Improvisation as Epistemic Practice

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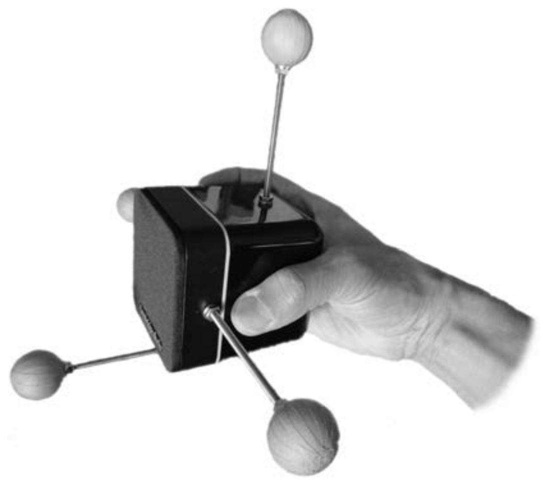

Image 1: Hand-held loudspeaker with motion tracking markers attached, as used in the exhibition version of *Random Access Lattice.*

Random Access Lattice is a sonic sculpture to be performed by its audience. I call it a sculpture as it is a virtual object that extends into real space and because it appears sonically by means of the movements performed by the audience. Such performance is typical for the experience of any kind of sculpture, as the spectators usually feel the urge (and pleasure) to move around a sculptural work in order to grasp its spatial features. In the case of *Random Access Lattice*, the audience instead moves a kind of probe or prothesis (c.f. image 1) with a palpating kind of motion through space, making the sculpture's invisible features audible.

This text is composed of a sequence of loosely connected improvisations on several of the themes that played a role in the making of the sculpture. Each section takes a certain angle to reflect about the work, complementing the others. I will first try to describe the experience of playing the sculpture. This will form a basis for discussing the concepts the work is rooted in, to be followed by a presentation of the modeling approach used for its composition. I will conclude with reflections about the improvisational aspects of composing and playing the sculpture and propose a way of (re)thinking improvisation as an epistemic practice.

Performing the Sculpture

Imagine you hold a small loudspeaker in your hand. It is formed such that you can grab it comfortably (c.f. image 1). Since it radiates sound, it is perceived as a directed device, a little bit like a flash light. By turning it with your hand, you can project the sound in different directions into the room. But what sound, you will ask. This depends on where the speaker is located in space and how it is moved by your hand. If you hold it still, it will remain silent. If you move it, it will play the sound that is – so to speak – stored at the speaker's current location in the space. The faster you move, the louder the sound will be. At the same place you will always find the same sound. These are the general constraints for performing the sculpture.

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[1] *Random Access Lattice* has been produced during of my guest professorship at (and with the support of) the Department of Speech, Music and Hearing (TMH) of the Royal Institute of Technology (KTH) in Stockholm and in the context of the project *Dancing the Voice* supported by a scholarship from the Wenner-Gren Foundations. The piece has been presented at the Exhibition on Sonic Interaction Design at the Norwegian Museum of Science, Technology and Medicine from May 29 to August 21 2011 (c.f. http://sid.bek.no, accessed Jan 13 2011). Several topics investigated through the creation of this piece form part of to the artistic research project *The Choreography of Sound* (c.f. http://cos.kug.ac.at, accessed Jan 13 2011), funded by the Austrian Science Fund (FWF): PEEK AR41.

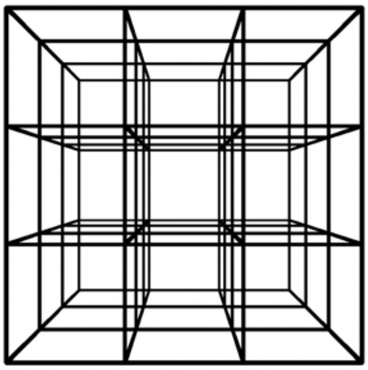

Image 2: An example of a lattice structure with a subdivision of 4. *Random Access Lattice* uses a subdivision of 25.

But what sound will I hear, you will ask again. In this version of the piece it is voices of men and women reciting poems in 44 different languages from all over the globe. They have been recorded by volunteers and made available to the public domain at the LibriVox[2] website. The recordings are arranged in a three-dimensional grid – a lattice (c.f. image 2) – forming a cube of 2 by 2 by 2 meters. The grid is very densely spaced, as opposed to the one in the image. There is a different voice at every 8 cm along each of the three axes in the cube. If you move the speaker in between the grid lines, you will hear a mix of the adjacent voices. Only if you move it exactly on one line, you will hear the individual voice stored there.

Along the two meters of the cube's lateral length seven seconds of sound are stored. When playing, you will feel that this is an appropriate choice with respect to the movements you can perform easily with the speaker. You will also notice that you have to move the speaker very carefully in order to obtain an interesting result. An arbitrary gesture will produce an arbitrary sound. The arbitrariness ceases if you manage to repeat the gesture exactly, as this will result into exactly the same sequence of sounds. You will experience the speaker as a very faithful and reliable sensor, exactly following your movements. This often produces a tactile sensation – as if you were touching the sound, while you explore its minute details by minuscule movements.

If you have ever manipulated an analogue tape, moving it forth and back over the tape head in order to locate the exact position where to apply a cut, playing the sculpture will feel familiar to you. This will also be the case if you have used the scrubbing tool of a digital audio workstation which simulates this process. Furthermore, if you are a turntablist familiar with scratching and cutting vinyl records, you will recognize the effect. At the same time you will notice that there are two important differences with respect to scratching. Firstly, the pitch of the sounds you are (re)producing does not change with the speed of your movement and secondly, you do not hear the same sound played backwards if you reverse the direction of your movement, but you hear another sound. These are the particular constraints of playing the sculpture.

You will notice – once you have learned to control your moves – that the speech is quite intelligible. This would not be the case if the voices were transposed according to the speed of your hand or played backwards when you reverse the direction of your movement. Reading out a different voice in the forward and the backward movement also gives you more sound material to play with when repeating a gesture. Once you got used to the constraints relating your movement to the sound, (which happens in an unconscious process performed by your body, feeling into the space of possibilities) you will be able to explore the sculpture's full potential inherent to its three-dimensional disposition. You will find out that

[2] http://librivox.org, accessed Jan 13 2012.

the sounds stored along one axis of the grid are only audible if you move along this axis. If your movement is not aligned with one of the three axes, which will almost always be the case in an unconstrained movement, you will hear a mixture of the sounds of all axes. The intensity of each sound will depend on the speed component on the respective axis. So, for instance, if you move only up and down, or left and right, or front and back, you will play only sounds stored along one of the three axes. This may also involve several sounds if your movement does not coincide exactly with one storage line (as mentioned already above). It is most likely that you will find yourself somewhere between 4 lines if you move along one axis. This means that, in total, there may be up to twelve sound audible at a time, four per axis. As a thought experiment, imagine the movement along a diagonal of the cube. This will cause a constant fade-in and fade-out of all 12 sounds possible at a time.

It is important to point out here that you will easily manage to cope with this apparently complex (when explained rationally) situation by virtue of your bodily intelligence and the bodily understanding you acquire in encountering the particular affordances of the sculpture while interacting with it. You do not need to read this explanation in order to perform the sculpture, but the description may be helpful to understand the rest of this text, if you did not make the experience.

Related Concepts

Random Access Lattice is a sonic sculpture exploring the relationship between movement and sound, especially with respect to the concept of audio recording. More than 150 years ago the idea of automatic sound tracing has been formulated by Édouard-Léon Scott de Martinville in Paris and has been realized with his phonautograph (c.f. image 3), a machine that visualizes the air pressure variations constituting what we experience as sound. Later technology, such as the phonograph by Thomas A. Edison (c.f. image 4), allowed also to play back such sound traces, recreating certain aspects of the sonic phenomenon that gave rise to its inscription.

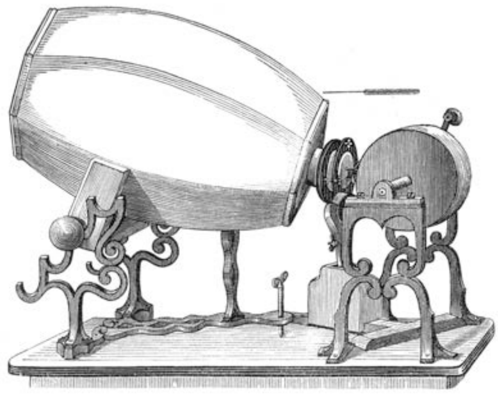
Image 3: An early phonautograph (1859)

Like any writing process, sound recording is dependent on the concept of movement, the principle linking time and space. In the recording process, the volatile temporal phenomenon of sound is transposed into a persistent spatial structure, such as the groove of the phonogram, the magnetic pattern on a tape, or the bit pattern on a compact disk or in computer memory (c.f. image 6). Sound playback reverses this transposition by reading the spatial structure, exerting a particular movement in order to recreate the temporal phenomenon.

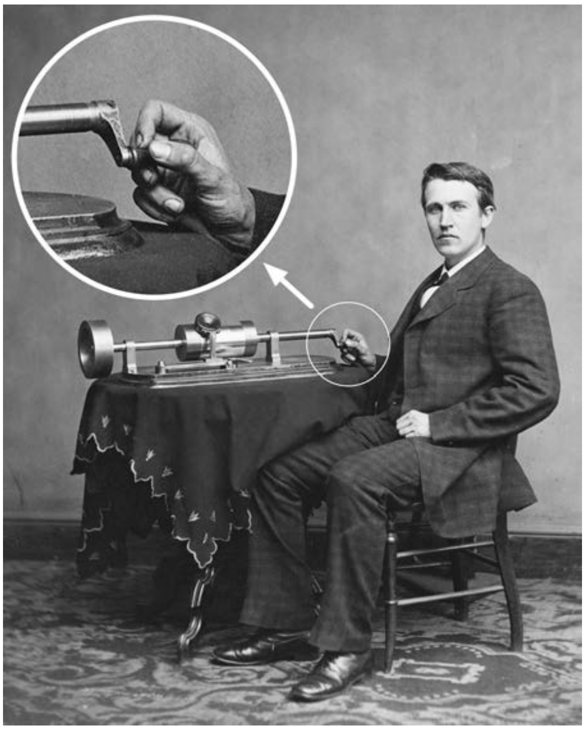

Image 4: Edison with his 2nd phonograph (1878). Photograph: Mathew B. Brady.

Since the inception of sound recording technology, the crucial implication of the relationship between the engraving and the tracing movement is common sense. If they do not match, the temporal integrity of the reproduction is compromised, which is a problem any sound recording technology has to solve. At the same time, the possibility of modulating this relationship was soon discovered by composers as an interesting means of transforming recorded sound. Through its spatial representation sound became manipulable (lat. manus, 'hand') for the first time. The direct link to the movement of the hand, relating the spatial and temporal representation of the sound, can be read off with magnificently clarity from Brady's photograph of Edison cranking his phonograph (c.f. magnified detail in image 4), exposing him as a scratching DJ avant la lettre. *Random Access Lattice* revisits certain aspects of this gesture.

With his seminal 1963 work *Random Access Music* (c.f. image 5), Nam June Paik exposed the implications of the sound reading motion to the gallery audience in an installation. He glued recorded magnetic tape on the gallery wall and on other obejects, creating an interactive visual and sonic artwork that the audience explored by means of a hand-held tape head. Moving the head over the tape (re)produced the (recorded) music. Speed and direction of the movement determined the kind and degree of transformation with respect to the recorded material. Through their bodily motion, Paik gave the audience random (as opposed to sequential) access to his music. Paik borrowed the term 'random access' from computer memory technology. Magnetic core memory (c.f. image 6) was the kind of random access memory in use between

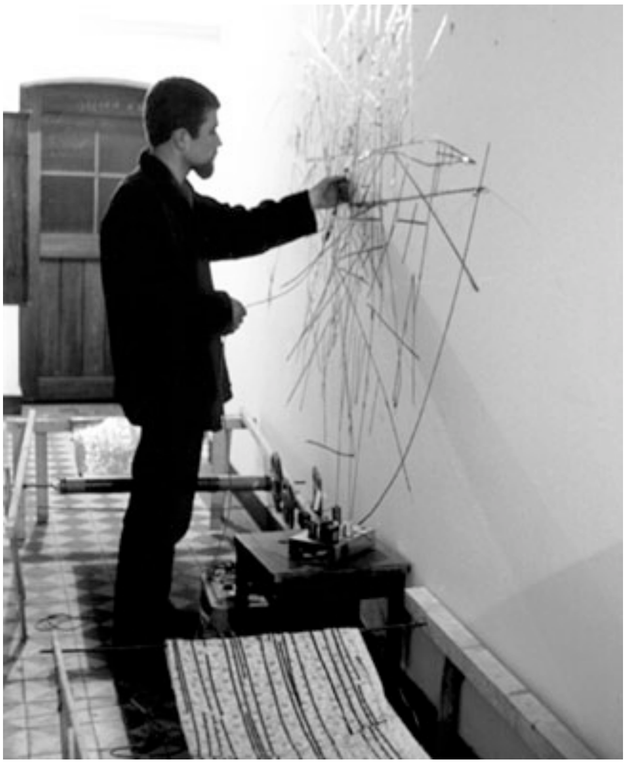

Image 5: Random Access Music (Wuppertal, 1963) by Nam June Paik. Photograph: Manfred Montwé.

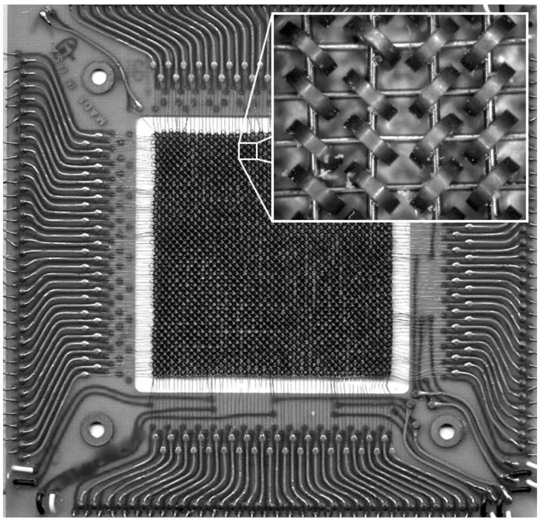

Image 6: Magnetic core memory with 64 x 64 bits, as used in a CDC 6600, the first successful supercomputer introduced in 1964.

1955 and 1975. It allowed to access a data element (a bit) at any arbitrary (i.e. “random”) position in the memory space with a constant access time, as opposed to magnetic tape data storage providing sequential access. Accessing the latter is not possible in constant time, as it involves winding the tape to the right position. This is also the case with sound storage on audio tape wound up on a reels – unless the tape is unwound and glued to the wall.

Random Access Lattice pays tribute to Paik's work by further abstracting from the mechanical principles of the sound recording process invented in the 19th century. In Paik's piece, several steps of abstraction had been taken already. By using electroacoustic transducers (microphone and loudspeaker) sound is handled in its analogue electrical format. As opposed to the phonograph recording, the pattern written to the magnetic tape is invisible and intangible. A special transducer, the tape head, which converts between electrical current and magnetic field, is needed to write and read the tape. Unlike with mechanical sound recording, there is no mechanical contact between the sound trace and the membrane reproducing the sound. The electrical current representing the air pressure variations links microphone, tape head, and loudspeaker. The speed of the hand motion directing the tape head over the tape determines the way the stored pattern is reproduced via the loudspeaker. The slower the lower and the faster the higher the pattern will sound.

In *Random Access Lattice* this link between speed and pitch is suspended by using a sound granulation technique first described by the inventor of holography Dennis Gabor in 1946[3]. This technique allows to read an audio recording at different speeds without changing its pitch. In 1955 the German company Springer produced a tape-based machine called Tempophone (c.f. image 7) that implemented this technique, allowing composers since then to independently modify speed and pitch of recorded sound material. Apart from applying this technique, which allows to ‘zoom’ into a sound recording while keeping its pitch, *Random Access Lattice* differs significantly from Paik's work in three other respects.

Image 7: Tempophone from around 1960.

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3 Denis Gabor, Theory of Communication, The Journal of the Institution of Electrical Engineers. London: Unwin Brothers. 93(3): 429-457, 1946.

Firstly, the sound is stored along each of the Cartesian axes in a three-dimensional lattice structure filling a cube. Where Paik's work extends the one-dimensional structure of the tape recording into a two-dimensional assemblage, a field of sound allowing for a random access, *Random Access Lattice* offers a densely packed crystalline structure that can be explored by unconstrained bodily motion in space – movement is not restricted to a surface. This is achieved by using an optical tracking system, which determines the position of a hand-held virtual sound head with high spatial and temporal accuracy (with in a millimeter, measured at a rate of 100 times per second). Secondly, the sound head and the loudspeaker is one and the same object. They form a hand-held tracked sensor which, when moved, reproduces the sound at the virtual location where it is stored in the lattice. Storage and reproduction location coincide, which underlines the spatial structure of the sound container realized with *Random Access Lattice*. And thirdly, the stored sounds may be played only in forward direction and never backwards. Each slab in the lattice carries two recordings, one for each reading direction. This is motivated by the sound material used. The whole lattice is filled with the voices of people reciting poems in various languages. Playing voices backwards makes them very hard to understand.

Composition as Modeling

At the core of the *Random Access Lattice* there is a computer program[4] which relates the data stream from the optical tracking system – the current three-dimensional position of the loudspeaker – and the sound sequences played through the loudspeaker. This program is the result of a compositional process, which I understand as a modeling task, as found in scientific modeling. There, computer modeling techniques are used to understand and predict the dynamics of complex systems, such as in weather forecasting. Unlike in scientific modeling, the compositional model is not used to explain empirical data or predict the dynamics of complex systems; rather, it is used to generate such dynamics in the first place, as a function of the audience interaction. From this perspective it can be said that the model in the case of composition has more of a poïetic than an epistemic function.

Composing means elaborating and continuously refining this model, which, at times, may include a complete redesign. After having gained enough experience with a model for judging it as insufficient, it will have to be discarded completely. Modeling is a way to express the particular constraints which are characteristic and generative of the work. In the case of *Random Access Lattice* this concerns the layout of the lattice, the mapping of the sound material to the lattice and the details of the sound granulation process, which depend on the analysis of the speaker’s motion (its position and speed, the latter measured on each axis separately). The way the constraints are expressed in the model reflects (as far as possible) the way they are thought. In this sense the model functions as a (textual) representation of what is operative in the work. This kind of externalization of thought is of similar significance for the compositional process as music notation used to be at other times. Once music is notated, certain operations are possible on the level of the symbolic representation which would not be otherwise. This is where the constraints of the notational system (and the representational system in the general case) suggest or ease certain

[4] realized with SuperCollider, “an environment and programming language for real time audio synthesis and algorithmic composition”, c.f. http://supercollider.sourceforge.net, accessed Jan 24, 2012.

manipulations of the musical material, i.e. become generative of compositional operations. Each representational system exhibits its particular set of affordances. Reflecting and the tools used for reflection intersect. The main difference between the notion of composition as modeling discussed here and composing using traditional music notation is that the modeling approach includes the modeling of the representation, typically by means of a programming language. Composition as modeling is self-reflexive in this sense.

Improvisation as Epistemic Practice

Performing the *Random Access Lattice* will always be a form of improvisation for two reasons. Firstly, the audience performing the sculpture does not know how to play it when it encounters the piece for the first time. But, while grasping its affordance, they engage in an initial improvisational exploration, which, depending on their readiness and dexterity, may develop into an outright improvisation. When composing the piece I was aiming at leading the encounter with the sculpture into such a (layperson) improvisation situation. My approach is motivated by the conviction that everybody is able to improvise, not least because daily life requires improvisation all the time. The audience will engage in a real improvisation if they feel invited to do so by the situation the installation incites. Secondly, due to the mere abundance of sound material (the lattice contains almost four hours of voice recordings) and the vastness of the possible combinations contingent on the movement trajectories (estimated at billions of different sound grains, inhabiting each a cubic millimeter of space), a performer will hardly be able to reproduce an extended sequence of sounds. This form of resistance against mastering the situation will induce an improvisational approach, even if an expert performer, such as a professional musician is playing the sculpture (c.f. video 1).

But also composing the *Random Access Lattice* involved a fair amount of improvisation – the latter forming an integral part of my compositional practice. By composition I understand the basic 'putting together' (lat. componere) of the different elements of the installation – the speaker, the tracking system, the sound material, the layout of the lattice, the motion analysis, the spatial and temporal mapping, and the sound granulation process. The disposition of these elements I understand as an experimental system in Rheinberger's sense[5], enabling the composition of the relationships among the elements (by means of modeling, as explained above). Intermediate results of this other level of composition are tested by experimentation through improvisation. The measurement tool used to assess these experiments can be seen in the embodied experience of improvising with the sculpture in statu nascendi. Through this process I discover what works and what does not work. On this level, all choices relating the elements are expressed in software (which functions as a kind of notation, describing something more of an instrument than a piece though). Evolving the software becomes part of the experimentation and is thus subject to the serendipity and contingency typical for improvisation. During the compositional process, the sculpture functions as the main epistemic object in the experimental system. The epistemic object transformes into a technical object, a black box, once this process has terminated and the piece is finished. Therefore, composition through improvisation may be qualified not only as a poïetic and

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[5] Hans-Jörg Rheinberger, Toward a History of Epistemic Things: Synthesizing Proteins in the Text Tube, Stanford University Press, Stanford, CA, 1998.

aesthetic but also an epistemic practice. Improvisation engenders knowledge in the compositional process.

When reconsidering now one of the intensions of the work, namely to research the relationship between sound and motion, especially with respect to the concept of audio recording, it can be seen how the epistemic dimension of improvisation becomes also relevant for the audience directly. Through improvising with the sculpture the audience familiarizes themselves with the findings of the compositional process in a pre-reflexive and non-discursive way – an engagement usually to be followed and/or accompanied by reflection and discourse, e.g. in the form of communication with fellow performers. So improvisation is not only accounted for as an epistemic practice in forming a part of the compositional process but also as an essential constituent of the experience of the work. In both cases it is the ludic engagement and tactile connection with the sound through bodily motion – the embodiment of the sound (i.e. the extension of the body into the sound) – which allows knowledge and understanding to emerge.