COMPOSERS' PANELS

COMPOSERS' PANEL 1

Chair: Ambrose Field
Panel: Krzysztof Knittel, Marek Chołoniewski, Franziska Baumann, Andrei Smirnov

Ambrose Field
A composer from the United Kingdom who writes music which combines human performance and digital technology. His work crosses style and genre boundaries, and explores new territories resulting from an unusual cinematic approach to source material. Field is a three time award winner at the Prix Ars Electronica, Linz, with honorary mentions for digital composition in 1997, 1998, 2006. His music is published and recorded by ECM Records, ORF, and other independent labels. BBC Radio Three commented that Field's work is 'Music pushing against its boundaries and aspiring to the visual'.
Field's new work *Being Dufay* (ECM 2071) is currently touring internationally, performing at venues including the Vienna Konzerthaus, The Perth International Festival, Dancity Festival Foligno Italy, The Chicago Early Music Festival and Kultursommer Rheinland-Pfalz.

Krzysztof Knittel
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Marek Chołoniewski
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Franziska Baumann
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Andrei Smirnov
see page 28

from left: Andrei Smirnov, Franziska Baumann, Ambrose Field, Krzysztof Knittel, Marek Chołoniewski

from left: Ambrose Field, Krzysztof Knittel, Marek Chołoniewski

from left: Franziska Baumann, Ambrose Field, Krzysztof Knittel

from left: Ambrose Field, Krzysztof Knittel, Marek Chołoniewski

from left: Andrei Smirnov, Franziska Baumann, Ambrose Field, Krzysztof Knittel, Marek Chołoniewski

COMPOSERS' PANEL 2

Chair: Stanisław Krupowicz
Panel: Natasha Barrett, Lidia Zielińska, Krzysztof Czaja, Andrzej Kopeć, Jøran Rudi, Clarence Barlow

from left: Lidia Zielińska, Krzysztof Czaja, Andrzej Kopeć, Stanisław Krupowicz, Natasha Barrett, Clarence Barlow, Jøran Rudi


Stanisław Krupowicz


Audience

Stanisław Krupowicz
born in 1952 in Grodno (now Hrodna, Belarus). He graduated from the Faculty of Mathematics and Mechanics of Warsaw University (1976) and the Chopin Music Academy in Warsaw (1981, diploma with distinction). In 1989 he received a Doctor of Musical Arts degree from Stanford University.
He is the author of many chamber, orchestral and electroacoustic works. His music has been performed in many countries in Europe, Asia and the Americas. He has received prizes at numerous competitions for composers, including the Alexandr Borodin Foundation, International Rostrum of Composers, 8th Irino International Competition in Tokyo, 2nd Prize at the NEWCOMP International Computer Music Competition in Boston, 2nd Prize at the 24th Young Composers' Competition of the Polish Composers' Union. He has held fellowships from the Fulbright Foundation, ASCAP, Prix de Paris, Barbara Piasecka-Johnson Foundation, and the Leverhulme Trust.
In 1993-96 he was a member of the Repertoire Commission of the "Warsaw Autumn" Festival. He co-founded and chaired (1998-2000) the Friends of "Warsaw Autumn" Foundation. Currently he teaches composition and computer music at the Academy of Music in Wrocław, where he also heads the Studio of Computer Composition.

Natasha Barrett
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Lidia Zielińska
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Krzysztof Czaja
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Andrzej Kopeć
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Jøran Rudi
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Clarence Barlow
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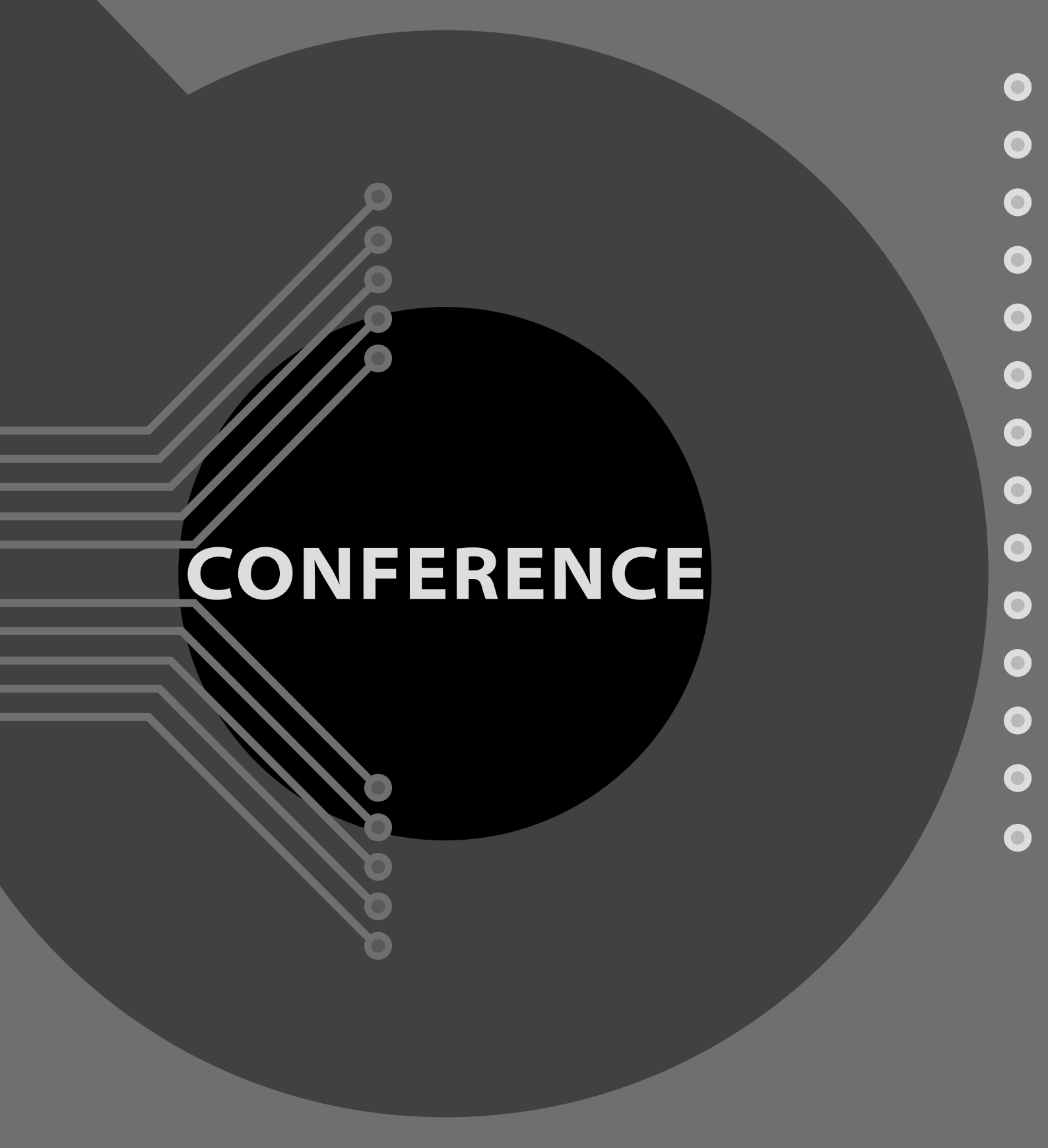
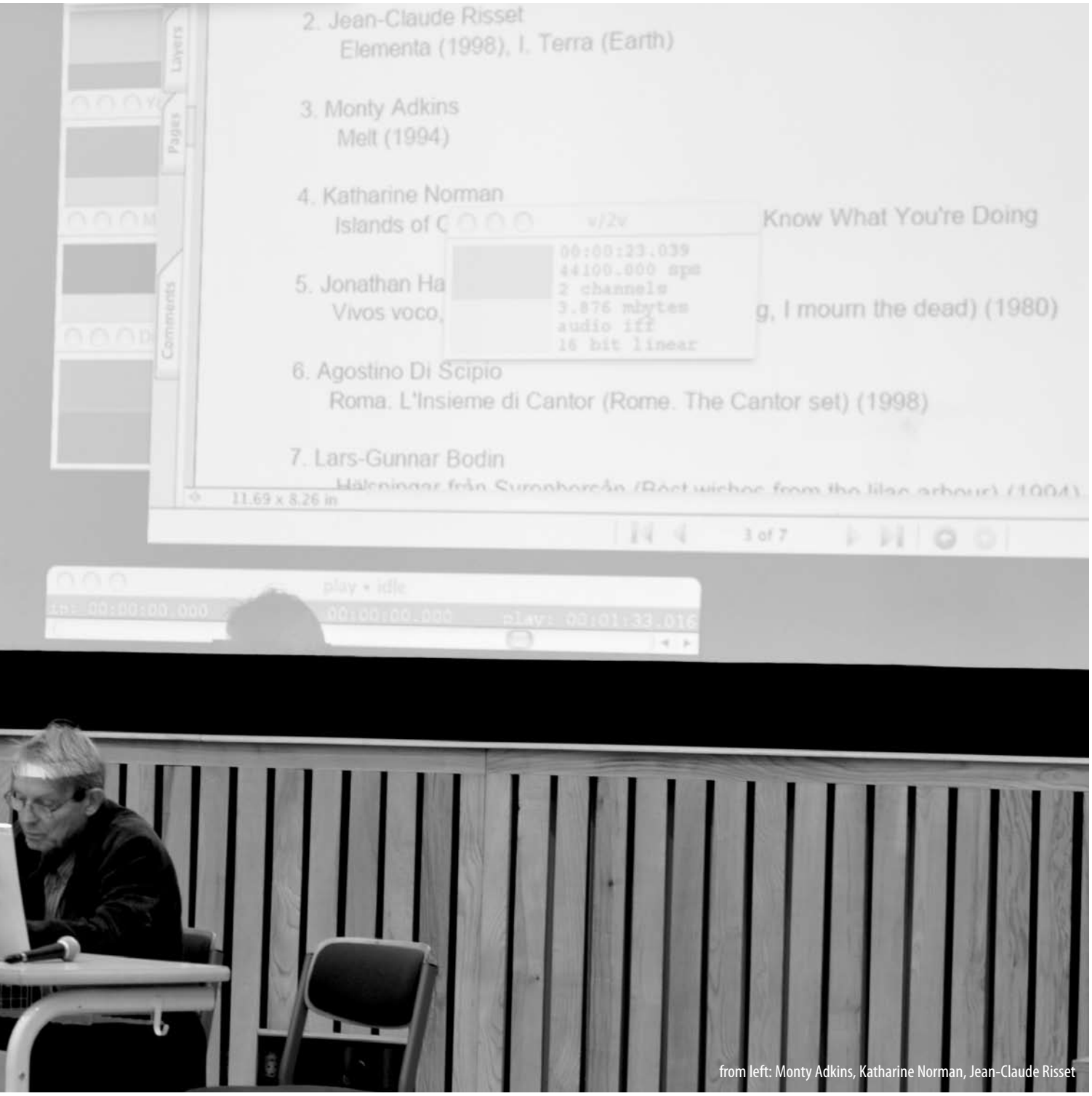

CONFERENCE

Session 1

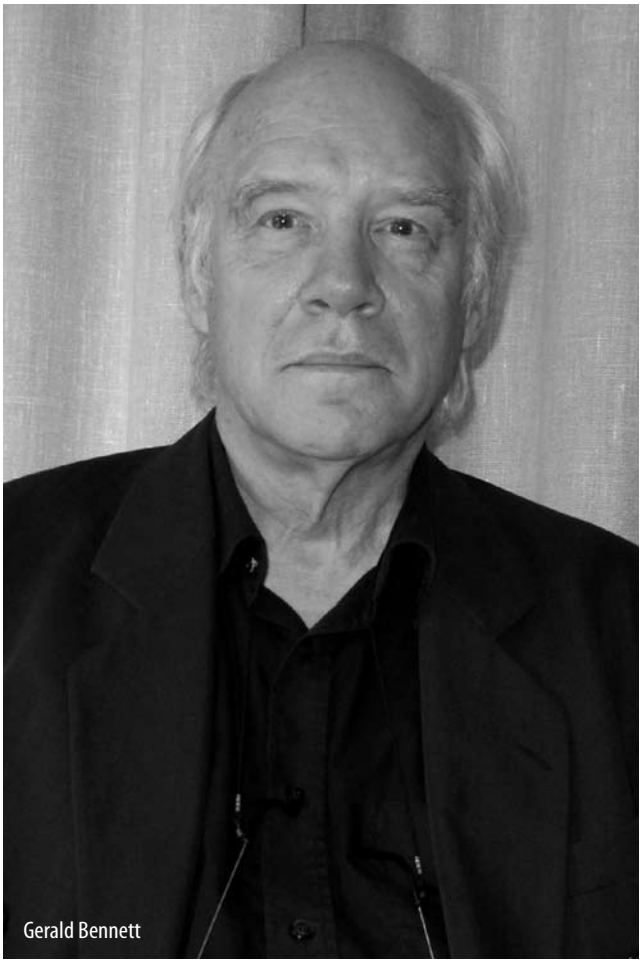
Listening and Relating to Electronic Music

- Listening to and understanding sound and music
- Soundscape of our times: does it change our musical interests and listening?
- Hearing and listening: does electro-acoustic music challenge listeners differently from acoustic music? If yes, why and how
- Abstraction and concrete
- Musical abstraction and sound art, convergence or opposites

Chair: Gerald Bennett
Panel: Katharine Norman, Jean-Claude Risset, Monty Adkins



from left: Monty Adkins, Katharine Norman, Jean-Claude Risset


Gerald Bennett

Gerald Bennett
born 1942 in New Jersey (USA). Graduated from Harvard College in 1964. Taught from 1967 until 1976 at the Basel (Switzerland) Conservatory, from 1969 until 1976 – Director of the Basel Conservatory. From 1976 until 1981 – Department Head at the Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris. From 1981 to 2007 professor of Music Theory and Composition at the Hochschule for Music in Zurich. 1985 – co-founder of the Swiss Center for Computer Music. Co-founder (1983) and from 1986 until 1992 – Secretary of the International Confederation of Electroacoustic Music (ICEM). Since 1993 – member of the International Academy of Electroacoustic Music, Bourges. In 2005 he founded the Institute for Computer Music and Sound Technology ICST at the Zurich University of the Arts. In 2010 – named Distinguished Visiting Scholar of the University of Manchester, England.

Listening to Electro-acoustic Music

Keynote speech

The following text makes no claim to be a tightly reasoned scientific contribution to the subject of listening to electro-acoustic music. Rather, it is an informal, personal and very incomplete collection of themes for discussion about the modes of aesthetic perception elicited by that music.

Seven years ago I wrote a text entitled *The Composer and the Listener* (in G. Bennett & F. Barrière, Ed. *Current approaches in Electroacoustic Music / Relationships between the creator and the listener in Electroacoustic Music. Proceedings of the International Academy of Electroacoustic Music 2002/2003*, Volume VII, Bourges 2005). I include here a slightly rewritten excerpt from this text. Farther below, I comment on a few differences between now and then.

The text from 2003 begins here.

The most important fact of electroacoustic music is its "acousmatic" character. Pierre Schaeffer, in Book I, Chapter 4 of the *Traité des Objets Musicaux* recalls the original definition of 'acousmatic' (given by the *Larousse*): the name given to disciples of Pythagoras who sat for five years behind a curtain listening to Pythagoras's lessons without being able to see the Master. The *Larousse* then derives the adjective as we use it today to refer to acoustical impressions whose sources we cannot know. The primary function of the auditory perception is to warn us of danger. Recognizing whether a sound means danger supposes an analysis and a decision about what produced the sound, and human beings are very good at making this decision, judging easily and quickly for instance whether a sound was produced by something's being hit, being scratched or being rubbed, or perhaps by a human voice. What happens when one cannot decide what made the sound? Anyone who has organized concerts of electroacoustic music for inexperienced listeners has heard the reaction: "That was fascinating, but the music frightened me." I think this is a good reaction, because it means the person listened well: the perception often could not decide what produced the sounds it perceived, and it reacted properly by inducing fear in the listener (who obviously knew that her life was not at stake and so interpreted the fear similarly to the fear of the Haunted House at the village fair).

This acousmatic fear, if I may be permitted the oxymoron, is the most essential aspect of our art. I know I carry it within myself,

and I am ready to be frightened by each new electroacoustic piece I hear (this is a different fright from that I feel when I know I have to listen to an instrumental piece by Mr. X or Ms. Y, whose banality or crudity or capacity to bore will leave me speechless). But I know that no electroacoustic composition actually threatens my life, and so this ur-emotion gets transformed into vulnerability, openness and emotional sensitivity. I believe that this situation is the basic condition of our music, and I think that for us composers the obligations – both professional and ethical – which devolve from it are obvious.

I would like to address four aspects of "electroacoustic listening": the continuity of the frequency space, the temporal space of electroacoustic music, association, and the representation of complex metaphorical relationships. None of this is new, but I would like to reflect on these points in connection with our listeners.

The continuity of the frequency space is trivial, but it is, at least initially, of capital concern to many listeners. The distinction between "tone" and "noise" seems to be a very primary one: maybe when the harmonic partials of a "musical tone" vibrate in resonance with the harmonic partials generated on the basilar membrane, a special "aesthetic happiness hormone" is secreted, who knows? On the other hand, nowadays most people who take the trouble to listen to a concert of electroacoustic music are no longer disturbed by the lack of harmonic relationships. Nor are they disturbed by the lack of melody and accompaniment or other archaic musical *topoi*. I believe that most listeners of electroacoustic music revel in the expansion of the frequency space and delight in the aesthetic take-over of acoustical and emotional domains remaining closed to instrumental music. In fact, I believe that the joy of electroacoustic music first expresses itself to most listeners by way of the frequency space, through the sounds themselves.

Electroacoustic music's behavior in the temporal domain is, at first approximation, quite the same as that of instrumental music. If I try to remember the way down the hill from my house to the village church about 300 meters away, I can only do so in steps: from the house door to the road, then to the neighbors' garage, then to the next neighbors' bush, etc. This path, which I know to be a continuum, is in fact discontinuous in my imagination, made up of short segments – this is the only way the memory can deal with the world's continuity. Music provides the continuum lacking in our everyday lives (but only when listened to non-analytically; analytical listening requires a change of mode, namely into discontinuous listening). That is probably one of the reasons why so many (not just young) people listen to their portable mp3 players whenever they can. But electroacoustic music, as an acousmatic art, touches our perception of temporal events even more deeply. The dissociation, and often magnification, of micro-temporal events from the mechanisms of their production emphasizes the sense of continuum, and so electroacoustic music should be, if only they knew it, an even greater balm than instrumental music to those who seek redress from the discontinuity their perception imposes upon them.

Association, the third aspect I shall consider, is a broad and important theme. I shall only mention two points relating to it. The first is that it is obvious that, without definite knowledge about the source of the sounds the listener hears, she is likely to interpret them in an associative way. A timbre, or perhaps the way the energy of a sound evolves, may remind one of something in everyday life, in other music, in literature, etc. In fact, associative reference to human experience is one of the reasons why music works at all. We all know the importance of associations in electroacoustic music, and it behooves the composer to pay close attention to possible associations in her or his music and to make those associations germane to the piece's poetic idea.

Electroacoustic music can also bring the "real world" into the concert hall. In music making use of fairly manipulated concrete sounds the boundaries between the "real" world and music's imaginary world become fluid, and the sounds of the "real" world bear the weight of the piece. Because the sounds are familiar, particular care is necessary to assure that either the associative path of the piece is clear, or that the sounds are understood in a sufficiently abstract manner to carry the piece along on its way.

The fourth aspect of listening to electroacoustic music I wish to address is the representation of complex metaphorical relationships. Much, perhaps all, music can be understood as metaphor, but the music of the 19th century often consciously sought this state: think of the many pieces by Beethoven which move from "darkness" to "light". Music's non-verbal quality invites us to think metaphorically, even when the referent of the metaphor remains quite vague. Electroacoustic music can point much more directly to the "real" world than can instrumental music and so can establish clearer referents for a metaphorical discourse while relinquishing none of the emotional value of the sound itself. All of us can give examples of this process from our own compositions. Perhaps some of you have heard my piece *Rainstick*. About two-thirds of the way through the piece, a singing voice "explodes" into dust particles. Most listeners understand this gesture in a metaphorical sense, even if they differ in their interpretation of the metaphor: for some, it means only a particularly dramatic passage from continuous to discontinuous, for others it signifies existential destruction in some unspecific way, for others again it means the dissolution of an individual.


Gerald Bennett

Not all composers wish to create metaphorical relationships in their music. It seems to me very difficult to avoid metaphorical interpretation of music, but these composers should keep a sharp ear ready to catch any tell-tale references that could be misunderstood. Metaphor seems to me to be the quintessential artistic mechanism: only by pointing away from its physical manifestation and towards common experience does our music take on human significance. Otherwise it remains, literally, "sound and fury, signifying nothing". Metaphor is my vehicle of communication with the listener. My music, and especially my electroacoustic music, leads the listener into imaginary worlds whose contours are familiar but new. But it is the associative nature of the music and the web of metaphor it creates which allow the listener to assign meaning and significance to what happens in these worlds.

Electroacoustic music as an acousmatic art invokes its own mode of listening, in which the listener is unusually attentive but also vulnerable. This attentive vulnerability imposes considerable ethical responsibility upon us composers, but at the same time it gives us a precious opportunity to communicate intimately and successfully with the listener, with an intensity possible in no other art.

The text from 2003 ends here.

Seven years later, there seem to me to be significant points missing in this very short summary. It was written by a composer who primarily thought of electro-acoustic music as being played under the best possible conditions in a concert situation to a more or less interested audience. Today people usually listen to music under very different conditions: relatively rarely in concert, more often over headphones. Many concerts of electro-acoustic music are live electronic concerts, which was less the case seven years ago. Similarly, electro-acoustic music in the form of Sound Art is much more common now than it was seven years ago. I shall consider each of these points briefly below.

I believe it is worth considering the origin and function of abstraction in electroacoustic music, for it is the propensity to abstraction which allows the listener to derive meaning from electro-acoustic music. At the same time it is also worth considering alternatives to the metaphorical mode of listening.

First to the simpler matters. I doubt that the shift away from the concert and toward individual listening has deeply changed the process of listening itself. Individual listening means that one can listen to a piece countless times, allowing the music to take on greater importance than if one had only heard it once. Certainly, there has been a shift away from the collective, public listening experience of hearing music in concert and toward private, individual listening. But this shift is not limited to electro-acoustic music and is probably rather sociological in nature and does not affect the process of listening in any fundamental way.

Live electronics illustrates visually the acousmatic experience: there is no evident relationship between what one hears and what one sees happening on the stage. For me, who like to close my eyes in concerts of instrumental music so as not to be distracted by visual input, this situation has never seemed difficult. I can understand,

however, that a performer could miss kinesthetic feedback and would like to let the body interact in richer ways with sound production. Performance artists (in Switzerland I think of Bruno Spoerri and Franziska Baumann) discover new possibilities of intimate physical interaction with sound production, leading often to very exciting performances. I suspect that for many performance artists it is the very fragility of acousmatic listening that urges them to look for new ways of relating visual and physical activity to sound. So while I do not believe that live electronics has fundamentally changed electro-acoustic listening, it may very well be that electro-acoustic listening (or at least the perceived inadequacy of the acousmatic mode of listening) has changed, motivated and inspired live electronics.

I do believe, however, that some aspects of Sound Art have changed listening. In particular, I think that sound installations in natural spaces force us to listen differently (in Switzerland again, I think of Andres Bosshard). In the same way as the identification of sound sources has been of evolutionary importance, so has spatial listening been necessary for survival. For me, spatial listening has an emotional directness similar to that of acousmatic listening (for the same evolutionary reason, I am sure). We usually hear sounds in resonant (that is, closed) spaces. To hear sounds in non-resonant (hence large and open) spaces is for me thrilling and magical. I have a similar (but attenuated) feeling listening to soundscape music through headphones. I cannot analyze adequately the reasons for the specialness of the sensation, but I think they have to do with relinquishing the certainty of one's own spatial position, something one only does at one's risk in the "real world". – The fascination of most Sound Art seems to me to reside in the visual domain (think of Jøran Rudi's magnificent *When Timbre Comes Apart*) or in the cognitive domain (think of the sonification of scientific data) and not primarily in the purely auditive domain.

The auditory perception is constantly on guard to protect the organism. All is well when the incoming acoustic signals are familiar. When a signal is unfamiliar, the cognition tries to decide whether or not there is danger. One way to do this is to move farther back from the sonic surface of the signal and to consider it from a greater level of abstraction (Was the signal loud? How was it produced?), hoping to find an association to something known (and not dangerous). The more experience with electro-acoustic music one has, the more "musical", i.e. specific to electro-acoustic music, one's associations will become. Some associations or chains of associations seem to point beyond themselves metaphorically to a referent from physical or mental experience. Others seem to be metaphors, even when one cannot recognize the referent. The listener constantly seeks associations and metaphors in order to give unfamiliar music meaning. The composer can decide to help the listener in this search. Or she can indicate to the listener that he should not seek "meaning" but should concentrate his listening on other facets of the music: momentary sonic beauty or ugliness, the specifically non-metaphorical character of a natural soundscape, the complex shape of a sonification, etc.

Electro-acoustic music differs from instrumental music in that the sound seems to speak and sing directly to the listener without the process of excitation and resonance of an external medium. Unfettered by tunes, metered rhythm or dynamics kept in a pleasant human range, etc. the listener of electro-acoustic music is free to create and explore her own modes of listening and of assigning (or refusing) musical meaning. For the listener, the great contribution of electro-acoustic music in all its forms, apart from the immensely rich repertory of the last 90 years, has been the astonishing expansion of the modes of listening and of assigning meaning to sound.

Gerald Bennett

Katharine Norman

A composer, writer and sound artist, Katharine Norman's PhD (Princeton, 1993) focused on computer music composition and written research on listening relationships to documentary sound recordings. In her instrumental composition she has concentrated on works for solo piano or piano with electronics.

Previous posts include Sheffield University and Goldsmiths, where she was director of the Electronic Music Studios. She has also taught at the Guildhall School of Music and Drama, in the department of

Katharine Norman

Communications at Simon Fraser University, British Columbia and in the department of English at Anglia Ruskin University. She returned to music academia in 2009 after six years working freelance alongside a separate career as a professional writer and editor.

She has composed instrumental music, music combining instruments or voices and digital media, and purely electronic work. Her music, for both digital media with instruments and for purely digital media, makes frequent use of documentary sound – conversation, city sounds, birds etc. – in a way that perhaps invites new appreciation both of the 'real world' and of the concert hall. Her CD *London* is available on the NMC label. *Transparent things*, a CD featuring pianist Philip Mead, in addition to purely electronic/digital work, is available on the Metier label. Other music is recorded on the Innova, Empreintes Digitales and Discus labels. Her music is promoted by the British Information Centre and can also be found at www.novamara.com, www.last.fm http://sonus.ca and at the Electronic Music Foundation, of which she is a charter member. Her work has been performed and broadcast worldwide, has received honorable mentions at the Bourges, Russolo and Alea II competitions, among others, and has been selected for performance at the ISCM World Music Days. Other awards include a Fulbright fellowship and the Holst Award.

Increasingly active as a writer on electronic and experimental music. Katharine Norman's cross-disciplinary book, *Sounding Art: Eight Literary Excursions through Electronic Music* (Ashgate, 2004), explores electronic music through the context of other arts and disciplines, and vice versa.

Listening Change

I'm going to pick up on a point Gerald makes in his keynote paper, but from a slightly different perspective.

Today people usually listen to music under very different conditions: relatively rarely in concert, more often over headphones.

...I doubt that the shift away from the concert and toward individual listening has deeply changed the process of listening itself.

Ways of listening have certainly changed, but actually I wonder if the process of listening – to sound as music, and as cultural expression more generally – is also changing, and in fact that change might be quite deep. That shift, from the concert and towards individual listening, is perhaps indicative of how our ways of engaging with the world, mediated by technology, are continuing to engender, and enable, behavioural change in us, and by extension our listening – and this is not necessarily a bad thing, or something we can control. So I'm going to try and attend to some considerations around listening change within the behavioural changes brought about by digital culture (rather than digital technology, of itself). On the face of it, some of my considerations might not seem to you to have direct significance for listening to electro-acoustic music, but I think, at root, they do.

from left: Monty Adkins, Katharine Norman

Culture (and listening) is a moveable feast

When it comes to listening, both in general and listening to music in particular, I think there is transformational change taking place which is part of that more encompassing transformational change engendered by a still-developing digital culture – and this change has significance for the digitally literate population at least. As the digital is embedded into human culture, our cultural expression will surely subtly change – and surely *is* already changing – our notions of music, and along with this our means of *experiencing* music have moved, shifted, travelled. But regardless of the fact that the digital is changing human culture as a whole, the changes in behaviour that arise (such as changes in *how we listen,* which might lead to a redefinition of what music is, or might be) ultimately proceed from us – since it is people, rather than the tools in their hands – or ears – that make culture 'happen'. So when we explore how music, and *our listening experience of it*, might be moving in new directions, as a result of cultural shifts and developments, we are also in the business of discussing how the human 'psyche' – the way our minds create our sense of self – is moving in new directions, too.

Look back to see how far we've travelled

This symposium is concerned with 'Electronics in the 21st Century'. We are already looking back at the very early twenty-first century as the period when digital tools have completely entered mainstream use – in the developed world at least. Certainly electronics and digital technology have expanded the aural horizons of musical performance, and the creation and manipulation of sound, but this has been going on since the early 90s, once digital technology became more available – it's no longer a novelty.

Mainstream conservative fear-mongering, as promulgated by the 'tabloid' press, is generally a good barometer of cultural change, and the kinds of 'concerns' expressed in order to resist it. (Regardless of the fact that those concerns are worthy of serious consideration, they are used to different ends in this context.) In the 1980s and 90s, popular opinion often worried away in particular about the physical effect on people of all this 'new technology' – the physical harm that tapping away at computers and slapping cell phones to our ears so unthinkingly might cause. More recently, fear-mongering mainstream discussions on the influence of technology have changed focus, away from the harmful effects of 'too much' technology, towards the effect of having too much *information*, or too much *access* to all kinds of unfiltered, uncensored information, and how this might affect – and undermine – human behaviour. We worry that our children will lack empathy if immersed in online war gaming, or that our social media lives will become fractured and leave us unable to concentrate on any one thing. We have moved: from obsessing over tools and things towards contemplating processes and behaviours – that is, how the digital is changing our consciousness – our experience in the world.

Generation X (the children of the 1960s-80s) were acquiring digital literacy, but Generation Y is born digital – immersed in social media and networked data. Such worries are indicative of the recognition of our changing relationship to technology, how we are changing ourselves and are, we feel, being changed. But perhaps this concern is really nothing new. Although Alexander Graham Bell invented the telephone, he refused to have one in his study, regarding it as an intrusion to thought.

Digital culture is increasingly silent, in a noisy kind of way

By this I mean that for a great many people the online environment is an ordinary, pervasive connection that extends the boundaries of experience and makes everything 'local' – here, and now, and available. On the one hand attention spans and concentration levels are deemed fractured by our constantly networked experience, which of course can be superficial and disruptive. (I count myself among those who have been known to check their email during a paper presentation, or follow up a reference on the web - just popping in to Facebook while I'm there. There, online.) But on the other hand, changes in the way we attend to life, and flit comfortably between the real and virtual in our day-to-day experience, are 'wiring' our consciousness in interesting, and empowering, ways.

How does this relate to listening and electro-acoustic music?

Certainly at times we need, and long, to step aside from information overload, to close our eyes and ears, to listen. But then again, our ability to attend to a number of stimuli simultaneously might encourage a different mode of listening that flows more rapidly between association, remembrance, understanding, pleasure and emotional engagement, without losing its way entirely. We are becoming adept at travelling in a variety of different directions, almost simultaneously. We can concentrate, or we can diffuse, our listening. And who's to say that we don't choose one or the other stance, dependent on our preference at the time, gaining different insights, and satisfactions, from each?

For people born after 2000 into moderately affluent circumstances the space of networked digital culture is simply *there* – and *theirs*, a difference from being born in the 'pioneering' digital years of the 1980s and beyond. And those people are already listening to, and making, electronic sound. Few children under the age of ten have in

their day-to-day existence heard the sound of a dialup modem, neither have they personal associations with the whirr of the cassette tape's fast forward travel, or the heavy clunk of pressing play-and-record. I don't think they will necessarily revere the sonic gestures of antique technologies for their romantic, retro associations, in the same way as some digital natives born in the 70s-80s, and some of us older folks, might do. More and more younger composers are working in instrumental and electronic music almost seamlessly, combining all kinds of resources without especial aesthetic confusion, and feeling equally at home with incorporating digital images and film. They are not working in 'multimedia' art, they are simply making art.

Of course many artists working in sound do not observe 'electro-acoustic music' as a distinct genre, nor a distinction between music and sound art, while others do and incorporate this 'genre' within a broad artistic sensitivity to sound. I think this unselfconscious adoption of different approaches is in one respect a result of the 'cult of the amateur' that access to digital resources has brought about. But surely it is also indicative of a shift towards listening to aestheticised sounds in a variety of ways, in different contexts, and in more than one 'context' at time – and without necessarily elevating one above all others. To me this bodes well for a more inclusive engagement with organized sound – and for more listeners to find a reason for listening as part of experiencing art.

How might listening flourish? One of my particular enthusiasms has always been listening engagement with 'real world' or documentary, field-recorded sounds, and considering ways of bringing this engagement into compositional decisions. So it is of particular interest to me that affordable digital recording technology has produced a renewed and, I sense, exponentially expanding interest in recording the sounds of the world – not only from composers and sound artists, but from a whole body of listeners who are simply interested in recording their sonic encounters. That's an interest that is motivated by a desire to listen – both actually and metaphorically – and to share and exchange listening – phenomenological experience. To be immersed in listening, as one might be immersed through reading – is to find oneself a world away. As Gerald has already remarked in his keynote paper, that kind of listening can be an intoxicating experience, even when not composed by another's sensibility. We are listening accompanied, taking sonic psycho-geographical journeys, getting the feel of a place and time. Sound – and listening – has become recognized explicitly by artists and composers as communicative of time, place and experience. Perhaps it is in fact one antidote to digital immersion in no-place, and no-time virtuality.

I'd like to finish with some words by audio theorist and historian Douglas Kahn, which I think neatly summarize just why sound, and listening to sound, and making art and electro-acoustic music, is so important, and so likely to continue to flourish, and change: 'In reality, sounds are never far enough above or below society to escape poetics, bodies, materials, technologies, discursive and institutional contexts or the beck-and-call of phenomenology's "auditory imagination". All that needs to happen is to admit that consciousness plays a part in auditory perception.' [*Sound Art, Art, Music* (2006), Douglas Kahn, http://www.douglaskahn.com/writings-1.htm]

Katharine Norman, September 2010
katharine@novamara.com

from left: Katharine Norman, Jean-Claude Risset

Jean-Claude Risset

born in 1938, composer and researcher. He completed scientific and musical studies (Ecole Normale Supérieure, composition with André Jolivet). For three years he worked with Max Mathews at Bell Laboratories to develop the musical resources of computer sound synthesis: imitation of real timbres (brass synthesis, 1965; pitch paradoxes, synthesis of new timbres and sonic development processes, 1967-1969). An author of many musical works, most of which resort to computer synthesis in conjunction with instruments or human voice. He published a catalog of computer-synthesized sounds in 1969. He set up computer sound systems at Orsay (1970-1971), at the University of Marseille-Luminy (1974), and at IRCAM, where he was appointed head at the Computer Department by Pierre Boulez (1975-1979). As a composer in residence at the Media Labratory, MIT (1987-1989), Jean–Claude Risset implemented the first real-time interaction between performer and computer with acoustic piano sounds. His work *Sud* (1985) is the first electronic music composition ever submitted for the musical option of the French baccalaureate.

For his pioneering work, he received the first Golden Nica (Ars Electronica Prize, 1987), the Giga-Hertz-Grand-Prize in 2009, and the highest French awards in both music (Grand Prix National de la Musique in 1990) and science (Gold Medal, Centre National de la Recherche Scientifique in 1999).

Presently "Directeur de recherche" emeritus, CNRS, he works on computer music in Marseille.


Jean-Claude Risset

Listening and Relating to Electronic Music

Gerald Bennett has pointed out several specific features of electro-acoustic music – a denomination that seems preferable to electronic music. Electro-acoustic music has considerably enlarged the vocabulary of music. Olivier Messiaen stated that the advent of electricity in the making of music was the most important event of the 20th century.

Around 1875, it became possible to record sound and to process sound using electrical technologies – electrotechnics, electronics, computers and digital electronics. Edgard Varèse prophetized electro-acoustic music in 1917, insisting that new materials permit novel architectures. In 1939, Cage composed *Imaginary landscape #1*, the first musical work existing only as a recording. From 1948, Pierre Schaeffer developed *musique* concrète in Paris, a new form of sonic art making use of recordings of acoustic sounds processed and assembled by means of radiophonic studio techniques: he was the principal pioneer of electro-acoustic music. From 1950, electronic music appeared in Munich and Cologne, with a different purpose: the main incentive was to achieve a precise realization in sound of scores specifying complex patterns of pitch and rhythm, using sounds produced by electronic devices. The two forms soon merged in electro-acoustic music. In 1957, Max Mathews pioneered digital sound recording and synthesis, giving rise to a new branch that could take advantage of the computer – a tool, or, according to François Bayle, actually a workshop providing intellectual as well as material musical tools.

Electro-acoustics is still in its infancy, and many developments are to come. Today most heard music is produced by loudspeakers. In my own childhood, most of the sounds were of mechanical origin – even the disc turntable. My world of music was instrumental. I only heard electronic music from the radio set: whistles when receiving short-wave stations – parasites which had some poetic overtones; or periodic modulations intended to jam radio broadcast – unpleasant memories from the 1939-1945 war ("Radio Paris ment, Radio Paris est allemand"). To me, these listening experiences did not relate with music.

Hearing has evolved to help living organisms to cope with a mechanical world, where almost all sounds were of acoustic origin (except for thunderbolts). Animal hearing has developed extraordinary powerful ways to analyse incoming sounds to gather information on the surrounding world and its potential dangers. Hearing is specially sensitive to the frequency aspects of sound waves, which are well preserved in propagation

– except for moving sound sources, but the listener takes advantage of the Doppler frequency shift to get information on the motion of sources (Chowning took advantage of this in his piece *Turenas* to convey with quasi-graphical precision the illusion of sound sources swiftly moving in space). Hearing is also capable of evaluating the direction and the distance of the sources of sound: receiving an auditory signal at a level of, say, 30 dB, it can tell whether it has originated from a powerful sound source far away or a weaker sound source close by. Also hearing has a great ability to make inquiries about the way heard sounds were produced mechanically – by hitting, blowing, scraping… but these mechanisms of recognition are not adequate for sounds produced electrically. Thus a sound synthesized by a computer with a sharp attack and a resonant decay will sound percussive, although there is no percussion in the computer.

Gerald Bennett just remarked that *acousmatic* fear is an important aspect of electro-acoustic music, which increases the listener's emotional sensitivity and openness: it relates to this inadequacy of hearing, which cannot sort out the origin of electro-acoustic sounds, so that the listener cannot rely on a familiar circumscribed universe. Surprise can be fearful, even in the instrumental world: specifically here in Poland, in the year of Chopin bicentenary, I would like to point to the end of his first *Scherzo*, where an insistently repeated chord from nowhere creates an eerie impression of fear – André Gide considered this was the first irruption of "le fantastique" in music.

By considering the evolution of hearing we begin to understand how resorting to physical models for synthesis can lead to sounds with strong physical identity, for instance in compositions by Ludger Bruemmer using the CORDIS simulation developed by Cadoz and ACROE in Grenoble. This methodology may be useful even when one attempts to develop entirely new sound material rather than simulation of mechanically produced sounds. One can think of simulating a world where the constants or even the law of physics would be different. Recently, in his work *Terra*, Cadoz has extended his physical model to control the compositional form as well as the production of sound.

One can also resort to ways of producing sounds digitally that do not relate to any acoustic world. From 1957, Mathews used simple waveform synthesis, additive synthesis adding simple signal elements such as sine waves (to produce for instance a quasi-periodic waveform by Fourier synthesis), and subtractive synthesis starting from a complex wave and recovering its original components. As early as 1959, he developed a compiler to produce musical sounds, MusicIII, using a modular concept: the user could design his or her own type of synthesis by assembling modules such as oscillators, amplitude and frequency modulators following a profile designed mathematically, graphically or otherwise. Starting in 1957, John Chowning developed his Frequency Modulation technique, a clever way to distort a sine wave, very effective for producing rich and varied sounds.

I personally think that resorting to the computer was an important development, permitting one to exert compositional control down to the microstructure of the sound, and to compose sound, instead of merely composing with prefabricated sounds, and I dedicated myself to developing some of its resources. The most striking instances of unprecedented musical possibilities are provided by three works of John Chowning: *Turenas* (1972), a milestone of kinetic music and of timbral continuum; *Stria* (1977), which unfolds sound on a large scale and takes advantage of the computer's capacity to produce arbitrarily non-harmonic sustained tones to maintain consonance for unusual intervals; and *Phone* (1981), where figures such as illusory singing voices are made to emerge from sonic chaos.

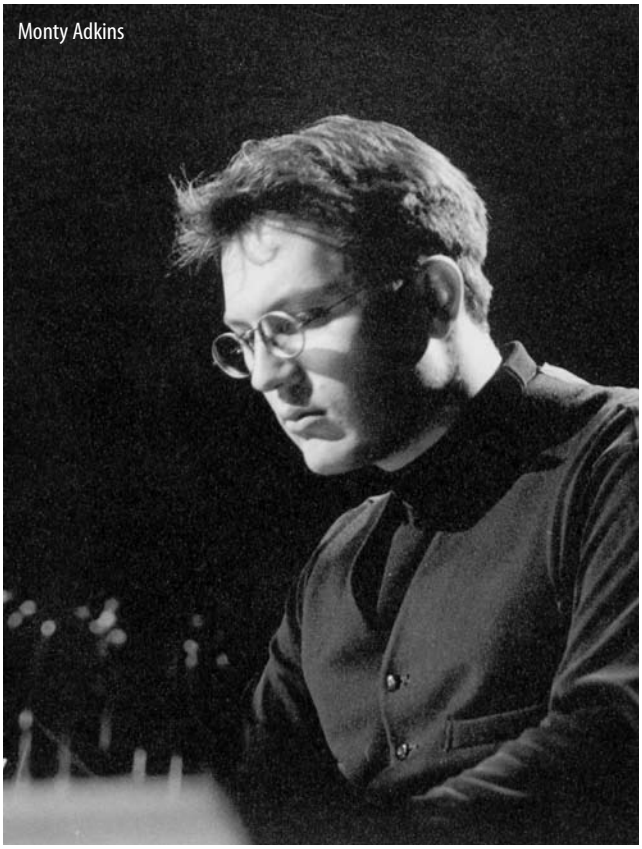
Electricity permits us to go beyond the limitations of mechanical instruments. With computer synthesis, one can approach any physical structure that one can think of, a very different situation from that of the instrumentalists, where the characteristics of the sounds are determined by the idiosyncrasies of mechanical sound production. The computer can be programmed at will. The physics no longer constrains sound production. Auditory perception becomes the determining factor for the ways in which we should organize the sound, insofar as music is meant to be heard (as Schaeffer liked to say). Auditory illusions can be demonstrated by constraining the physical parameters of sound so as to exploit the qualities of perception to deceive it about physics. As Purkinje spoke about the visual domain, "illusions, errors of the sense, as truths of perception". This change of point of view where perception becomes the arbiter, Carolin Tora-Makenlott compares to the Copernican revolution.

Composers of electro-acoustic music can work to hide the possibility of assigning a heard sound to any distinct source – Schaeffer advocated "écoute réduite" to avoid reducing the perception of the sound to a simple label and to encourage the listener to appreciate the sound in all the details of its morphology. They can, on the contrary, capitalize on the

"poetry of reality", an expression used by Dziga Vertov and illustrated by Katherine Norman in her music. In my own work *Sud*, I tried to marry musique concrète using clearly identifiable sound sources – the sea, birds, insects, instrumental sounds – with more ductile synthetic sounds that would follow an arbitrary recognizable pitch scale. Processing these sound would gradually merge these two distinct worlds, using in particular cross-synthesis, whereby two sounds are analyzed to produce a descendant sound that retains certain features of either of the parent sounds (similarly to sexual procreation) – a process originated by Cézanne, who wanted to unite "curves of women and shoulders of hills". The "scenario" of the piece is mostly the gradual merging of these distinct worlds of sounds.

Gerald Bennett discussed metaphors. I would like to add that I myself often use metaphoric scenarios in my electro-acoustic works, and also in my "mixed" works, which associate live voice or musical instruments with recorded sounds. For instance, in *Mutations*, one gradually moves from a pitch scale with distinct steps to endless ascents along a pitch continuum: the gradual passage is suggested by going through a scale of harmonics (frequency f, 2f, 3f, 4f, etc) (the intervals between successive harmonics diminish as the range of the harmonics increases) and also by intended pitch excursions deviating from the steps of the scale.

Jean-Claude Risset


Monty Adkins

Monty Adkins

a composer, performer, and lecturer on experimental electronic music and audio art. He has created installations, concert and audio-visual works, and a number of collaborations with contemporary dance. His works have been commissioned by Ina-GRM, IRCAM, BBC Radio 3, Huddersfield Contemporary Music Festival (HCMF), SpACE-Net and Sonic Arts Network (SAN), among others.

For his works he has been awarded over 20 international prizes including the Stockholm Electronic Arts Award (Sweden), Grand Prize at Musica Nova (Prague, Czech Republic), and five prizes at the Bourges International Electroacoustic Music Competition (France).

Having read music at Pembroke College (Cambridge, England, UK) Adkins then studied electronic music with Jonty Harrison at the University of Birmingham, where he performed across Europe with the Birmingham ElectroAcoustic Sound Theatre (BEAST), and with Simon Waters at the University of East Anglia (Norwich, England, UK).

Metaphor, Abstraction and Temporality in Electro-acoustic Music

1. Introduction

This invited paper was written in response to Gerald Bennett's 'Listening to Electro-acoustic Music' presented at ArtMusFair 2010, Warsaw, Poland and was first given as part of a panel responding to Bennett's paper exploring Electronic Music and the Challenges of the 21st Century. Other contributors to the panel were Katharine Norman and Jean-Claude Risset. Gerald Bennett's presentation dealt with issues of metaphor, abstraction and temporality in electroacoustic music. I will consider each of these in turn.

2. Metaphor

In its inclusivity of sound sources electro-acoustic music encourages listening strategies that extend beyond those traditionally associated with western classical music. In instrumental music the way we make sense of what we are hearing is to engage in listening metaphorically. Throughout the history of music we have become encultured to interpret various musical configurations, what Steven Jan [1] refers to as memes, as metaphors for emotions or states of being. One such example is the descending semitone figure found in Baroque music and beyond, from Bach, Haendel, and Purcell through to Mahler and Richard Strauss, and universally used to indicate grief and lament. A secondary, more localized example would be the descending third in the clarinet in Beethoven's *Symphony No. 6 'The Pastoral'* (1808) symbolizing the song of the cuckoo. In contrast to instrumental music, when listening to electro-acoustic music we must acknowledge that the modes of perception are different from those of instrumental music. In electro-acoustic music, because of its extended sound palette and removal of visual cues, we encounter a metaphoric/metonymic axis of perception – a model first proposed by Roman Jakobson in 1956 [2].

> Metaphor belongs [...] to the selection axis of language, allowing [for] the possibility of *substitution.* Metonymy, however, belongs to the combination axis of language, allowing for the perception of *contexture*. [3]

Michael Bridger has applied the metaphor/metonym axis proposed by Jakobson to electroacoustic music. Bridger writes that,

> It is arguable that much electroacoustic music operates in a largely metonymic mode, contrasted with other music's predominantly metaphoric operation [...] perhaps it could be argued that in conventional music an essentially metaphorical process is conducted by an overtly metonymic (syntactical) apparatus; and that in electro-acoustic music these emphases are reversed [...] electro-acoustic music, then seems to be a medium that commonly presents expressive potential in a metonymic rather than a metaphorical mode [...] certainly, in its use of concrete sounds, or non-musical human voice sounds, the inevitable Gestalt response is essentially metonymic. [4]

The issue of metonymy in electro-acoustic music is significant as it encourages significant intrinsic-extrinsic listening strategies that are alien to the hermetic world of instrumental music. These extrinsic connections are both dynamic and fluid depending on both cultural and generational differences. Both Michael Bridger and Denis Smalley have further identified the tendency of listeners to electronic sound to search for an implied physical source that produced the sound and therefore derive mental imagery that is directly associative rather than metaphorical as in traditional instrumental musical expressivity. In Smalley's terminology, these sounds are remote surrogates, where vestiges of gesture and spectro-morphological attributes may stimulate extrinsic connections. In Gibsonian terms we find the perceptual system of the listener hunting within its known cultural and physical environment to assign meaning to the sounds presented within a composition. Smalley writes,

> The wide-open sonic world of electroacoustic music encourages imaginative and imagined extrinsic connections because of the variety and ambiguity of its materials, because of its reliance on the motion of colourful spectral energies, its emphasis on the acousmatic, and not least through its exploration of spatial perspective. There is quite a difference in identification level between a statement which says of a texture, 'It is stones falling', a second which says, 'It sounds like stones falling', and a third which says, 'It sounds as if it's behaving like falling stones'. All three statements are extrinsic connections but in increasing stages of uncertainty and remoteness from reality. [5]

Depending on the intent of the composer these extrinsic connections may be actively sought, enriching the layering of meaning to be found in a work. However, Bridger implies that this initial metonymic mode of perception implies a certain poverty in electroacoustic music. Bridger writes that there,

> seems to be some justification for rewarding the imaginative leaps of metaphor as a higher order mental activity than the more restrictive logic of metonymy which is clearly close to primitive levels of perception vital to survival, but because of that may be less likely to nourish artistic sensibilities which are associated rather with reflection and enrichment. [6]

Bridger's argument is more complex than he posits as the dichotomy between metaphoric and metonymic modes of listening are not as clear-cut as is indicated. In a work such as Francis Dhomont's *Espace/Escape* (1989) we listen in a de-synchronized dual mode of perception. Initially we listen in a metonymic mode attending to the recognizable concrete sounds and their extrinsic implications. As the work progresses we engage a secondary metaphoric mode of perception in which we reinterpret sounds as metaphors signifying notions of space and mobility. It is important to acknowledge this dual mode of perception as it differs greatly from our perception of traditional instrumental music.

3. Abstraction

Throughout the history of the arts and music we encounter different movements that tend towards or away from abstraction. We find abstraction advocated by Clement Greenberg in the 1950s revering the work of Rothko, Pollock and the abstract expressionists. A similar concern for abstraction and sensation is to be found in Christoph Cox's writings on the neo-modernist microsound artists such as Oval, Carsten Nicolai, Richard Chartier and Taylor Deupree. Cox writes that,

> the neo-modernist sound artists undertake an investigation, at once spiritual and scientific, into the basic forms of aesthetic matter and the fundamental conditions of perception… to the postmodernist, the new sound art might seem to retreat from social and political concerns. But neo-modernism has a politics of its own – a distinctly avant gardist one that recalls both Greenberg and Theodor Adorno and implicitly criticizes post-modernism for its symbiotic relationship with the culture industry. In eschewing mass-media content, the genre proposes a more radical exploration of the formal conditions of the medium itself. Against the anesthetic assault of daily life, it reclaims a basic function of art: the affirmation and extension of pure sensation. [7]

My own work deals with predominantly abstract forms and abstract sound and I'll use this as a short case study to illustrate my thinking. *entangled symmetries* (2010) is concerned with an essentially abstract musical syntax and abstract structure. Musically it is indebted both to acousmatic techniques and glitch aesthetics. Perhaps more importantly is the dematerialization of the acoustic source: the instant recognition of a physical stimulus required to create a sound (a piano) but one that is physically absent. The impetus for creating such a listening context is to place the listener at the centre of the work. When played through headphones (the ideal for binaurally encoded sound) the listener is literally in the centre of the sound. This desire for abstraction and dematerialisation is echoed in the writings of Susan Sontag in *The Aesthetics of Silence*. Sontag writes that,

> In the modern era, one of the most active metaphors for the spiritual project is 'art'… The 'spirit' seeking embodiment in art clashes with the 'material' character of art itself. Art is unmasked as gratuitous, and the very concreteness of the artist's tools appears as a trap… the artist's activity is cursed with mediacy. Art becomes the enemy of the artist, for it denies him the realization – the transcendence – he desires. [8]

What I am aiming for in *entangled symmetries* is not necessarily transcendence but what Deleuze would term 'immanence'. Often regarded as the opposite of transcendence (a divine or empirical beyond), Deleuze employs the term plane of immanence 'as a pure immanence, an unqualified immersion or embeddedness, an immanence which denies transcendence as a *real distinction*' [9]. On the plane of immanence there are only complex networks of forces, particles, connections, relations, affects and becomings:

> There are only relations of movement and rest, speed and slowness between unformed elements, or at least between elements that are relatively unformed, molecules, and particles of all kinds. [...] We call this plane, which knows only longitudes and latitudes, speeds and haecceities, the plane of consistency or composition (as opposed to a plan(e) of organization or development). [10]

For me, in order to convey this sense of unqualified immersion the musical argument has to be abstract and free of metonymic modes of perception as any such suggestion would imply a re-engagement with physicality and an awareness of spaces in which the listener

is situated rather than one which the listener is inhabiting and embedded within.

4. Temporality

There is a striking similarity between Deleuze and Guattari's 'plane of immanence', pure sensation and the directionlessness of what Don Ihde terms 'surroundability'. Gordon Fitzell writes that,

> The concept refers to an enveloping sensation or "auditory aura" that emanates an "ambiguous richness of sound". [...] From the perspective of temporal experience, surroundability constitutes the opposite of directionality. Whereas directionality refers to a perception of predictable change along a particular dimension, surroundability refers to an experience devoid of predictable change. Within such a perception, the onset of each event is "enriched by the depth of those [perceived events] which have just preceded it *'equally'* present". [11]

Any discussion of sonic material that is directionless, devoid of predictable change, that creates an auditory aura perceived as continuing 'present' is inherently concerned also with issues of temporality. Prior to emergence of the Darmstadt avant-garde musical time was considered to be primarily linear, centred on the teleology of tonal structures. Many electro-acoustic works still follow this notion of musical linearity, defined by Bob Snyder as 'a metaphor of physical causation, [...] an attempt to make musical events seem to cause each other'. [12] Acousmatic works by Gilles Gobeil, Jonty Harrison, Natasha Barrett and Diana Salazar-Simpson all work within this model.

In the post-war era there have been numerous composers who have considered alternative modes of temporality in their work. Pierre Boulez wrote that,

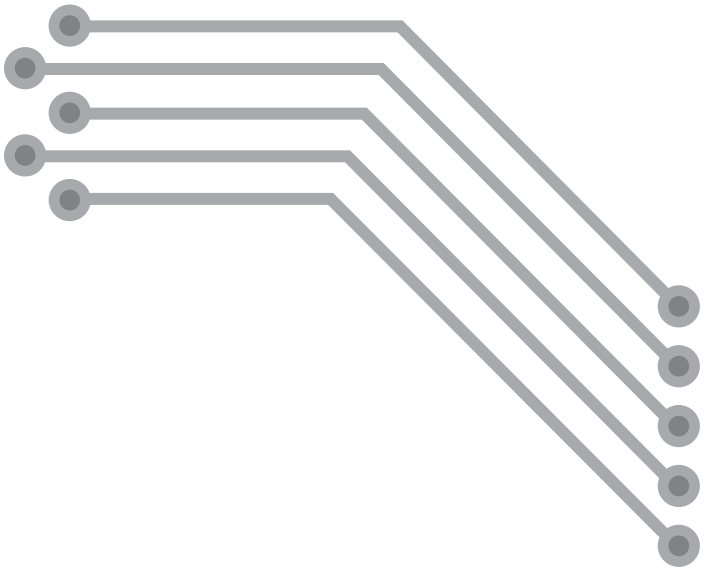
> A composition is no longer a consciously directed construction moving from a "beginning" to an "end" and passing from one to another. Frontiers have been deliberately "anesthetized". Listening time is no longer directional but time-bubbles, as it were. [13]

Stockhausen formulized this thinking further in his concept of Momentform [14] whilst Morton Feldman aimed at a disorientation of memory through constant changes in short fragments of material.

In order to understand how long-form compositions such as *entangled symmetries*, Richard Chartier and Taylor Deupree's *Specification Fifteen* (2006), the *monochromes* series (2009) by t'um and the works of Eliane Radigue extend the traditional linear concepts of temporality it is useful to consider in relation to Edmund Husserl's exploration of experiential time [15]. In his theorizing on the structure of consciousness, Husserl developed the notion of a *subjective time-consciousness* that is distinct from objective time. From this, Husserl went on to propose the idea of 'inner time-consciousness', the main focus of this being an individual's 'temporal span'. Husserl maintained that the temporal span comprises three main parts that are inseparable: primal impression, retention, and protention. Fitzell writes that,

> Devoid of substantial directionality, a nonlinear temporal experience permits no protentions of closure, only nondirectional protentions of continuance. Unlike linear music, which features readily apparent and often predictable temporal trajectories, nonlinear music curtails a listener's ability to anticipate conclusion. The effect is one of enduring present awareness. [16]

The drone compositions of Eliane Radigue are characterised by non-directional protentions of continuance. Radigue studied with Pierre Schaeffer in the 1950s, worked periodically at the Studio d'Essai, and was Pierre Henry's assistant in the early 1960s. However, following her experience working at NYU on a Buchla synthesiser in 1970 Radigue developed a highly individual compositional voice which had much more to do with the minimal aesthetics present in music and art in New York at the time than those espoused by Schaeffer and Henry. In the years covering the composition of the *Adnos* trilogy (1974, 1979 and 1980) Radigue because deeply



influenced by Buddhism, an influence that was to culminate in the three-hour *Trilogie de la Mort* (1988-93).

What Radigue's works present is an extreme case of perceived parametric consistency, continuity that Thomas Clifton refers to as static succession, as 'sameness succeeding itself' [17]. Although Radigue's works do change over extended periods of time, the perceived moment-to-moment progression is one of implied motionlessness. Applying Husserl's ideas to Radigue's almost imperceptibly changing sustained tones the listener would identify a continuity of 'phases' between the beginning and end points as 'expired duration'. At any one moment in the composition prior to the end-point, the listener is unaware of the remaining duration though aware of duration resulting in the listener sensing no protentions of closure.

5. Conclusion

In order to accommodate the wealth of electronic music now being created we must be open and inclusive in our thought and terminology. For me, whilst the ongoing discussion of the metonymy-metaphor and abstraction-reality perceptual axis are important it is the different approaches to temporality that most characterize the plurality of contemporary electronic music.

6. Notes

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Session 2

Technological Innovation

- Short historical overview
- Current research fronts and development trends
- Influences
- Is technology today less linked with musical innovation than commercial mass-market needs?
- What role does musical innovation play for technical innovation?
- What role does technological innovation play for musical innovation?

Chair: Xavier Serra
Panel: Yann Orlarey, Daniel Teruggi, Andrew Gerzso

from left: Daniel Teruggi, Yann Orlarey, Andrew Gerzso, Xavier Serra


Xavier Serra

Xavier Serra

Associate Professor at the Department of Information and Communication Technologies and Director of the Music Technology Group at the Universitat Pompeu Fabra in Barcelona. After a multidisciplinary academic education he obtained a PhD in Computer Music from Stanford University in 1989 with a dissertation on the spectral processing of musical sounds that is considered a key reference in the field. His research interests cover the understanding, modelling and generation of musical signals by computational means, with a balance between basic and applied research and approaches from both scientific/technological and humanistic/artistic disciplines.

Dr. Serra is very active in promoting initiatives in the field of Sound and Music Computing at the local and international levels, being editor and reviewer of a number of journals, conferences and research programs of the European Commission, and also giving lectures on current and future challenges in the field. He is the principal investigator of more than 15 major research projects funded by public and private institutions, the author of 31 patents and of more than 75 research publications.

Research approaches and challenges in Sound and Music Computing

Keynote speech

Sound and Music Computing is a term used to identify the academic field dedicated the study of sound and music by computational approaches. Other terms, such as Music Technology or Computer Music, are also used to describe this field of study. In this article we discuss some core ideas that were presented in the Sound and Music Computing Roadmap, a document that was elaborated with the participation of a number of key researchers in the field, and we emphasize some of the concepts that we believe are more pertinent here. After revising the definition of the field, we summarize the current active research topics, then we revise the research approaches that are being used to tackle them and we finish by identifying some research challenges.

Definition of the field

According to the Sound and Music Computing Roadmap [1]: "Sound and Music Computing (SMC) research approaches the whole sound and music communication chain from a multidisciplinary point of view. By combining scientific, technological and artistic methodologies it aims at understanding, modelling and generating sound and music through computational approaches." The disciplines involved in SMC cover both human and natural sciences. Its core academic subjects relate to music (composition, performance, musicology), science and technology (physics, mathematics, engineering) and psychology (including psycho-acoustics, experimental psychology and neurosciences). SMC research tends to be quite applied and thus it is relevant to identify the current areas of application, which include: musical instruments, music production, music information retrieval, music libraries, interactive multimedia systems, and auditory interfaces.

Current research topics

The SMC field is quite dynamic and the relevant topics of research have been evolving and changing through the years. The current active topics could be grouped into the following categories.

Processing of sound and music signals

Here we include all the research topics related to sound synthesis and processing. This has been the most active research area in SMC for more than 40 years. Quite a number of the research results of

the 1960s and 70s are now standard components of many audio and music devices, and new technologies are continuously being developed and integrated into new products. Given that these technologies have already become so common and that most recent developments represent only incremental improvements, research in this area has lost some of its prominence in comparison to others in SMC.

Understanding and modelling sound and music

The aims of this research are to develop veridical and effective computational models of the whole music understanding chain, from sound and structure perception to the kinds of high-level concepts that humans associate with music – in short, models that relate the physical substrate of music (the sound) to mental concepts invoked by music in people (the 'sense'). For this pursuit research is carried by combining diverse fields, including the ones that relate to the sound itself (physics, acoustics), others related to human perception and cognition (psycho-acoustics, empirical psychology, cognitive science), others related to human and social sciences (musicology, sociology) and yet others related to computational modelling (signal processing, machine learning).

Interfaces for sound and music

This topic deals with the design and study of controllers for music performance and sound interaction. The concept of 'musical instrument' has changed with the use of the digital technologies. In the new digital instruments the gesture controller (or input device) that takes the control information from the performer(s) is always separate from the sound generator and its study requires specific approaches.

Assisted sound and music creation

One of the first uses of the computer in music was as a tool to help in the compositional process. This has remained a relevant topic of research and many computational approaches have been explored to assist composition. The term Algorithmic Composition has been used to describe the use of formal approaches such as: mathematical models, knowledge-based systems, grammars, evolutionary methods, systems that learn, or hybrid systems.

Research approaches

The search for knowledge is the basic aim of all research activities. In sound and music computing this search for knowledge is accomplished using methodologies coming from scientific, technological, and artistic fields. These cover approaches aiming at different goals but any research project must fulfil the following requirements [2]:

1. It must define a series of research questions or problems that will be addressed in the course of the research. It must also define its objectives in terms of seeking to enhance knowledge and understanding relating to the questions or problems to be addressed.
2. It must specify a research context for the questions or problems to be addressed. It must specify why it is important that these particular questions or problems should be addressed, what other research is being or has beenm conducted in this area and what particular contribution this project will make to the advancement of creativity, insights, knowledge and understanding in this area.
3. It must specify the research methods for addressing and answering the research questions or problems. In the course of the research project, it must be shown how to seek to answer the questions, or advance available knowledge and understanding of the problems. It should also explain the rationale for the chosen research methods and why they provide the most appropriate means by which to answer the research questions.

Within these general requirements, the scientific method is well established. With it we develop a hypothesis and test it by controlled experimentation or observation. There is a collection and analysis of data to produce results and the drawing of valid conclusions based on those results. This type of methodology is useful in basic research, which is not that common in SMC topics.

Most of the research in SMC uses engineering methodologies. In engineering research we design and develop a solution to a problem to yield a product, process or environment that serves a real need. In SMC it is typical to develop software or hardware tools for specific applications.

The hardest type of research to be systematised is the one coming from the arts. A work of art is a human creation that contains an idea other than its utilitarian purpose. The research that relates to artistic creation is called practice-based research and is a form of research that aims to advance knowledge partly by means of practice. Practice-based research is research where some of the resulting knowledge is embodied in an artefact, such as a piece of music. Whilst the significance and context of that knowledge is described in words, a full understanding of it can only be obtained with reference to the artefact itself. In SMC all these different methodologies coexist, and most problems and their solutions are highly interdisciplinary. However, any research project has to follow the basic research criteria identified above.

Research challenges

In the SMC Roadmap [1] five research challenges have been identified:

1. *Design better sound objects and environments.* The growing abundance of electronically generated sounds in our environment, coupled with the rapid advances in information and sensor technology, present SMC with unprecedented research challenges, but also opportunities to contribute to improving our audible world.
2. *Understand, model, and improve human interaction with sound and music.* The human relation with sound and music is not just a perceptual and cognitive phenomenon: it is also a personal, bodily, emotional, and social experience. The better understanding of this relation from all these perspectives will bring truly useful and rewarding machine-mediated sonic environments and services.
3. *Train multidisciplinary researchers in a multicultural society.* SMCis a highly multidisciplinary domain that requires special expertise. But the way the established academic disciplines are being taught makes it difficult to acquire the proper knowledge. Thus there is a need for the establishment of appropriate educational programmes for training these specialists.
4. *Improve knowledge transfer.* A large part of SMC research is devotedto applications that can be directly exploited in the arts, in industry and in society at large. Proper knowledge transfer should result in an impact much larger than the current one.
5. *Address social concerns.* The role of the SMC field goes beyond that of a mere provider of technological or commercial solutions. SMC has the potential to contribute to maintaining and furthering the richness of human culture and preventing the global technological trends that make the world uniform. Also, SMC should empower users, putting the relevant choices and decisions back into the hands of the individual.

To tackle the challenges that focus on research issues there is a clear need to open up our current research approaches, bringing in new paradigms and methodologies, and promoting new interdisciplinary methodologies. Next we identify some research problems and approaches to solve them.

The Semantic Gap in SMC – the discrepancy between what can be recognised in music signals by current state-of-the-art methods and what human listeners associate with music – is the main obstacle on the way towards truly intelligent and useful musical companions. Current research efforts aim at the automatic recognition and modelling of higher-level musical patterns (e.g., rhythmic or harmonic structure), but they still essentially adhere to the traditional bottom–up pattern analysis scenario. The bridging of the semantic gap will require a radical re-orientation (1) towards the integration of top-down modelling of (incomplete) musical knowledge and expectations, and (2) towards a widening of the notion of musical understanding. This re-orientation can be achieved by embracing and exploiting other media (including the Web), and modalities (including for example semantic issues related to the illusion of movement and gesture in music). This research will have to be notably multidisciplinary, involving, among others, specialists in musicology, music perception, artificial intelligence, machine learning, and human movement understanding.

Artists have an extremely refined understanding – albeit (perhaps) not in 'scientific' terms – of issues of perception and perceptibility and, more importantly, of the effect of sound, including its emotional and social ramifications. In order to understand the human experience of sound and music in its full breadth, SMC needs to exploit this resource. Artists may bring up new questions and ways of looking at human and social contexts related to sound. Joint art/research projects, even those that, at first sight, focus on 'artistic' and not overtly 'scientific' questions, should be promoted and adequately funded. In fact, the strict distinction between the 'artistic' and the 'scientific' must continually be challenged. The SMC community should also make efforts to strengthen this viewpoint in funding agencies and among decision makers.

The current methodologies for understanding music are typically based on experimental methods that address the cognitive system of a single listener in a laboratory environment. In practice, however, music is most of the time a social activity in which musical engagement is influenced by the behaviour of other participants. Existing empirical and experimental methodologies should be expanded towards understanding aspects of social music cognition. These involve the study of the social context in which musicians and listeners influence each other during musical activities. Also the tools for collaboration, information and communication exchange are now developed in the context of e-science and e-learning and there are no collaborative tools that incorporate all the music specific information, such as audio files, scores, or extracted audio features. Such tools should take into account the profile and experience of users.

Apart from cognitive theories of music such as tonality and rhythm categorisation, the human sciences (e.g. musicology, anthropology and sociology) have had little impact on the development of SMC technologies. And yet there is a large amount of knowledge about the social functioning of music that is currently unexploited. Cross–fertilisation between the human and natural sciences, as it is currently being developed in embodied music cognition, may offer new concepts and perspectives for understanding the social functioning of music. Good examples include concepts such as synchronisation, corporeal attuning in response to music, empathy and the sharing of actions. These concepts may provide a useful framework for the development of artistic applications that take into account social interaction as a basic feature of artistic expression. Current SMC research is also dominated by a narrow focus on traditional Western tonal music. SMC should make a conscious effort to transcend this focus, which tends to exclude SMC researchers from other cultures, making it difficult for them to publish results on their 'native' music. The goal must be to establish a common awareness in the SMC community of the importance of multicultural research.

Conclusions

The field of Sound and Music Computing is becoming a well-established field of research, with well-defined problems to be tackled, a clear context in which to frame these problems and with well-defined methodologies to tackle those problems. The SMC Roadmap was a good document that summarized key issues of relevance to the field, however it was published a few years ago, and since then a number of important developments have happened. Therefore it would be good to update the Roadmap. Here we have tried to summarize some key points of that Roadmap while updating a few concepts.

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from left: Daniel Teruggi, Yann Orlarey, Andrew Gerzso, Xavier Serra