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Loops, Games and Playful Things

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This article focuses on the creation of an audio engine for Urban Musical Game, a multi-partner project led by Institut de Recherche et Coordination Acoustique/Musique. Product design, informatics, engineering and musical composition work in close interaction to harmonize several issues: wireless technology embedded in everyday objects, real-time gesture analysis and recognition, content-based audio processing, modular MaxMSP patching, game design, and experimentation on listening modes.

Keywords: Audio Gaming; Generative Music; Popular Music

Urban Musical Game (UMG)

In 2010, I was invited by the Real-Time Musical Interactions team at (Institut de Recherche et Coordination Acoustique/Musique) IRCAM—Centre Pompidou, coordinated by Frederic Bevilacqua, to work on *UMG*, a project in collaboration with the design agency NoDesign and the association Phonotonic. UMG was presented at the festival Future en Seine (Paris, June 2011), and a first version of its interactive sound design has also contributed to the first prize of the 2011 edition of the Margaret Guthman Musical Instrument Competition as part of the Interlude project.

UMG is at the same time an interactive musical game, a street performance, and a music-enhanced sport: it features balls augmented by wireless sensor technology, and deploys advanced algorithms for real-time motion analysis and recognition (Bevilacqua, Schnell, Rasamimanana, Zamborlin, & Guedy, 2011; Rasamimanana et al., 2011; Schnell, Bevilacqua, Guédy, & Rasamimanana, 2011), as well as a complex audio rendering engine integrated into Max/MSP.

Musical Background

This project explores the infinite possibilities lying between the listening processes involved in a gaming situation and the moment when the music finds a way to the conscious foreground; the *family resemblances*[1] between those possibilities; the ambiguity (that UMG seems to have built into its DNA) between 'playing games' and 'playing music'.

The forms of listening arising from the ubiquity of popular music have been analysed in different areas, from cinema studies, to popular music, sound design and videogames literature (Chion, 2005; Friberg & Gardenfors, 2004; Gaver, 1986, 1989; Stockfelt, 2007). With my installations *Reactive Ambient Music* and *Undertones*, I explored a twisted approach to the idea of *background music*, using unorthodox paradigms, like the bad imitation strategy and the confusion between natural and artificial soundscapes (Cera, 2007, 2009).

My experiments with popular music (Cera, 2000, 2004) are mainly based on operations of hybridization, intended as the creation of musical organisms by the manipulation of structures belonging to two (or more) musical genres. Compositions like *Deliverance* (soprano sax and electronics), *Dueling Zombies* (ensemble and electronics), and *Murder in the MIDIfreaks farm* (big band and soloists) explored different hybridization techniques: sequential morphing, mirroring/deformation, collage of musical dimensions, accumulation of *musemes* (Tagg, 1994). Such operations allow for the progressive deconstruction of a musical fragment until it becomes abstract, and in the process exploring the whole spectrum of nuances between recognizability and unrecognizability. For UMG I wanted to design a machine embodying this kind of musical operations, to use its features in connection with the game's interactivity, and to manipulate the qualities of listening through the semiotic weight of the music. Borrowing terms from videogames literature, such a machine does not behave in a simply *interactive* way, nor in a simply *adaptive* way, but in a continuously shifting mode. Similarly, its algorithms could be considered as *transformational*, but they push the manipulation of the musical materials so far that the result becomes as open and rich as in *generative* contexts (Collins, 2009).

UMG is aimed at an audience in a public space and especially at young users (who are often not used to experimental or classical music), immersed in a game situation. The use of simple musical codes, extracted from everyday experience of music, seemed more suitable than the creation of a new, ad hoc, experimental language. The multiple forms of listening involved in an interactive gaming situation indicated a possible direction towards some form of interesting investigation. This article will trace the process of designing such a machine and creating the database of sounds it uses.

Engines

The structure of the UMG sound machine is based on three engines. These engines have the same internal configuration based on six players, characterized by a musical function: (1) Bass Drums, Kick; (2) Medium Drums, Snare, Timbales; (3) Low Pitched Lines, Bass; (4) Medium Pitched Lines, Guitars, Synthesizers, Piano; (5) Small Drums, Hi-Hat; and (6) Free Track, Various Percussions, Voice, Other (Figure 1).

The three engines differ by their beats per minute (BPM) setting and by the soundfiles they can therefore play. The BPMs of the first and second engines are in a 3/2 relation. The BPMs of the second and third engines are in a 4/3 relation. The reason for this structure is the availability of a large number of polyrhythmic combinations of polyrhythms from the superposition of layers belonging to different engines.

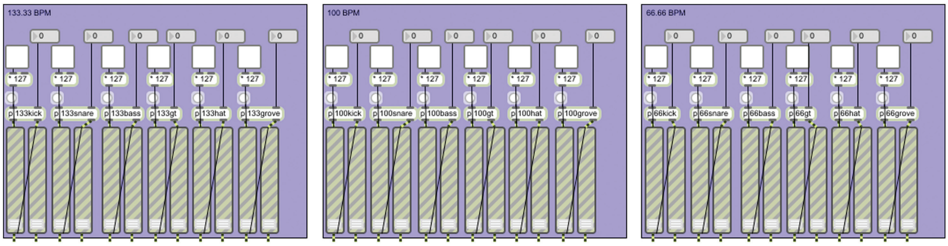

Figure 1 The Three Six-track Engines.

A rhythmically simple pattern can become a complex one, when superposed on a complementary BPM (Figure 2).

The machine automatically adapts the materials of all three engines to a given tempo (BPM) and beat grid. This process transforms the sound materials' temporality while preserving its percussive elements and polyrhythmic interactions. These temporal transformations are synchronized to multiple beat grids according to the common tempo. The audio processing modules of the MuBu for Max/MSP (Schnell, Röbel, Schwarz, Peeters, & Borghesi, 2009) library allows the performance of these operations. Norbert Schnell from the IRCAM's Real-Time Musical Interactions team rewrote my first prototype, changing the engines' core and adding a series of additional features: the possibility to freeze, scrub, scratch, shuffle each track, increasing the possible transformation strategies. Figure 3 shows some first sketches for grids.

Figure 4 is an example of a grid implemented in MuBu. If the sound file had the same BPM as the general setting, a straight line would mean a normal playing of the soundfile, from beginning to end.

The segmented line shows how the playing position evolves over time. The non-linear reading of the sound file results in a distortion of the original beat pattern. Since the jumps and changes in playing speed coincide with the beat grid of the original file, and with the target beat grid as well (shown as vertical markers in the figure), the temporal transformations always result in consistent rhythmic patterns. In addition, these transformations adapt the deviation of each percussive element in respect to its original beat grid precisely, preserving the fluctuations (i.e. the 'groove') of the original performance. Figure 5 shows another example of the musical effect of this kind of operation, in traditional notation. In this case (repetitions of the initial portions of the soundfile) the MuBu grid line would be evolved by steeper jumps.

Recording

I prepared loops associated with 21 different musical genres making a total of 126 soundfiles (with sound description interchange format (SDIF) markers) available for recombination. Examples of genres I used as a reference are '90's metal', 'bluegrass', '60'funk', 'ambient', 'garage', 'dub', 'techno', 'lounge' and 'punk'. In order to create these materials I performed and recorded multiple instruments myself in my studio.[2] Even if the final arrangement of

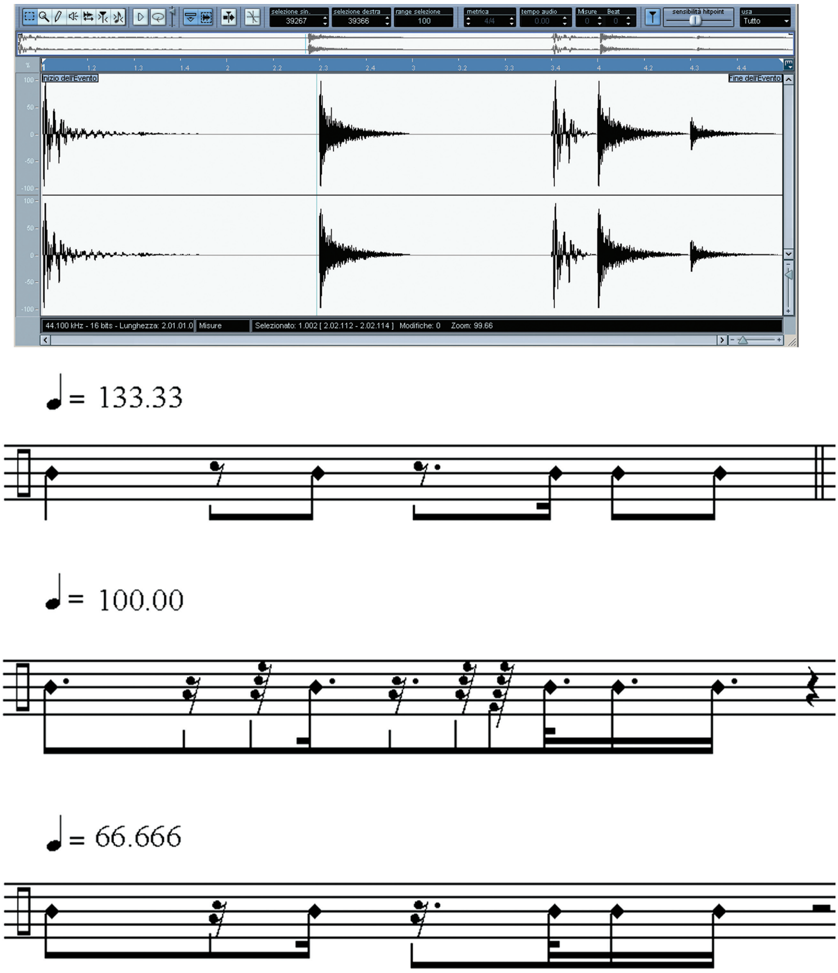

Figure 2 A Pattern Superposed to Different BPM Settings.

layered sound files associated with a given genre mixes recordings of acoustic instruments and electronic sounds, it is always based on an original acoustic recording, serving as a template. Figure 6 shows a moment from one of the recording sessions.

Along with the three complementary beat grids corresponding to different tempos, the pitch sets are another important constraint for the composition of the loops. I tried to limit the use of functional harmony, privileging the use of small pitch-set riffs. Hence, the absence of loops in genres characterized by rich harmonies (like classic jazz or progressive rock), and the prevalence of loops based on simple, often monodic riffs (like techno, metal and garage) or with a strong presence of drones, *bordone*, pedal-notes (like bluegrass and ambient). I tried to use sets with pitches in common, in order to expand the possibilities for freely combining different layers associated with different genres.

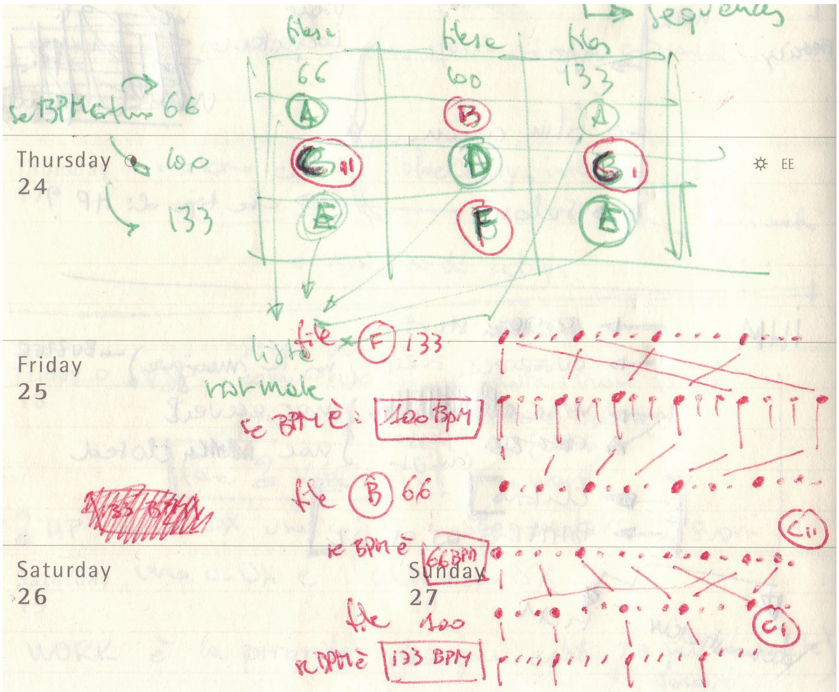

Figure 3 First Ideas for the Creation of Rhythmic Grids.

Recombining and Rewriting

The UMG's engines freely use the collection of sound files as raw materials following an unusual path in the process of composing (Figure 7).

The interactive re-composition of the original sound files induced by the ball movements[3] and the evolution of the ball games relies on a high-level control architecture based on presets. A preset defines: the assignment of soundfiles to the different tracks of the three player engines, the tempo and beat grids, the playing modes (normal, scrub, scratch, freeze, etc.), and the mapping to the control streams extracted from the ball movements. The software architecture of this section has been designed by Julien Bloit, using the Jamoma Modular library (Place & Lossius, 2006). Along with the recombination and transformation of the six tracks, each engine can perform a set of actions: (1) *Shuffle*—Jumping between different parts of the sound files, used for shaking motions (shaking a ball will play fast, short fragments of a soundfile) and for triggering sound events on impacts (e.g. selecting individual sound events from the 'kick drum' tracks); (2) *Collapsing loops*—Generation of progressively shorter loops, up to a single 8th or a 16th note are used to sonify an excited or frantic gaming situation; (3) *Scratching*—Analogue tape or record-like scratching, used, for example, when the ball is turned or turning around a given axis. Turning the ball will scrub in the sound, like a vinyl record—fast spinning results in the

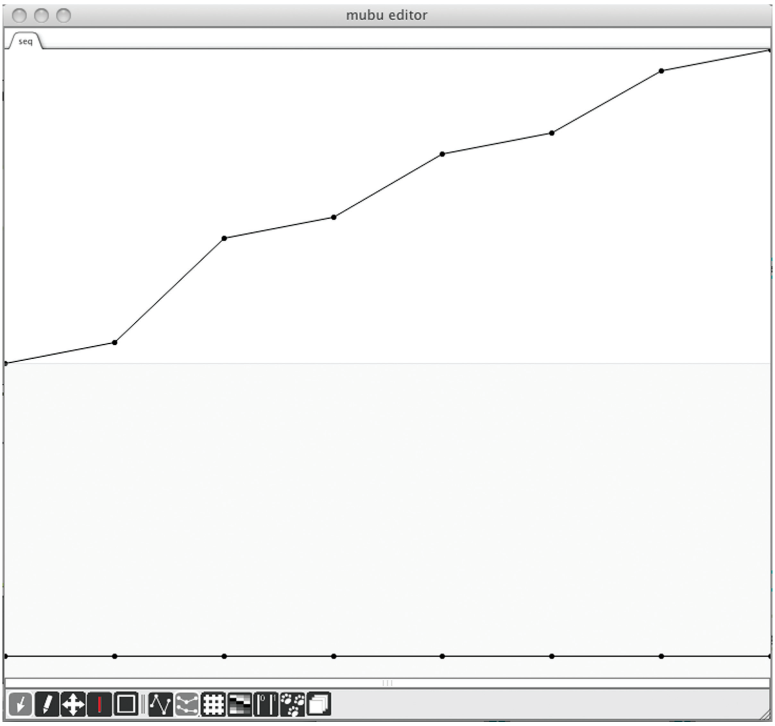

Figure 4 A Grid Translated into the MuBu Framework.

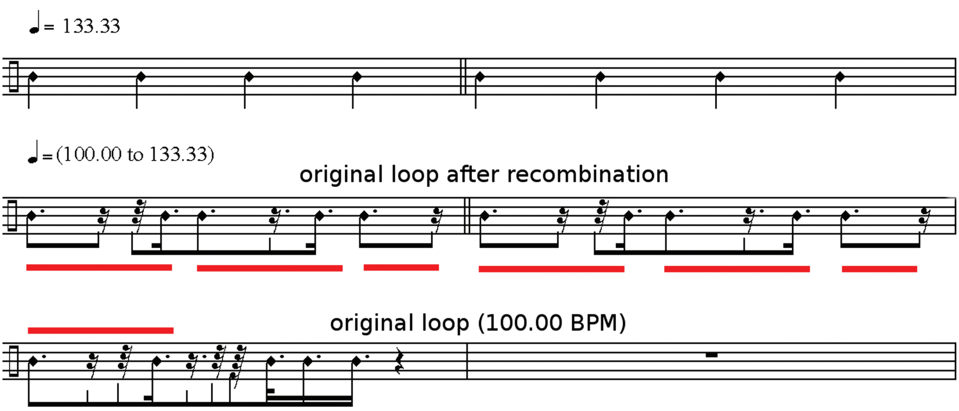

Figure 5 Visualization of the Effect of the Grids.

effect of a fast-forwarding/reversing tape; (4) *Freeze and Scrub*—Granular freezing at a given position of the sound and scrubbing through a sound file, used to sonify the trajectories of the ball launched in the air (the sound is 'frozen' and then slowly scrubbed and re-pitched). In order to explore and use the 126 sound files in the database easily, it

Figure 6 Recording Session.

is necessary to categorize its content. Figure 8 shows an example of preparatory work categorizing the recorded sound materials following general ideas of groove, overall mood, and prominent pitches.[4]

The numerous presets, created in a collaborative effort with the whole team working on the project, are associated to different game scenarios (i.e. game) and, within a given scenario, automatically controlled by the analysis of the sensor data.

For example, in the 'Basket Ball' scenario, the beat grids change following the excitement of the game (derived from the analysis of the ball movements) and the score

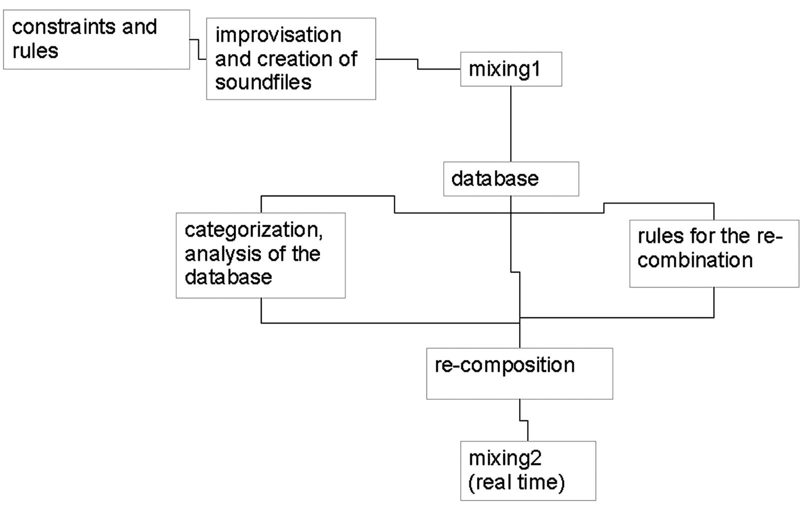

Figure 7 Path from the Improvization Rules to the Final Sound Production.

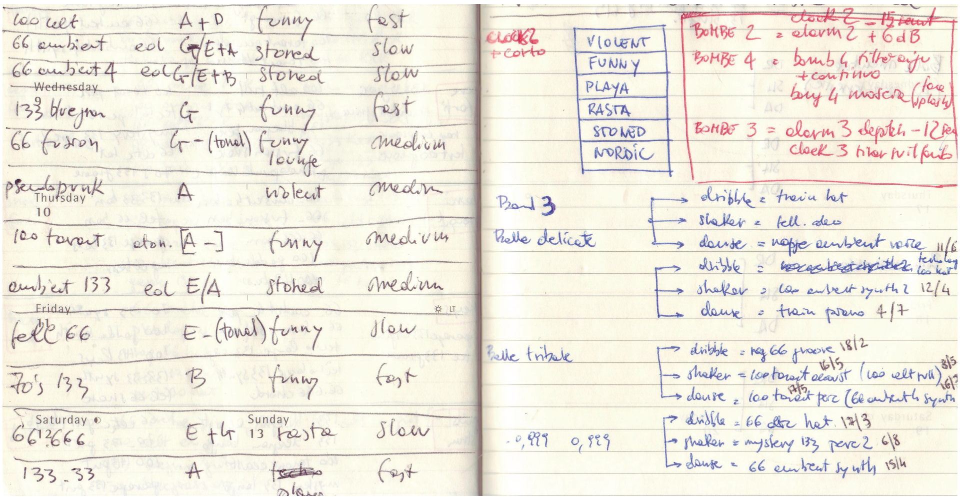

Figure 8 First Attempt to Create a Database Categorization.

(detected by sensors inside the goals). If the game is static, the music will be staggering, slow, and broken. If the game is too nervous, the music will accelerate, the loops will be shorter and shorter, and become frantic. A musical genre is associated with each of the teams competing in the game. If one of the teams shoots a goal, the musical accompaniment will switch to the musical genre associated with that team. In addition, the musical arrangement becomes denser with each goal by adding a track. Following the alternation of goals by the two teams, the music will switch back and forth between the two genres, alternating, for example, sequences of 'heavy metal' and 'techno'. In the case of a draw, the result is a combination of the two musical families, in fact a harmonic, rhythmic and timbral hybrid. The overall tempo is slightly oscillating,

Figure 9 A Moment in the 'Basket' Mode.

controlled by the evolution of the game derived from the sensor data. Additional sound effects directly sonify the movements of the ball. For example, long passes engage freezes on one of the tracks, and the ball hits are sonified with kick sounds. These changes seem to excite the gamers' behaviour, adding a strong sense of implication even in a very simple game between unknown participants (Figure 9).

Mixing

The composition and mixing of the sound file tracks in the collection to consistent arrangements happened in two phases. The first phase was the finalization of each of the 21 loops composed of six tracks. The arrangement of the presets within the different playing scenarios added a second phase to this process. The composition of the sound materials implies that virtually all tracks of the collection can be combined arbitrarily, regardless of the overall timbral shape. To avoid a too heterogeneous collection of materials I followed several strategies. For example, I exported the individual arrangements keeping the same mastering plug-in (*Izotope Ozone*) on the master bus for all the loops, or I applied limiting and multiband compression sections to the sub-mixing sections of the Max/MSP patch. The final audio goes to four big loudspeakers at the corners of the playing field.

Conclusion

UMG is a successful confluence of several interests, including research on gesture and movement analysis and real-time interactive sound synthesis, as well as composition for an interactive generative music environment—experimenting with everyday music listening, and the hybridization of different genres and codes of popular music. For the cohesion of such a number of competences, the role of the composer is fundamental. To imagine systems of sound production and to adapt them to the necessities of the project; to realize musical contents according to the technical constraints; to summarize and render in music the expectations of all the different agents; to assure the migration of the starting ideas into the final result. In all of these areas the different practices of traditional composition find new expressions and applications.

Acknowledgements

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Notes

[1] I started my work for UMG by reading an observation by L. Wittgenstein about how different games can be considered under the light of the concept of *family resemblance* (Wittgenstein,

1953). I always have been interested in shedding a similar light on the categorization of today's and yesterday's commercial music genres (Fabbri, 1999).

[2] An old electric guitar tuned a fifth lower, a few acoustic guitars, a open-back banjo, an electric upright bass, a fretless bass, several kinds of small percussion instruments, a ukulele, a few old synthesizers from the '80s, an Italian 200 watt amplifier from the 70s. I used several microphones, some of them very old, along with two Line 6 PODs for some direct recording of the electric guitars and basses. In addition, Julien Bloit, from the IRCAM team, recorded several drum tracks with contact microphones, that I used to trigger percussion samples, mainly from the *Vienna Instruments Library*. Additional parts were directly created in *Cubase* with different virtual studio technology plugins, as well as MaxMSP patches connected via a *Rewire* connection. Benjamin Miller, from the IRCAM team recorded a few Parisan soundscapes, used for the 'Ambient' tracks.

[3] Gesture analysis is based on:

(1) Low-level features, directly extracted from gesture data (energy, kick, fall, spin, etc.)—mid-level data fusion, integrating several gesture dimensions together and considering data over time (dribbling tempo estimation, angle calculation with Kalman filtering, etc.)

(2) Higher level 'gesture following', used to define more complex playing techniques based on gesture data temporal patterns (rolling, dancing, dribbling, shaking, etc.)

(3) This gesture information is sent to the audio engines through open sound control.

[4] I used different kinds of visualization, such as the MuBu grids, simulations in a multitrack digital audio workstation, and SDIF markers that have been useful to imagine different configurations. Unfortunately the timbral aspects and the effect of micro-variations of the groove can hardly be visualized, so that a preset can be validated only by listening.

References

Bevilacqua, F., Schnell, N., Rasamimanana, N., Zamborlin, B., & Guedy, F. (2011). Online gesture analysis and control of audio processing. In J. Solis & N. Kia (Eds.), *Springer tracts in advanced robotics: Volume 74. Musical robots and interactive multimodal systems* (pp. 127–141). Berlin: Springer Verlag.

Cera, A. (2000). Deliverance, a monster in a war field: A hybrid composition born at IRCAM. In T. Mitchell & P. Doyle (Eds.), *Changing sounds: New directions and configurations in popular music* (pp. 410–415). Sydney: University of Technology—IASPM.

Cera, A. (2004). Composer avec la popular music, entretien avec Andrea Cera. Propos recueilli par Nicolas Donin. In N. Donin & B. Stiegler (Eds.), *Cahiers de Médiologie/Ircam, n. 18, Révolutions industrielles de la musique* (pp. 47–52). Paris: Fayard.

Cera, A. (2007). Noir miroir. Ambiguïtés topographiques, sociales et interactives de la musique. In J. Goldman (Ed.), *Circuit. Musiques contemporaines, vol. XVII, n. 3, Musique in situ* (pp. 29–38). Montréal: Les presses de l'université de Montréal.

Cera, A. (2009). Écoutes et mauvaises imitations. In É. During, L. Jeanpierre, C. Kihm & D. Zabunyan, (Eds.), *In actu. De l'expérimental dans l'art* (pp. 259–267). Djon: Les presses du réel (Publications des Marquisats/Ecole supérieure d'art de l'agglomération d'Annecy).

Chion, M. (2005). *L'audio-vision (son et image au cinema)*. Paris: Armand Colin (Original work published 1990).

Collins, K. (2009). An introduction to procedural audio in video games. In N. Collins & A. R. Brown (Eds.), *Contemporary music review, special issue on algorithmic generative audio vol 28/1* (pp. 5–15). London: Routledge.

Fabbri, F. (1999). *Browsing music spaces: Categories and the musical mind*. Keynote paper presented at the 3rd Triennial British Musicological Societies' Conference, University of Surrey, GB.

Friberg, J., & Gardenfors, D. (2004). Audio games: New perspectives on game audio. In *Proceedings of the ACM SIGCHI International Conference on Advances in Computer Entertainment Technology* (pp. 148–154). New York: ACM (The Association for Computing Machinery) Press.

Gaver, W. (1986). Auditory icons: Using sound in computer interfaces. *Human-Computer Interaction*, *2*, 167–177.

Gaver, W. (1989). The SonicFinder: An interface that uses auditory icons. *Human-Computer Interaction*, *4*(1), 67–94.

Place, T., & Lossius, T. (2006). Jamoma: A modular standard for structuring patches in Max. In *Proceedings of the International Computer Music Conference 2006*, New Orleas (pp.143–146). Ann Arbor, MI: MPublishing, University of Michigan Library.

Rasamimanana, N., Bevilacqua, F., Schnell, N., Guedy, F., Maestracci, C., Flety, E., Zamborlin, B., Petrevsky, U., & Frechin, J.-L. (2011). Modular musical objects towards embodied control of digital music. In *Proceedings of the Fifth International Conference on Tangible Embedded and Embodied Interaction* (pp. 9–12). New York: ACM (The Association for Computing Machinery) Press.

Schnell, N., Bevilacqua, F., Guédy, F., & Rasamimanana, N. (2011). Playing and replaying—sound, gesture and music analysis and re-synthesis for the interactive control and re-embodiment of recorded music. In H. von Loesch & S. Weinzierl (Eds.), *Gemessene Interpretation—Computergestützte Aufführungsanalyse im Kreuzverhör der Disziplinen, Klang und Begriff, Volume 4* (pp. 267–281). Mainz: Schott Verlag.

Schnell, N., Röbel, A., Schwarz, D., Peeters, G., & Borghesi, R. (2009, August). MuBu and friends—assembling tools for content based Real-Time Interactive audio processing in Max/MSP. In *Proceedings of the International Computer Music Conference 2009*, Montreal (pp. 423–426). Ann Arbor, MI: MPublishing, University of Michigan Library.

Stockfelt, O. (2007). Adequates modes of listening. In C. Cox & D. Warner (Eds.), *Audio culture. Readings in modern music* (pp. 88–93). New York: The Continuum International Publishing Group.

Tagg, P. (1994). *Popular music. Da Kojak al Rave. Analisi e interpretazioni* (R. Agostini & L. Marconi, Eds.). Bologna: Cooperativa Libraria Universitaria Editrice.

Wittgenstein, L. (1953). *Philosophical investigations*. Oxford: Blackwell.