glissando start and ending pitches, and SFX length) make the two curves more alike under the condition that the player needs to hit the ball while it is rising. Thus, however not mathematically identical, in effect the two curves may be perceived as equal, and therefore the server toss SFX is perceived as the sonification of the position of the ball.

example, a sudden attack to the playable character by in-game enemies results in a matching rise in arousal characteristics of the music, and the identification of a specific enemy involves the introduction of a theme or leitmotiv.

To understand the full potential of sound-driven game control we need to look closer at the ways in which music can evoke motion through rhythm and expression.

THE SERVE TOSS RELOADED: THE CONTROLLER LAYER

The use of the serve toss sound in *Wii Sports Tennis* may be related to the absence of an actual ball (which one can physically strike), as an alternative cue is needed to initiate the player's action. Therefore, the purpose of the sound of the serve toss is to trigger the player's movement. According to Fogg's (2016) behavioral model, in addition to motivation and ability, triggers are the key element in persuasive design; "without a trigger, the target behavior will not happen" (online). Furthermore, triggers are especially interesting for game (sound) designers since they are the only element in Fogg's model that can be designed. The example of *Wii Sports Tennis* demonstrates that, at the game controller layer of Jørgensen's model, sound can be used successfully for changes in the player's behavior, resulting in a movement. This kind of kinetic interaction related to sound is well known from the music game or rhythm-action game genre that includes games such as *Guitar Hero* (2005) or *Rock Band* (2007).

"Rhythm-action games are video games in which the player must respond in some way to the rhythm or melody being presented, either through repeating the same melody or rhythm by pressing buttons (with hands or feet), or kinetically responding in some way to the rhythm, often using specially designed controllers" (Collins 2008, p.).

In general kinetic and sensory interaction, the haptic modality is regarded as an important aspect of interaction with virtual worlds (Mihelj, Novak & Begus, 2013). However, "the haptic modality is currently underutilized and poorly understood as a design material in game design" (Nordvall 2014, p.1). Nevertheless, sound as a trigger for behavior, as well as the rhythm-action game genre, shows the potential of game sound design at the controller layer. Therefore, to utilize sound as a trigger for motoric actions or expression seems like a valuable opportunity for new sound-driven game mechanics and controllers that go beyond the tradition of the music game genre.

To understand the full potential of sound-driven game control we need to look closer at the ways in which music can evoke motion through rhythm and expression. Firstly, concerning rhythm, movement and musical rhythm are closely connected, share neurological pathways and "indeed the close connection between music and dance suggest that musical rhythm might have evolved from rhythmic movement" (Trainor & Zatorre 2009, p.178). Some game mechanics are based on the rhythmical input of the player, as it happens in *Patapon* (2007) and in *Beat Sneak Bandit* (2012).

Secondly, in regard to expression, this also contains motion as one of its sub-components; according to Juslin & Timmers, 2010), also musical performance expression can be "conceived of as a multi-dimensional phenomenon that can be decomposed into subcomponents that make distinct contributions to the aesthetic impact of a performance "(p.454),. Unfortunately the use of expressive musical motion hardly has been explored outside the music game genre but still shows great potential if we look at the *Smart String* instrument of *Apple's Garageband app*.

Even though the physical interaction is with a limited haptic glass screen, players nevertheless intuitively adjusts their movements; they touch and impact with the screen in order to generate the expressive motion matching *pizzicato*, *marcato* and (speed dependent) dynamic sustained string sounds.

CONCLUSIONS

Game sound designers strive to design sounds that can inform the player, trigger behavior or evoke emotions. Therefore, the success of game sound design benefits from the use of design patterns. Studies in semiotics, cognitive neuroscience, psychoacoustics, affective prosody, and music psychology offer precious perspectives to understand these processes. Not only does the layered interface model of Kristine Jørgensen help game sound designers in choosing the location of their intervention with precision, it also helps them to optimize the balance between expectations of realism, hypermediacy, and immediacy of the style needed for any given game. Sonic design proves to be effective in integrated design, providing the player with information integrated into the gameworld. In the process of sound design, knowledge of design patterns is an important element for the development and production of sound. Awareness of aspects of sonic design in relation to the gameworld and players' expectations can help make the production process of game sound design methodical and effective, but it also implies a more holistic approach to game sound design than what the one that dominates current game studies and game development. Not only does a broader, and integrated, sonic approach to game design help to better understand the full potential and extent of game audio, but it also offers further creative opportunity in game design for the future.

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AUTHOR'S INFO:

Tom Langhorst is a lecturer and researcher at Fontys University of Applied Science – school of ICT, Eindhoven, the Netherlands. His work and research focus on the crossover between (persuasive) design and technology. Tom is educated as musician, music theorist and composer and previously worked in the video games, entertainment and advertisement industry, as well as interaction designer for product design and innovation.

MICHAEL AUSTIN
Howard University, Washington, DC
michael@mlaustin.com

Tim Summers, *Understanding Video Game Music*

Scholarship about video game music is finally coming of age. Ludomusicology, or the study of video game music, is a burgeoning academic field of research that seeks to move video game music from the margins of game studies and its perception as a peripheral accompaniment to gameplay to its place as a central element of the game-playing experience. With very few exceptions, almost all academic journal articles or scholarly books on the topic have been published after 2000, and the majority of this research has been published within the last ten years. Early work in this area has dutifully served its purpose to establish video game music as a field that is worthy of critical attention, and helped to validate the work of *ludomusicologists* within musicology.

Interest in video game music is also evidenced by the growing number of academic conferences on video game music in Europe and North America, special interest groups in established academic societies, and the ever-growing body of published scholarship in this area.

Tim Summers takes this work a considerable step further. A Teaching Fellow at Royal Holloway, University of London, he is a co-founder of the UK Ludomusicology Research Group, which convenes an annual academic conference on video game music. Blending his expertise as a lecturer and scholar of music and games, Summers is usefully didactic (without being at all patronizing or condescending) and teaches readers about video game music and the ways it can be analyzed.

> *Understanding Video Game Music* is among an only handful of monographs specifically dedicated to music in video games, and it is one of the very few to be written by a musicologist for a primarily academic audience.

After a short introduction, Summers devotes Chapter 1 to the discussion of the video game as a musical source. Although musicologists and music theorists often rely heavily on a physical musical score for their analytical work, ludomusicologists rarely see the music they study engraved on musical staves. And as Summers explains, the music of a particular video game can vary widely

depending upon the action of the player, the console the game is played on, and the version of the video game being played. Here, Summers also describes the types of music one is likely to find within video games, making sure to draw attention to the music of menus, loading screens, and session pauses, which is often overshadowed by the game's overworld music.

Chapter 2 outlines methods of analysis for video game music. Summers points out that actually playing the game is an important part of analyzing game music; watching online play-through videos only does not afford scholars the opportunity to hear the music that results from their interaction with the game. Summers then points to various analytical techniques already familiar to music scholars, such as the mapping of themes and motives, harmonic analysis, topics theory, music psychology, hermeneutics, formal analysis, ethnomusicological approaches, and performance studies, providing explanations and examples for each. He also points to sources outside of the game, such as production documents, trade magazines, interviews with creators and composers, patents, and player reviews as important satellite sources for analytical information. While Chapters 1 and 2 constitute the book's first part, dedicated to the techniques and materials of video game music analysis, the second part of the book offers critical perspectives and case studies.

In Chapter 3, Summers first introduces his concept of musical texturing, or the ways in which game designers rely on the pre-conceived references, cultural significance, and other "baggage" that comes with the music they use in a game to fill in some of the gaps left by deficiencies in the visual material, which "has the result of creating depth, implied detail and rounded context to the surface level of gameplay activity, elaborating beyond the basic frames of the gameplay mechanism" (60). He also goes on to introduce *epic texturing* in *first-person shooters,* or the ways in which music can change the perspective of the player from being solely focused on gameplay and instead connect "the player both to the subjectivity of the avatar and to the higher-level background narrative in which the avatar is placed" (83). For example, Summers refers to the music in *GoldenEye 007* (Rare Ltd., 1997) as an example of how the James Bond Theme (or an approximation of it) that plays throughout the game connects the player to the narrative of James Bond films they may have seen and to the franchise as a whole.

Addressing the notion of virtuality in game music, Chapter 4 outlines musical styles and compositional conventions used in various genres of racing games and how the music is employed to create an illusion of realism for the game's player. Summers also points out that music can create historical context for a game, either by using music from the concrete, "real" world, as with *Civilization IV* (2K Games, 2005), or by using music written by a contemporary composer using cinematic tropes and other musical signifiers that anachronistically allude to music of a different time period, as with *Age of Empires III* (Microsoft, 2005). In the chapter that follows, Summers uses speech act theory to discuss

the power of music to communicate information within games, whether it alerts the player of the presences of a nearby enemy, conveys emotional material to the player, or directs them in the correct path to complete an in-game task.

Summers begins Chapter 6 by highlighting the strong connection between game music and its cinematic antecedents. As he recounts, not only are themes and other musical material in video games often directly borrowed from film and TV, the style and tropes from film music are used to give video game scores a cinematic quality. A thorough analysis of *Final Fantasy VII* (Square, 1997) demonstrates the value of a cinematic soundtrack and repetitive *leitmotifs* in depicting characters and their location, and in communicating emotional information to the game's player. Summers argues that music "routinely has a greater aesthetic priority, descriptive power and significant informational content in games than in film, primarily because of the graphical and sonic limitations of the rest of the media components, resulting in a proportionally larger role for the music" (p. 175).

Finally, Summers underlines in Chapter 7 the importance of interaction in the analysis and overall understanding of video game music. Examples of ways in which players interact with the game musically include *Legend of Zelda: Ocarina of Time* (Nintendo, 1998), wherein players use the buttons on their Nintendo 64 controllers to "play" an ocarina within the game. Likewise, karaoke games, dance games, and other music games, such as those in the *Guitar Hero* series (Harmonix 2005-2015), demand a type of interaction that is both performative and intrinsically musical (or at least rhythmic). He also describes in detail games, such as *Super Mario Galaxy* (Nintendo, 2007), that are played almost as instruments, mixing the pre-recorded music of the game with quasi-musical sound effects added by player action and interaction with the game. Summers also recounts instances wherein interaction with video game music is less "musical", but still interacts and is synchronized with the ludic action, as with the snowboarding games in the *SXX* series (EA Sports, 2000-2012). Summers ends with an epilogue that further explores the connection between playing games and playing music, and discusses the value of fun in both music-making and game-playing contexts.

Chapters 3-7 end with a valuable "Conceptual Toolkit" that highlights key points from the case studies presented in each chapter. In addition to its eight constituent chapters, *Understanding Video Games* includes an insightful Foreword by video game music composer James Hannigan on the value of both theory and praxis for video game music and its recognition as a legitimate form of aesthetic expression. This publication offers an additional game index, while its most useful extra feature is a seven-page appendix titled "How to Hear a Video Game: An Outline", which serves as a step-by-step guide to both listening to and analyzing the origins, genre, form, function, and extra-musical connotations of video game music.

Summers is able to present numerous musical examples and offers several options for analysis in each chapter. He asks important ontological questions about the source of video game music "texts" and their various versions and iterations––for example, which is the one "true" version of a video game's music?.

Although there are several video game audio and music books that are written primarily for practitioners hoping to break into the video game industry currently on the market, *Understanding Video Game Music* is among an only handful of monographs specifically dedicated to music in video games, and it is one of the very few to be written by a musicologist for a primarily academic audience. In my estimation, this book serves two vital functions for the field of ludomusicology. First, it offers a great introduction to the field of ludomusicology. But, despite the fact that this book was written primarily for budding ludomusicologists, Summers does a great job of defining gaming and musical jargon and explaining disciplinary assumptions in easy-to-understand terms for non-practitioners. Moreover, this book may be especially valuable to historical musicologists, as well as to media studies and game studies scholars, because of the way Summers builds his arguments from the ground up, describing the experience of gameplay (and in situ analysis) in great detail, and clearly laying out the foundation each analytical technique he introduces. Composers and industry professionals would also find this volume useful for broadening and deepening their understanding of the form and function of video game music across a wide range of styles and genres. In addition, each chapter of the book's second section presents aspiring ludomusicologists with many exemplary models of game music analyses to emulate. The book includes a range of useful tables and figures that present theoretical and analytical information in a wide variety of formats, and it features excellent musical examples and transcriptions of game music.

Secondly, this book serves as a much-needed overview of the various ways in which video game music can be approached and analyzed by ludomusicologists. When writing single book chapters or journal articles, ludomusicologists have little print space to expand their analysis of a musical example from a video game beyond one or two analytical techniques. Through this single-authored monograph, Summers is able to present numerous musical examples and offers several options for analysis in each chapter. He asks important ontological questions about the source of video game music "texts" and their various versions and iterations (for example, which is the one "true" version of a video game's music?). Of the recently published monographs on video game music, Summers' is perhaps the least esoteric. But despite its utilitarian design, it raises important questions and introduces valuable new theories and analytical techniques, while simultaneously clarifying, refashioning and championing tools already used by ludomusicologists. Most importantly, it helps to further ground the study of video game music in preceding musicological, philosophical, and media studies traditions.

REVIEWER'S INFO

Michael Austin is Assistant Professor of Media, Journalism, and Film at Howard University in Washington, D.C. and serves as coordinator of the Interdisciplinary Studies Program in the Cathy Hughes School of Communications. His research focuses on music and sound in contemporary media, especially in music videos, video games, and other emerging/interactive technologies.

HILLEGONDA C RIETVELD
London South Bank University
h.rietveld@lsbu.ac.uk

Michael Kamp, Tim Summers & Mark Sweeney (Eds), *Ludomusicology: Approaches to Video Game Music.*

Michael Austin (Ed), *Music Video Games Performance, Politics and Play*

As an expanding interdisciplinary field at the intersection of game studies and musicology, as well as sound studies, the interactive symbiosis between audio and visual elements of video games is essential in understanding game experience. The editors of *Ludomusicology*, state that the discipline, "at its broadest, attempts to see our engagement with music, any kind of music, in terms of play" and emphasize that "there is a special relationship between playing video games and engaging in their music" (Kamp, Summers & Sweeney, 2016, p.1). In the afterword to Austin's edited collection on music video games, William Cheng similarly observes that "much of ludomusicology's literature to date upholds music and play as a match made in heaven" (2016, p. 297). Earlier collections have appeared on video game music, such as a set of case study essays edited by Donnelly, Gibbons and Lerner (2014), as well as a comprehensive seminal collection edited by Collins (2008) that provides both industry and musicological perspectives, and that gives recognition to the chiptunes scene and to the growing importance of mobile phones in game sound.

> Both collections address the complexities, and pleasure, in the interactions between digital games and music. They provide an imaginative snapshot, and barometer, of the state of play in the study of game music, which has seen a steady growth in academic publications over the past decade.

While *Music Video Games* appears as part of a series in "Approaches to Digital Game Studies", offering a broad approach to the study of musical gaming, the

Ludomusicology collection is published as part of a series on "Genre, Music and Sound", which shifts the analytical focus to a musical understanding of video games. Born from an annual conference of the same title, organized by three musicologists who are also the editors of the collection, *Ludomusicology* takes on the task to systematize boundaries to the field of game music, albeit with an open attitude to the relationship between music and video games in general. This provides space for a range of methodological approaches from a musicological perspective. For example, music enhances both immersion into, and interactivity with, the game. In her paper, Isabella van Elferen develops a theoretical model in which musical affect, literacy, and interaction are identified as key elements in player immersion through the employment of game music.

An additional important characteristic of game music is that it is non-linear. Therefore, as Tim Summers points out in his study, the game must be played repeatedly to hear and analyze the variable, shifting, soundtrack. Only then can game music be fully understood in connection with its technical context, para-musical sources, and intertextual processes. In his paper, Mark Sweeney delves deeper into *intertextuality* through discussion of *Dead Space*, showing how cinematic conventions in the use of classical music can be heard in the use of neo-romantic (melodic) music as a narrative device, and the application modernist musical forms (which deconstruct traditional tonality) as underscore to signify and generate fear during game play. Michiel Kamp, meanwhile, investigates *paramusical* aspects of games, adapting Gérard Genette's notion of *paratexts*, shifting the focus of analysis to game music also exists in the *peritext*: "all those materials that surround and are attached to the text itself" – p. 75), outside the diegesis of game play, including menus and start screens. Summers suggests reaching further, beyond the game environment, including interviews, for example, to better understand the context of composition.

Focusing, by contrast, on the object of music-led digital games, music video games offer an opportunity to delve into a specific relationship between music and games. Such games can range from tools that enable the creation of music through game play (a type of gamification of music making) to games that involve the contexts in which music is developed, played and interpreted. Within a ludomusicological assessment of smartphone music games, Anahid Kassabian and Freya Jarman narrow down what they would include into the category of music games by deconstructing the main concepts involved in what such a game may entail, such as the activity of play, the structure of a game, and the very notion of "a music game". On the one hand, they include games, such as *Guitar Hero*, that allow control of "the production of sounds [during] the entirety of game play" and in which sounds are "a major part of the play" (p.122). On the other hand, they exclude games about music and musicians, and also games, in which sounds are only "a consequence of game play", including (perhaps surprisingly) games such as Rez, characterized by an explicit attempt to make sound an integral part of the gameplay mechanics.

The *Music Video Games* collection offers a broader view of what to include as a music game. In the editorial introduction, Michael Austin provides a range of definitions of music game play, suggesting that engagement with music can be compared to both the pleasure of game play as well as the structuring aspects of a game. Here he briefly considers music games as musical instruments. This is further explored in a separate chapter, where he theorizes music-controlling games as types of sequencers. In this way, games are understood in terms of mechanics, dynamics, and aesthetics, whereby gamification of music sequencing opens up new approaches to making music. Back in the editorial introduction, though, Austin also calls for an object-oriented approach that approaches music games in terms of genre rules and interface interactivity, such as rhythm-matching, pitch-matching, music-mixing and musical-making games. In this way, the focus turns to performance, on the personas that players may adopt during gameplay, and on the resulting music.

To illustrate the difference in approaches between the two collections, research by Melanie Fritsch appears in both collections. In *Ludomusicology,* she addresses the reinterpretation of the musical scores of *Super Mario* for orchestral performance. By contrast, in *Music Video Games* she investigates the use of Michael Jackson as a musical persona. Rather than enabling music making and performance, metonymic music games, then, allude to (known) musicians, to music making, or to the music industry. This type of music game veers away from how Kassabian and Jarman define music games in their contribution to Ludomusicology. The scope of *Music Video Games* collection is broad; it considers a wide range of music-focused digital games from historical, cultural and pedagogical perspectives, inspiring Cheng to call for "a ludomusicology that bounces along feelings of musicality, pleasure, and imagination, rather missions that get mired in agonism, definitional boundaries, and high scores" (p. 303).

> There is space for the further development of a ludomusicology as a rich subject area that is more than a sub-discipline of musicology, to further engage with the technological, social, cultural and economic dimensions of game music. There is also space for an inquiry into the symbiotic relationships between popular music and game music, both within games as well as within the sounds, attitudes, and interfaces of popular music forms.

Both collections address the complexities, and pleasure, in the interactions between digital games and music. They provide an imaginative snapshot, and barometer, of the state of play in the study of game music, which has seen a steady growth in academic publications over the past decade. Where they do differ, though, is that *Ludomusicology* aims to establish a sub-discipline in musicology of varying conceptual perspectives, including Medina-gray's discussion of modular video music composition and Gibbon's assessment of the role of classical music in games. *Music Video Games*, however, offers approaches to

games that, rather than residing in musicology, are anchored in the interdisciplinary fields of media and cultural studies, with an interest in the politics and performance of play; for example, Plank's detailed study of online communal participation in *Mario Paint Composer*, and O'Meara's contextual study of *Rocksmith* as a music game and as pedagogical device.

Such diversity shows there is space for the expansion of ludomusicology as a rich subject area that is more than a sub-discipline of musicology, to further engage with the technological, social, cultural and economic dimensions of game music. As a field of study, there is scope for the further development of debate in order to refine critical approaches to the analysis and understanding of game music within variable contexts of creativity, production, distribution, performance, subjectivity, and play. There is also space for an inquiry into the symbiotic relationships between popular music and game music, both within games as well as within the sounds, attitudes, and interfaces of popular music forms. We've only begun to scrape the surface of a vibrant area of study that is still to be systematically explored.

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Donnelly, K.J., Gibbons, W. & Lerner, N. (Eds). 2014. *Music in Video Games: Studying Play*. London and New York: Routledge.

REVIEWER'S INFO

Hillegonda C Rietveld is Professor of Sonic Culture at London South Bank University and, between 2011-17, Chief Editor of IASPM Journal, the journal of the International Association for the Study of Popular Music.

INTERVIEW

The Ludomusicology Research Group

In this interview with Mark Sweeney, GAME discusses the activities of an important research group for the study of music and games.

GAME: You started the Ludomusicology research project in 2011 to offer a musicological and academic approach to the study of games, as a group of three young academics. What was the motivation for this?

Mark Sweeney (Ludomusicology Research Group): I was just getting started with my doctoral research on aesthetic theory and video games music when my doctoral supervisor, Peter Franklin, put me in touch with Tim Summers. Tim was in the final stages of completing his doctoral work on video game genres and music at Bristol. We met in the King's Arms in Oxford to discuss our research and hit it off, and in our discussions about the landscape of video game music research, between us we only knew of one other doctoral student at that time, Michiel Kamp, who was at a similar stage to me at Cambridge. Michiel's thesis was (eventually) titled *Four Ways of Hearing Video Game Music*.

Although we were all working on different things, we all had a similar background having taken undergraduate and masters courses in musicology, and the three of us decided that it would be great to organize a conference to see what sorts of research other people were doing on this material – video game music. We also decided that as part of the conference organization, it would be helpful to have a website, so we founded the Ludomusicology Research Group in August 2011, and I built the initial site and started posting news items that we hoped would be of interest to the broader community.

The main motivation for the group was, from the outset, ultimately about discovering what other research was taking place around the world, and who was out there paying serious attention to video game music. It was a very important "discovery" phase, and we wanted to provide some form of a hub (the website, and the conference) to connect researchers together and share ideas. Of course, although we now have a more clearly defined community, the discovery phase is open-ended and is central to our group philosophy.

GAME: When did the first LUDO conference take place? How many people did it attract? What academic/professional background do they have? Over the years, has there been a shift in the type of people who attend?

M.S.: The RMA Study Day at St. Catherine's College in Oxford was the real starting point for the Research Group. Around the time we set up the website, we also linked up with Huw Catchpole-Davis who was doing a doctorate in composition at Oxford, with a focus on interactive and generative musical systems. In fact, it was Huw who designed the logo that we've used for all our branding ever since!

With support from our supervisors – Nicholas Cook (Cambridge University), Peter Franklin (University of Oxford), Guido Heldt (Bristol University), Robert Saxton (University of Oxford), and Duncan Williams (University of Oxford) – the four of us secured funding from the RMA and were very fortunate that both Anahid Kassabian and Isabella van Elferen agreed to provide keynote addresses at the inaugural Ludo conference. Tim had heard Anahid speak at Bristol, where she had expressed her interest in the video game as a musically significant medium. Michiel had studied with Isabella in Utrecht, and we were all familiar with her work on the topic.

Through Jonathan Williams (Oxford), we were also lucky to make contact with industry professionals like Rich Aitken at Nimrod Productions, who also gave up his time to participate and present. The incredible input of all these people ensured the event was a success and laid the foundation for future events.

We were fortunate that several other major practitioners and academics found our "Call For Papers" and attended the event, including Melanie Fritsch, Stephen Baysted, and Roger Moseley. Given that we hadn't done anywhere near as much promotion for the conference as we do now, it was quite surprising we had so many excellent contributors and delegates!

The number of delegates has increased, steadily, year-on-year. It's great to see many Ludo regulars returning every year, and there are always news faces too, and occasionally people representing previously underrepresented disciplines.

GAME: In the context of the Ludomusicology project, how does the group apply a musicological approach to game music, and distinguish between the study of game sound design and of game music?

M. S.: Although the very term "Ludomusicology" betrays our disciplinary background, as a group, we have from the outset conceived of the emerging field as being particularly interdisciplinary. At our conferences, we have always made efforts to include a wide range of papers from researchers and practitioners that represent a considerable diversity of disciplinary perspectives. Musicology is one discipline amongst many that is involved in this. We know that the term has been understood as divisive in some quarters, but we don't mean it to be exclusionary

at all. It's a fun, lighthearted term; it's become a useful shorthand to refer to the area of study, a way to network scholars, be honest about our backgrounds, and a way to say that we are taking to this material with a scholarly attitude.

GAME: How does Ludomusicology intersect with other centres and scenes regarding the study of sound and music in games?

M. S.: While we have been primarily in contact with other academic organizations and initiatives studying video game sound and music (see below), some of our colleagues are regular posters on the Overclocked Remix forums, which originate in the gaming community. There are more and more web-based communities and blogs focusing on music in games, in addition to real-world events like Video Games Live, and our connections with these are necessarily loose and informal.

The North American Conference on Video Game Music was established in 2014 by Steven Beverburg Reale, William Gibbons, and Neil Lerner, after Steven got in touch with us following our 2013 conference in Liverpool. In 2016, their committee also included James Buhler, Karen Cook, and Elizabeth Medina-Gray. NACVGM is very close in spirit to our Ludo conferences, and there has been plenty of crossover in delegates and presenters. Our close relationship with our colleagues in North America is particularly important, and from the outset we worked together to provide greater access to conference opportunities on both sides of the Atlantic.

Game Music Connect was established in 2013 by James Hannigan and John Broomhall (composers for multiple media forms, including games) and was targeted at primarily amateur, pro or semi-pro composers, but also to audio directors. We were very fortunate to have James Hannigan present at Ludo2014 in Chichester, alongside Richard Jacques and Winifred Phillips (both composers for successful games).

GameSoundCon was established in 2009 by Brian Schmidt and is targeted broadly at people working in the industry, or those involved in music and sound for more traditional media (film, T.V., music, etc.) who want to learn how games are different from linear media.

However, even older than all of these is Audio Mostly (http://audiomostly.com), which held their 10-year anniversary conference in October 2016 in Sweden (in 2017, the event was held in London). The first Audio Mostly conference (also in Sweden) in 2006 was described as a "conference on sound in games", and in the following year, this was expanded to "Audio in all its forms".

In December 2016, we teamed up with colleagues from NACVGM and Audio Mostly to launch the Society for the Study of Sound & Music in Games (SSSMG). SSSMG is an umbrella network with an extensive advisory board of leading academics and practitioners. The aim is to provide a hub to connect together these various groups of people working on game audio and to support

advances in the understanding of sound and music in games. The SSSMG helps anyone who investigates game sound and music, whether in an academic or professional setting, to discuss the topic together, exchange ideas and information, and keep up- to-date with new research. Anyone can join, and the members are always looking for new approaches to the subject.

SSSMG have since announced our plans to launch a new journal entitled the Journal of Sound & Music in Games (JSMG). JSMG will be an academic peer-reviewed journal presenting high-quality research on video game music and sound. The journal will not seal game audio into a scholarly suburb, but will instead be an outward-looking publication that seeks to engage game audio practitioners and researchers from a range of disciplines, including anthropology, computer science, media studies, psychology and sociology, as well as musicology. Keep an eye on the website in the coming months for updates on this exciting project.

GAME: What are your selection criteria for venues of the Ludomusicology conferences? How did Southampton contribute to the presentation and experience of the 2016 event?

M. S.: Our original aim was to encourage inter-university collaboration and dialogue, and to establish game music as a research strength for UK academic musicology. I think this was because, at the start, we did not foresee the international scale of the emerging field or our full potential role as a hub to facilitate and encourage research on video game music across the globe and cross-disciplinary borders.

We're particularly grateful to Anahid Kassabian who was the first person to suggest another conference after the Oxford study day and kindly offered Liverpool as a host. By doing the second conference the next year, it implied it was going to become an annual event. Even by this second year, authors were contacting us to say, "I can't make it this year, but I'll make the next one", under the assumption it was going to be an ongoing project. This set the precedent we've been lucky to be able to follow.

Subsequently, our selection criteria for the Ludomusicology conference venues have evolved on a pragmatic basis. In 2015 we held our first overseas conference at Utrecht University, and we hope to alternate between the UK and the [European] continent in future, if possible. We also try to take into account the accessibility of the host institution for international travelers and do our best to keep costs as low as possible for what is still predominantly an early career academic demographic.

We have been fortunate to have a great diversity of approaches at the Ludo conferences. In particular, we've had solid papers from computer scientists, ethnomusicologists, psychologists, theatre studies, and so on. In terms of disciplines, we see ourselves as a broad conference. All disciplinary approaches are welcome

to come and play together in this domain. We have tended to focus on game music through the lens of musicology, because we have that disciplinary background and that this was an area that musicology hadn't really approached very much before. There is sonic substance in games that is understood by creators, players, and critics as specifically musical, and the disciplinary approaches that musicology has built up has interesting things to tell us about this material. One of the most exciting things about this topic is that it is so well suited to interdisciplinary collaboration. Just as we bring (primarily) our musicological training to bear, so we want to learn from those with disciplinary resources we don't have, and to try and discuss these together. Every year, we've had involvement from industry professionals [mainly game composers], and we see it as a significant priority to cultivate those links alongside developing cross-disciplinary connections.

GAME: How do you reflect back on the experience of the Ludomusicology Research Group concerning the growing attention for music-related aspects of gaming?

M. S.: It's been inspiring to be working in this field at a time of such growth and interest. If we hadn't started something like this, it would have evolved elsewhere anyway. The connections make it useful to be aware of other research in progress, and an opportunity to talk with other scholars working on similar ideas. I think it also helps to cultivate a collaborative, rather than purely competitive approach. One of our long-term delegates said to me during our 2016 conference: "It's great that we can be critical of each other so much more now." I'm delighted that this person felt this way – that we can now hold each other to a higher academic standard and that it provides a comfortable, supportive environment for discussion and productive criticism.

GAME: Has anything changed regarding game music in the industry and/or in the academic world? Has the academic world been chasing up developments only, or is it also fostering new ways of looking at games? And, how do you think the area of game music and sound studies is developing now?

M. S.: It has been fascinating to see game audio studies slowly becoming part of an accepted landscape of study. It took film music scholarship quite some time to establish its own legitimacy, so I think we're making good progress. We've also been lucky to witness exciting times in the industrial development of game audio and sound.

We are on a continued mission for further interdisciplinarity, and that's going to be especially important in discussing new developments of VR [Virtual Reality]. This is an interesting phase of audio development when some of the fundamental questions about game audio that we've been talking about are now being discussed by industry practitioners, some of which are also consult-

ing with academics [on] how to approach these issues. We have been working in partnership with ThinkSpace Education (https://thinkspaceeducation.com/?v=79cba1185463), a provider of professional degrees in game audio. This is one way that the research at our conferences helps to inform the practice of those who are entering the industry as audio professionals.

Again, coming from musicology, we've tended to emphasize historical and critical approaches related to user experience, musical cultures, and compositional creation. In that sense, yes, it is retrospective, but it's also an attempt to understand the experience of players who are at the heart of this cultural locus. And that's a concurrent phenomenon. We would, though, be very interested in engaging in closer dialogue with the industry. There's certainly the potential for this kind of study to develop into industry-facing research, as a domain that has the time and resources to engage with questions about music and audio in games that commercial companies do not have the expertise, time and resources to answer.

GAME: Please tell us more about the edited collection Ludomusicology: Approaches to Video Game Music (2016). How was this shaped within the context of the research group and its conferences? When did you start work on this?

M. S.: We are delighted that our edited volume, Ludomusicology: Approaches to Video Game Music, was published by Equinox. The majority of the chapters were born out of papers given at our inaugural conference in 2012, although we did not begin work on the project until much later. Authors have taken time to expand those ideas and develop them. Rather than focusing on history or particular types of game, we've been trying to put together a collection that will be useful to provide different ways of understanding this game music, which is one of the main projects of our scholarship.

AUTHOR'S INFO:

C Mark Sweeney (independent researcher) is a founding member of the Ludomusicology Research Group, and the Society for the Study of Sound and Music in Games. He has co-edited an anthology of essays and a journal special issue, and co-edits the book series "Studies in Game Sound and Music". Mark's research interests stem from a DPhil thesis on aesthetic theory and video game music, completed at the University of Oxford where he was also a Stipendiary Lecturer in Music at St Catherine's College.

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