Towards spatial music

An essay written for Earshot- the Journal of the UK&Ireland Soundscape Community   *By Jan Jacob Hofmann, April 2002*

How would it sound like, if there was an electroacoustic sound in the room where you are, being 3.5 meters above your head behind you to the left, sounding like the knocking on a metal beam, a wooden object or the sound of a glass broken. Or, even better, something in-between them, something artificial. Carbon-fiber, liquid ether, a sound of a material not yet invented, maybe objects that seemed vivid. Were we able to imagine how this object would feel like, if we touched it? Could we guess by the sound if it was hard or soft, transparent or solid, smooth or as rough as a rock? Would we be able to sense its temperature or have an impression of colour?
If it was totally dark in the room, would we imagine an object? Would we be able to guess its size? Maybe even its approximate shape? Would we associate a spherical object if the sound was like that? Or, if it had irregular shape, would we hear this? Could we tell if it was hard edged and defined, or blurring into the space? How would a transparent, gas-like material sound like, how a swarm of little grainy objects in space? If we had several of these objects, moving independently through the speakers, how would they relate to each other? Would they modify the space you are in? Would it be possible to imagine the shape of the space created by the voids in-between the sounding objects? Would the space change as the sounding objects change? Would this result in an architecture enriched by the quality of movement and constant change?

In summer 1997, towards the end of my postgraduate study, I was asking myself these questions and began my research not knowing which result it would lead to. By that time I thought some sounds generated with my analogue - modular synthesiser, mixed on my four- track tape and distributed by two speakers and some fancy spatializing- gear, which I hoped to buy for little money would give a good impression of sound- objects in space. Very quickly I realised that even the conventional "Quattro" approach would lead to poor results in terms of localisation of the sound, so would the just upcoming surround technique, the spatializing box I was looking for simply did not exist. I was heading for an unlimited acoustic space surrounding the listeners in every direction to relate them with an unpredictable evolving architecture of sounds. Step by step – I had bought my first computer by that time and taught myself Csound, a very flexible, text driven sound synthesis programme – I approached the Ambisonics technique, which allowed fairly stable images and precise localisation of sound in space for a large number of listeners. Ambisonics also addressed the height of the sound, so 3d - music became feasible. The sound moved completely independently of the speakers – that was the sound -image I was looking for. I now was able to assign a precise position to the sound.

Position

The parameter "position" in music is often negleted, as is the parameter "time" in architecture.

We usually think of music as consisting of several sounds with certain timbre, pitch, amplitude and duration (duration can be seen is a temporal parameter, more precisely as "temporal extension" likewise to "position in time" of a single sound). Giving the sound an additional parameter, the position in space, liberates it from the sound-producing source, be it a musician, an animal, a piece of metal or a loudspeaker. This makes it possible to consider the sound as an independent, autonomous element of its own, just defined in terms of its quality, time and space.

Just like the architect would set a pillar, a slope or a wall in space, it is now possible to generate single sounds, place them in time and assign a x,y and z co-ordinate to it.

As we then have several elements of sound in space it is possible to generate a whole environment of sound with them, like an architect would create a building from the material he works with.

Finally, the listener would be moving through several soundscapes evolving out of each other like a person moving through different spaces or rooms of a building. In this way my approach is an architectural one, as I am an architect working with sounds: by putting some object in space, I try to modify, perhaps define the edges and the character of space. Sounds are treated as freely moving elements in space, interacting with each other, being involved in a process of development as they generate gestalt.

Movement

Movement is a carrier of very complex information. A whole algorithm carries information about the hidden interior to the realm of perception. Watching movement we can see the interaction of the moving body's own inherent way of behaviour with the mass of its own body and the gravity according to physical laws and in relation to the exterior. A tree swaying in the wind, the leaves swinging at the branches, the complex movements of leaves falling off into the autumn wind. A cat jumping up on a table. A flock of birds. We can guess not only the mass of a body changing direction but also its energy or power it has. Even more subtle information is as sent out for example by a moving human body: Is he or she vivid? violent? sort of disabled, happy? self secure? The movement contains it all, I think.

I usually like to assign a characteristic way of movement to each special kind of sound I am working with. Together with the timbre and the progression in time a whole character of sound is created. The sound may move constantly from one position to another, perform a curve, slowly come to a halt or stop abruptly, accelerate, vibrate or bounce unpredictable and fast, driven by a particular amount of randomness. It may also vanish here and show up there, having done this without particular movement in-between. Or originate somewhere far in the distant, pass above the listener and vanish in the depth again at the opposite.

The electronic sound

As the electronically generated sounds are controllable at pleasure in terms of intensity, colour, attack and decay, they can be equipped with different qualities, which are rather related to materiality: transparent/ solid, sharp-edged/ blurred, smooth/ rough, heavy/ light, hard/soft, spherical/ angular, warm/cold, etc... This way the sound gets a second quality of architecture, despite its position in space: materiality, bodilyness, and quality of surface. The sound may for example have a very sharp attack. No-one would assume that this sound is coming from a soft object, for soft objects are usually not able to produce such sound. Also, sounds with extremely high- frequency- content may be perceived as colder than others. The progression of the frequency-spectra in time in correlation with the overall amplitude at a particular moment may be a characteristic trace to guess the material content or, more precisely, parameters of the material itself such as flexibility, elasticity and density.

The use of randomness in amplitude results in an impression of rough surface, whereas I often regard sine-waves or some frequency modulated sine-waves as smooth. Randomness used in terms of frequency leads to noisier/hissier sounds, which seem grey, light-grey or dark-grey to me, depending on the frequency band. This even has an analogy in the realm of light, where the presence of all wavelengths at once lets the colour disappear. Finally, by granulating a sound into a thousand particles and recollecting them, so that they overlap each other randomly, an impression of transparency may be achieved. The use of reverb applies a similar process to the sound. By being able to design the quality of the material at pleasure, it is possible then to let the material be a carrier of information or meaning and maybe evoke some kind of emotion related to that material within the listener.

Environment

While working on this project, I got conscious of the importance of creating not just a sound in space, but also place it in a virtual environment. Distance and depth may only be perceived that way. It is easy to understand if we hear a sound moving off into the distance: not just the amplitude will decrease, there may also be an increase in the amount of reverberated sound in relation to the direct, unreverberated sound. The moment I do create this reverberation with some programmed reverb- unit, I do assume an environment, as the reverberation consists of a multitude of refracted sound in some environment. This environment may also carry information about itself as well as about the position of the sound-source within it. Peter Lennox * talked of a figure and ground relationship of sound and environment. The human ear seems to be extremely sensitive to microscopic small events within the time domain and our brain is often able to distinguish between the original sounds and its reflections in an environment. He also elaborated how the brain might be able to make this distinction and how information about the position of the sound might be extracted from the environment. Due to the flexibility of Csound it was possible to create a series of reflections in a virtual environment and place them appropriately in the time domain as well as in space. I made this whole pattern of reflection change due to the position of the sound, so that it

may deliver information about the changing position of the sound, leading to a more intelligible, more transparent image of enhanced depth.

*[Lennox et al.: 3D audio as an information-environment:
Manipulating perceptual significance for differenciation and pre-selection. Paper presented at the ICAD (Proceedings of the 2001 International Conference on Auditory Display, Espoo, Finland, July 29-August 1, 2001)]

Composition

Back to the music. Evolution, interaction and non-linear processes are often major features in my pieces as well as method of composition. I like the objects to interact with each other, submitting the whole piece to a continuous change. This may be done by exchanging energy between the objects. Or two objects may imitate, morph or exchange their behaviour. Internal forces and necessities drive the progression of the piece. That is why I also avoid rhythmic grids or harmonic scales of pitch. No melody, seldom harmony, a rhythm only by chance. Other aspects which are important to me are related to density - densification and dissolvance, concentration and expansion in terms of time and space, but also boundaries and transitions, being discrete or continuous. This concerns the micro- scale, for example the distribution of grains within a sound as well as the macro scale up to the whole composition.

Relationship between sound and perceiver

So as my task is to create sounds all around the listener, there is no direction privileged – I do want to avoid the frontal approach of stage music, which I believe would be totally inappropriate here. So there is no preferred direction to which the listeners are requested to face towards. As stated above, I am heading for an unlimited, direction-less acoustic space surrounding the listeners.
In the context of this "sonic architecture project" I decided also to avoid any visual component, such as a combination with film, lights, or visualisation of the musical material by real- time computation. For two reasons I do want to present within a totally darkened room. First, audio image localisation is much more precise if not related or even misled to more or less corresponding visual events. Secondly, I do avoid visuals, even light, to allow the listener to concentrate on inner images, which the music might evoke. Just after reception of the sonic environment, the corresponding architecture can possibly be created within the listener's head.

Relationship between spatial design and temporal design

Spatial design is all about relation of the elements to each other, their position and their size. This folds into the dimension of time in a piece of music: Now the elements relate

to each other lined up at a time-axis. Still objects are designed in relation to each other. As the relation was a spatial once in architecture, the relation becomes temporal in music or temporal AND spatial in spatial music.

The means of design remain the same: In architecture as in music for example tension evolves by various ways of contrasting material (=timbre). Or the parameters describing the material such as "size" (similar to "amplitude"/"duration" in terms of music) may be put into contrast. Or, finally, the distribution of the material in space or time may be contrasting in parameters such as "density" or "amount of order and disorder". This is achievable both in architecture and music.

So in my opinion, there is not such a big difference in design of music and architecture: the difference is more in the perception of the two arts.

Let's focus on the element of change and movement: Still music is considered as an art that changes in time whereas architecture is regarded as being static usually. But is the relation of architecture and music really that way? Architecture as "frozen music?"

From the moment being performed, the sounds are aswell fixed, recorded in time, even in the most free and improvised music: As soon as the time pointer of presence has passed a particular part of a musical piece, it is fixed in the fact of what has happened. Still we perceive a piece of music as moving forward, evolving, but maybe this is just an illusion of our perception similar to the way we perceive motion as we watch a film, consisting of actually totally fixed frames. Maybe the only moving thing in time is ourselves as we are the time- pointers perceiving the piece? What concerns tape music, the iron-particles that carry the information are pretty well fixed at their precise position in time. Even in wild, free improvised live music, one sound comes after another in time, no way to alter it.

But our perception is different: A note rises up in its beginning and releases sooner or later more or less abruptly. We regard this element as changing in amplitude, maybe in timbre and in pitch also. That is where our impression of music as constant change comes from. Temporal design, which is just another word for composing music, is about development. What about the architecture?

In architecture usually the only moving object is the visitor of the building. All objects of the building do exist at the same time. They do not change (at least not in a perceivable way). The visitor of the building, the perceiver, again is the "time- pointer" moving through the building, but putting the perceived objects in a far more fluid temporal relation to each other this time: There is no determined way of perceiving one thing before the other. Even simultaneous perception of distant objects, seperated by a void, is the usual way we perceive things in any building. Let's look at Corbusier's work to get a sophisticated example: Corbusier was a master of counterpointing objects, material and elements with void. Or- to put it the other way round: He defined the empty space by accompanying it with elements of concrete, iron and glass. But actually he built voids, one could say, and took care, that they are perceivable. To let the relation of void and material be perceivable for a visitor, he often liked to insert a ramp to connect two levels. That way a visitor could slowly move in three dimensions through the void of his building, watching the elements around him move: pillars coming closer and vanishing again behind, walls that change direction, a ceiling that gradually becomes the floor of the next level as he is moving upwards trough the void. This concerns his work of the early twenties in particular. Later, when he collaborated with Iannis Xenakis, curved

objects and ruled surfaces were introduced as an element of change in architecture: the angle of a surface changes constantly from one end of the surface to the other.

I guess we should make a difference between movement and change here. Change may be assigned to the quality of an object whereas movement regards the position relative to the perceiver. Change regards time and is related to music. Movement regards space and comes from the realm of architecture. As the element of change was introduced into architecture by the use of curved and ruled surfaces, I want to employ the element of movement in music by my work.

Epilogue

Finally I would like to put my work into some context. The music of Iannis Xenakis and John Chowning have been extremely important for me – and a source of inspiration for this project! Iannis Xenakis, a mathematician, engineer, architect and composer related his music very closely to architecture and his architecture very close to music. Mathematics was the base for both his music and architecture. He can be considered as the pre-cursor of granular-synthesis technique. He built temporary spaces, the polytopes (multi-spaces), which were designed with the laws of mathematics/ stochastics and of course his intuition. In these spaces he played his music, designed by similar rules. He also liked to extend this to the realm of light with hundreds of flashes, beams and bulbs, all computer-driven. He performed showers of light, spirals, undulating or pulsating sequences. He is able to tell stories in music as his composition seems to follow some internal dramaturgy. Not much later, John Chowning, the inventor of the FM-Synthesis technique evoked the idea of moving sound sources in me. He used four speakers set up in a square and the panning technique to let the sounds move between them. He also dealt with the perceived distance of a sound: His laws of attenuation and ratio of sound and reverberation are still commonplace amongst composers of spatial music. They are employed also in my project. Listening to his works, especially "Turenas", I instantly got the impression, that a sound may have materiality and shape. He used a predecessor of Csound to generate his amazing pieces by computer.

A different approach, "The Room Containing Sounding Objects", is used by composers like David Tudor at his piece "Rainforest" or Michelangelo Lupone and his "Planophones". Tudor spread out different sounding objects in the room, where the listener was able to walk around in between them, creating his own piece of music driven by the attraction of the sound he was lead by. Lupones planophones are mounted above the heads of the listeners: They consist of panels of wood and metal, leather or plastic, which are driven to sound by several piezzo- crystal- drivers mounted on them. The listener may also move freely beneath them, listening to the differences in timbre according to the material, which is used to transduce the . Acoustic spaces of different character are created beneath the planophones.

There is also the approach to let the room itself sound: "The Room as a musical Instrument". This usually deals with the natural resonances, whichare hidden in every room. By speaking a sentence into a room, recording it and feeding it back into the room, Alvin Lucier gained the inherent resonances of the room he was sitting in. Alvin Lucier re-recorded this output and fed it back over and over again, creating a huge delay and feedback line, which the room was part of. He continued to do this, until all

modulation of his words was smoothed out and taken over by the resonance and the reverberation of the room.

So all these composers are in some relation with the space their pieces are performed in: Whereas Lucier uses the room as an instrument and subject of investigation at the same time, Lupone and Tudor insert sound sculptures into the room like sculpturers. The sounding element here is at the centre, the listener may put himself into relation by approaching from different directions. There is a huge amount of choice left to the listeners, which kind of influences what they will listen to. Still the sounding object is infront of them.

Chowning's, Xenakis' and my approach is the other way round: The listeners are preferably at the center, everything is happening all around them. In the spatial sense, this is exactly how architecture usually is perceived: man surrounded by objects.

Biographical Notes:
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Born 17.6.1966 at Duesseldorf, Germany. Worked with electronic sound since 1986.
Diploma in architecture at the Fachhochschule (University of applied sciences) Frankfurt /M, in Feb. 1995. Entered the class of Peter Cook and Enric Miralles at the Staedelschule art school Frankfurt/M, a postgraduate class of conceptual design and architecture. Diploma at the Staedelschule in Nov. 1997. Course for sound- spatialisation and psycho- acoustics at the CRM /Rome with M. Lupone/ L. Bianchini in Nov. 1998. Works as a composer of electronic sounds, photographer and architect in Frankfurt.

Recomended Listening:
John Chowning: "Turenas – Stria – Phoné" Wergo CD 2012-50
Alvin Lucier " I am sitting in a room" LCD 1013
Michelangelo Lupone: "In un grattacielo" EDIPAN 3058
Bernard Parmegiani: "La Création du Monde" INA 1002
Bernard Parmegiani: "de natura sonorum" INA 3001
Barry Truax: "Digital Soundscapes" CSR-CD 8701
David Tudor: "Rainforest I" Mode CD 64
Iannis Xenakis: "Electronic Music" EMF CD 003

Links:
All about Csound: http://www.csounds.com/
Ambisonics: http://www.york.ac.uk/inst/mustech/3d_audio/ambison.htm
About Planofones, Michelangelo Lupone and the CRM: http://www.crm-music.org/
Peter Lennox's Paper presented at ICAD 2001" 3D Audio As An Information- Environment"
http://www.acoustics.hut.fi/icad2001/proceedings/papers/lennox.pdf
Peter Lennox's "Online Book" about spatial hearing, Ambisonics and perception:
http://www.thisplay.com

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