REVISITING A RELATIONAL APPROACH TO ELECTRONIC MUSIC PERFORMANCE

by

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ABSTRACT

The relationship between people and digital processors in electronic music performance has been a widely discussed topic since the first musical applications of microprocessors at the end of the 70s by the League of Automatic Music Composers. In this dissertation I make the point that this relationship is too often reduced to the role of machine agency with problematic consequences for new applications of micro and nano processors in performance: critical misunderstandings in the chain of mediations between people and machine stem from the lack of understanding of human actors, especially regarding their intuitive processes, and not from the assessment of machine behaviour. Starting from Herbert Simon's theory of bounded rationality, the discussion highlights how this faulty assessment was among the major causes of catastrophic outcomes of recent social phenomena involving new technology. Electronic music performance is also a social phenomenon that falls in this category. To make this point, I analyse two case studies closely related to improvisation that, contrary to more common approaches, successfully integrated new media displaying more attentiveness to human intuitive processes, as they are known today according to modern neuropsychology: the Berlin's Echtzeitmusik and the New London Silence. Once the narrative of the relationship between people and machines shifts to take into account modern notions of intuition and human and nonhuman agency, we open the field for alternative approaches to integrate micro and nano processors in electronic music performance. All the discourse that follows explores these alternative approaches proposing standpoints of observation that draw from relational aesthetics and actor-network theory. The thesis ends with the presentation of a portfolio of relational works exploring the aesthetic of the relationships among a broad variety of actors, providing practice-led examples to look for new narratives to answer the question: how do the relationships between human and nonhuman actors contribute meaningfully to the aesthetic of electronic music performance?

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KEYWORDS

Electronic music, performance, improvisation, emergence, actor-network theory, bounded rationality, Herbert Simon, League of Automatic Music Composers, Echtzeitmusik, New London Silence, relational aesthetics, relational music, network music.

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Introduction

On Jan 21, 2013 Beyoncé performed the national anthem at the presidential inauguration of Barack Obama. The performance was celebrated widely; the audience was thrilled, cheered loudly, and rushed to voice their approval on social media; the first reviews from the official press were in awe, with the Guardian's music section calling it a soaring highlight while praising a specific moment when "she flicked out her distracting in-ear monitor as she reached the crucial soaring notes of this most testing piece."[1] But the day after, something suddenly flipped the state of the event's reception: a representative from the U.S. Marine Band said that Beyoncé was not singing live and the band's accompanying performance was taped. The distracting in-ear monitor was indeed of little use for lip-synching. The social media enthusiasm turned into dismay and anger. The Daily News first page titled "STAR SPANGLER SCAMMER. Outrage over Beyoncé's anthem lip-sync." The New York Post added fire with the opening title: "Sham-elot. Beyoncé faked it. And so did the Marine Corps Band." From one moment to the next, the same acoustic waves that came out of the loudspeakers and provided an enjoyable musical experience were tainted inside the memory *a posteriori*, on the basis of information that had little to do with the acoustic shape of the music. A century and a half of musical aesthetic influenced by German idealism propelled the idea that music is all about itself and its internal rules of organisation. Considering only this idea, the audience response to Beyoncé's lip-sync might seem to make no sense, or could be merely ascribed to a lack of musical understanding. But the limits of this conception of music have been made clear through scholarship looking at the social matter refracted in the musical form,[2] unveiling the coevolution of musical aesthetic and ecology,[3] and from a neurological standpoint, with fMRI studies linking reward responses to our acquired familiarity with harmonic structures[4] and all sorts of sounds.[5]

[1] Keller (2013)
[2] Lewis (1996 and 2008) and Born (2017)
[3] Feld (2012)
[4] Koelsch (2011)
[5] Salinpoor et al. (2013) and Mencke et al. (2019)

There is more to Beyoncé's story. First, it reminds us that what we know about a performance affects the possibility to enjoy a rewarding experience, and, more importantly, the memory of the experience: psychologist Daniel Kahneman reminds us that "I am my remembering self, and the experiencing self, who does my living, is like a stranger to me."[6] Both in real time and retrospectively, our aesthetic experience of a performance is always mediated by implicit knowledge of the modalities through which the performance unfolds. As it happens with sound, we also process performance settings intuitively, and intuition is nothing more and nothing less than pattern recognition:[7] *different patterns stored in our memory will profoundly affect our experience and recollection of the performance and the reward we can get from it;* this will happen mostly unnoticed, far from the spotlight of our conscious thinking.

Second, Beyoncé's case underlines how the relationship between gesture and sound production can deeply affect our sense of the performance. Our experience is mediated by complex and shifting relationships between many actors that play a role in the performance. If two actors -in this case the theatricality and the acoustic shape of the music- stay the same but the perception of their relationship changes, the aesthetic contents of the performance change consequentially. Any attempt to isolate aesthetic contents from these relationships is futile: *the relationships between the actors of the performance convey aesthetic contents.*

Third, the dynamic of this playback scandal underlines how visual cues that let us associate gestures and sound production are not the only way we understand how the performance unfolds. On the contrary, sometimes visual cues can carry little information or even be misleading. As this case demonstrates, if the relationship between visuals and sound is tangential and goes beyond what meets the eye in first place, it does not mean that the information the relationship mediates is less relevant. *Tangential relationships can have far more profound consequences than direct ones.*

[6] Kahneman (2011) p.390

[7] "The situation has provided a cue; this cue has given the expert access to information stored in memory, and the information provides the answer. Intuition is nothing more and nothing less than recognition." (Simon, 1992: 155) And Daniel Kahneman sums it up: "the mystery of knowing without knowing is not a distinctive feature of intuition; it is the norm of mental life." (Kahneman, 2011: 237)

Through tangential relationships, the technological object in question, amplification, as simple as it is, becomes the fulcrum of a complex matrix of mediations: its ambiguous role merges with moral foundations of fairness and loyalty,[8] generating an unstable situation in which sound, visual cues, and verbal information can all flip the state of the performance in the blink of an eye, both in real-time and retroactively. Moreover, the demographic of the audience of Beyoncé's performance should encourage the reflection that tangential relationships between the actors of the performance are not the intellectual privilege of a selected group of experts working on interaction design, but they are the silent backdrop of all sort of meaningful musical performances involving electronic media, from Beyoncé's lip-synching the national anthem to Jerry Hunt's mysteriously triggering sounds with his shaman-like stick.

This essay is about electronic music performance, and Beyoncé's performance, as much as it involves to some extent electronic media, does not fall within my scope. Electronic music performance identifies a set of practices involving electronic media whose borders are not easy to define. The kind of electronic music performance I will explore meets a minimum requirement: its course of action can be significantly altered toward unforeseen directions while the music unfolds. This is what I will refer to when I will use the term electronic music performance. Nonetheless, odd as it may seem, in those three points we can infer from observing Beyoncé lip-synching the national anthem, there are all the ingredients for a radical revision of the way we practice and discuss electronic music performance, and for the redefinition of the concept of relational music – or, in its more general and well-known form introduced by Nicolas Bourriaud, relational aesthetics.[9] Starting from each one of the three observations I made about Beyonce's performance, I will now outline the objectives of this essay and how the text accompanying the musical works should be interpreted.

First observation: different patterns stored in our memory will profoundly affect our experience and recollection of the performance and the reward we can get from it.

[8] Haidt (2012) p.146
[9] Bourriaud (2002)

The fact that our behaviours, including musical creation and listening habits, are constantly shaped by an array of forces we are unaware of is overwhelmingly supported by evidence in recent neurological studies.[10] In the last twenty years the number of findings on the subject has grown exponentially from a few pre-emptive attempts to tens of thousands of published studies. One study sheds light on the role of a tiny part of the brain, the nucleus accumbens, in our perception of reward associated to music.[11] The nucleus accumbens is a key area to understand the pathways of the signals carried by the neurotransmitter dopamine, a neurotransmitter responsible for the feeling of reward.[12] In the experiment, participants monitored with a brain scanner (fMRI) were asked to listen to 30-second-excerpts of unheard music matched to their preferences by music recommendation software, such as Pandora and Last fm. Participants then placed bids with their own money that were used to categorize each excerpt according to desirability ($0, $0.99, $1.29, and $2) for the purposes of analysis. What came out is that the auditory cortices responsible, among other things, for the recognition of familiar acoustic patterns,[13] were always active when listening to music, but increased activity in the nucleus accumbens was the strongest predictor of a high bid. The study concludes that the auditory cortices in combination with the nucleus accumbens contribute to the rewarding nature of musical sounds and musical reward is by no means to be limited to harmonic or metric structures. Both for novelty seekers and for people happy with the comfort of tradition, some degree of familiarity with what is going on in an artwork is necessary to form expectancies to be confirmed or violated;[14] and familiarity comes with information processing patterns. What is the state of affairs of the patterns that allow us to process the relationships among the musical actors in electronic music performance? In terms of general diffusion, it is well below the threshold that would allow one to notice the benefits to considering the performance in

[10] Sapolsky (2017) pp.603-604
[11] Salimpoor et al. (2013)
[12] Sapolsky (2017), pp.64-65.
[13] Zatorre and Zarate (2012)
[14] Stuber et al. (2008) and O'Doherty (2004).

relational terms.[15] There are three major obstacles, that should be addressed to reverse this outcome: 1) the current state of music technology acts as an invisible force that shapes our decision to engage with tools for fixed media instead of the unknown results of performances; 2) music technology is linked to the communication channels that most commonly carry musical information, and these channels are not designed to carry the information contained in the relationships among the actors; 3) teaching methods tend disproportionally towards the more productive fixed media.

These obstacles will be expanded in chapter 3 and they will be presented as default positions. But before getting there and proposing solutions regarding current uses of digital processors in performance, I will deal with a fundamental issue: it is not possible to reverse the current state of affairs if we do not see clearly the motivations to do so, because changing habits and converting technologies requires a daunting commitment and, by default, we choose habits.[16] According to the thesis, there are three steps to take for any motivation to be effective and they will be discussed in chapter 1. 1) Understanding whether and how salient events of our decade are mediated in the musical form, thus influencing the aesthetic discourse. 2) If indeed this mediation process affects musical aesthetics, interpretative keys that help us to highlight how experiences other than the single-handed aesthetic vision of the composer affect our musical decision-making do have consequences in the music we play and in our listening choices. In light of this, I will insist on a theory that is not commonly discussed in music research, but which has been of capital importance for disciplines involving decision-making in settings where technology plays an important role such as game theory and economics: Herbert Simon's bounded rationality. 3) Presenting case studies of successful application of a relational approach. Such musical experiences are regularly neglected or the attention they receive follows excessively strict partisan lines. The innovations of Jim Horton and the League of Automatic Music Composers in the late 70s paved the

[15] With lack of familiarity with the relationships unfolding, free improvisation can become merely a sociopolitical stance about a more equal society, network music a misleading demonstration of how interconnected we are supposed to be through the new media superhighways, an electronic music performances an empty showcase for understanding what a new theatrical controller does.
[16] Kahnemann (2011) p.367

way for things we take for granted today, such as the use of microprocessors in music, and for other things that are not as widespread but continue to gain attention such as network music realised as internet connected bands.[17] After more than 40 years, neither Horton nor the League has a Wikipedia page and their work is seldom known outside a restricted group where they achieved cult status.[18] As much as I would like to deal with this historical matter, this experience deserves far larger and better fieldwork than what I can do in the scope of this dissertation. As information about Jim Horton is scarce, I wrote an appendix based on the autobiographical notes that John Bischoff gave me[19] and the email exchanges we had about them,[20] but for the League I refer to the comprehensive linear notes they wrote in occasion of the 2008 release masterminded by Jon Leidecker for New World Records and covering their activity in 1978-1983. The notes are freely available on Tim Perkis' website.[21] I will selectively discuss the League's work in the chapter about emergence, but hopefully more focused efforts will soon address this lacuna in our musicology. On the other hand, I will discuss in more depth some musical movements related to those improvisors often referred to as the third generation of improvisors. While they have received worldwide attention, this has yet to translate to a proportionate literature; moreover, the third generation of improvisors are rarely considered for the aspects I think are truly unique and conductive to the

[17] More precisely, the inclusion of internet connections was experimented in the group that arose from the experience of the League, the Hub (John Bischoff, Chris Brown, Scot Gresham Lancaster, Tim Perkis, Phil Stone, and Mark Trayle). About their process see Haworth, 2014.

[18] In 2003 Agostino Di Scipio discussed a problem common to interactive music: "interaction is normally referred to the *man/machine* interrelationship, never to the mechanisms themselves implemented within the computer: the array of generative and transformative DSP methods in interactive music systems usually consists of separate processes and functions working independent of one another" (Di Scipio, 2003). To which we can imagine the League of Automatic Music Composer responding describing their practice: "Each composer had programmed his computer with a music program that was by itself able to produce music; however, the programs were also able to input data that would affect the musical content and to output data that would affect another computer's program." (Bischoff, Gold and Horton, 1978). The problem should jump to the eye simply by looking at the years of publication, and the League's approach was by no means a short-lived experiment: they kept doing that for all their lives and, with new members and new groups, such as the Hub, they still do it now. Also, their article was not an obscure note found in a drawer, but it was even reprinted as a part of *Foundations of Computer Music* for MIT press in 1985 (p.588-590).

[19] In 1999 Leonardo Music Journal published Bischoff's introduction to the notes with a link to the original text (Bischoff, 1999). As of now the notes are still available at http://suntebo.org/history/

[20] See appendix 1

[21] http://www.perkis.com/_site/writings/leagueCDnotes.pdf – New World Records has also a sister repository called DreamOnline.org were many recordings of the League are available.

relational approach I advocate for. Their work will be analysed through the lens of bounded rationality.

Second observation: the relationships between the actors of the performance convey aesthetic contents.

This point has been subject to intense debate since Nicolas Bourriaud introduced the concept of relational aesthetics in 1998, observing how new participative art forms of the 90s proposed "an art form where the substrate is formed by inter-subjectivity, and which takes being-together as a central theme, the 'encounter' between beholder and picture, and the collective elaboration of meaning"[22] Some of the limits of his theorisation have been highlighted by many authors.[23] The most consequential disagreement for my work is expressed by Claire Bishop, who criticises Bourriaud's relational aesthetics for its lack of critical attention towards the subject matter:[24] even though Bourriaud's premise is the lack of an ideological clout, he *de facto* indulges in the ideological praise of structures whose contents cease to matter when the participatory phenomenon staged is in line with the moral standpoint he advocates for. Crucially, Bishop notes that Bourriaud does not engage with the quality of the relationships the artwork deploys, and that the actors' characteristics are lost in abstract structures ontologically detached from the matter of the artwork. If we lose track of the actors by looking too high above them, to those ontologically severed structures that cage them, we also lose track of the actors' earthly, unique and inexhaustible vitality.

It is essential to note that even if Bourriaud had the merit to bring attention on relationships, it was by no means a new concept. Improvisors had always implicitly included relationships into the aesthetic discourse, and in some cases they openly addressed how human relationships were inseparable from aesthetic.[25] The same can be said for the more specific field of computer music

[22] Bourriaud (2002) p.15
[23] Born (2017) pp.33-39
[24] Bishop (2004) pp.64-65
[25] Fredric Rzewski quoted in Lewis (1996) p.119 and Prévost (1995) p.50

performance: the League of Automatic Composers used to draw diagrams of their networks indicating the various input nodes with their names because the performance was a meeting point where pieces of software developed individually, with unique behaviours, were put into a relationship through a network, and no node of the network was supposed to take over.[26] Moreover, according to one of its founding members, John Bischoff, the League's attention to relationships between agents, both human and nonhuman, was already a continuation of the work that their oldest member, David Behrman, was pursuing before the advent of microprocessors with analogue circuits.[27]

In chapter 2 I will discuss emergence, Actor-Network theory (ANT), and their musical applications: together with bounded rationality, emergence and ANT will form the theoretical bedrock on which lies my revision of a relational approach. In chapter 4 I will then proceed to propose the relational theory. Drawing from Claire Bishop's point, in the relational theory I will focus on the aesthetic qualities mediated by the relationships between actors, and the aesthetic qualities of the relationships will be the core for the revision. I will also engage directly with the proposition of patterns to process what happens in a relational performance. The relational approach will be embraced in practice in chapter 5, where I will present the portfolio of works associated with this dissertation.

Third observation: tangential relationships can have far more profound consequences than direct ones.

About thirty years ago, Mark Weiser insisted that personal computers would have become second nature and their ubiquitous integration with our daily life would have brought them from demanding

[26] League Alku, Archive 1978-83

[27] "He was a big influence on us because he was already using analog electronics to response to changing performance conditions, especially the pitch parameter. In a way the League could be viewed as expanding on his idea by creating links between many different performance parameters at once." (John Bischoff, personal email exchange)

the focus of our attention to operate unnoticed in the background.[28] This scenario has mostly translated into reality in many fields where our behaviour is affected by digital calculators in silent normality. Our online searches attune the contents of future searches to our tastes, the alarm clocks change on their own when daylight savings time kicks in, and even water boilers can have processors that learn from our daily use how to cut the bills. In music oriented to fixed media, this silent and normal agency of the tools used for its production comes out often. Only considering the rhythms that surround us on a daily basis, many of the genres and subgenres of dance music would be unthinkable without the perfect rhythmic precision that was made possible by the computer's grid.[29] In the opposite direction, in Burial's music those signature beats that are out of tempo but feel so natural, exactly like the drummers we listen to in the recordings of the ethnographers, where the result of him using Sound Forge, a popular free audio editing program that has no grid.[30] When new musical technologies become so entangled with the musical practice that cease to call for attention, we can be sure to notice some changes in the music too. Were this normalisation process also true for electronic music performance, it would be reasonable to expect a series of consequences: if the controller used is considered merely an instrument functional to human musical expression, as it is often the most common case, we would expect the attention to shift from the controller to the music achieved with it; in case the instrument's behaviour were an integral part of the performance, we would expect the question "what is the electronic instrument doing?" turning into "how are the relationships highlighted by the performance contributing to the aesthetic of the sounds I'm listening to?"; were the relationships in play starting to feel vaguely familiar, we would expect the interest to move from extremely simple and direct relationships to more sophisticated and tangential ones; we would expect such tangential relationships to posit an articulated, engaging, and challenging world, as we expect from the sounds of a musical phenomenon in its maturity.

[28] Weiser (1991)
[29] Ostertag (2009) p.161
[30] Burial (2007)

These expectations are rarely met. Reading through the pages of Tim Rutherford-Johnson's *Music After the Fall: Modern composition and culture since 1989,* the discrepancies are staggering: Laetitia Sonami spent a few years developing and perfecting the prototype of the well-known lady glove controller and more than twenty years working on the music to play with it, but while her glove is indeed mentioned, not a single word is said about the music; in a chapter called "Networks," while some experiments pre-1989 are reported, the League's groundbreaking and continuative efforts in network music are not even mentioned. It seems that the more relationships become articulated and second-nature the lower are the chances that the music where they leave a trace will capture the spotlight.

I cannot avoid thinking that the most recent heartfelt generational motivation to make new things happen is inspired by those extremely tangential relationships between our agency and the natural environment that is climate change. New generations do not seem to have any inherent problem at grasping the value of processes whose consequences they do not immediately experience. Hoping that this interest in the full spectrum of the degree of causality of an actor's agency could also translate to a broader pool of listeners and music makers, tangential relationships will be the main focus of this essay: even if they will be explicitly addressed only in chapter 4 and 5, they will be the constant backdrop of the discourse starting from the first chapter about bounded rationality.

1 – New technologies, old behaviours: bounded rationality and the electronic music improvisor

> Although the physical technology a modern army employs is wholly different from the technology employed by the armies of Nineveh or Egypt or X'ian, the processes people used in these ancient armies to make decisions or to manage people appear quite familiar to us and largely unchanged over the centuries. Basic organizational processes have not yet undergone a deep revolution.[31]
>
> Herbert Simon

Bounded rationality is a theory that stems from the assumption that we do not live anymore in a world where our ability to solve a task is proportional to the information we can access. The new information channels overwhelmed our ability to process information and attention, not information, is now the scarce resource: bounded rationality is a theory about the limits of the human mind to process information. The theory came out in the 50s and had profound impact in many fields dealing with human decision-making and its computer modelling, such as game theory, economics, and psychology. His author, Herbert Simon, is by no means unknown, indeed he is often regarded as one of the greatest scientists of the twentieth century, but he is often the most famous scientist musicians never heard of.

The main goal of this chapter will be to show how bounded rationality provides a sound interpretative key for major events of the last decade and unveils subtle associations between the dynamics involved in these events and the musical discourse about human limits in improvisation that unfolded at the end of the 90s. This analysis will highlight the motivations to start a revision of relational music and will point to Simon's theory as the basis for such a relational approach.

The discourse will rely on information from fields and events whose associations with electronic music performance is far from obvious. Therefore, it will be essential not to lose track of

[31] Simon (1997) p.vii

the three steps I will follow to get to the point, steps that were briefly sketched in the introduction but I recap here in further details.

1) Before discussing how bounded rationality can highlight associations between salient events of the last decade and aesthetic matters, I will have to discuss whether or not creating these associations can affect future aesthetic trajectories. According to the thesis, neither the predominant classical aesthetic theories that owe to German idealism and dispatch entirely with social mediation in music, nor the idealised forms of mediation proposed by many counterculture movements of the 60s and the 70s can capture how our experience is mediated in the musical form. On the other hand, more recent theories do and the first step will be describing how these theories address the lack of interest in social mediation of the classical aesthetic theories, but also refrain to accept idealised models of society typical of the 60s and the 70s.

2) Once the reasons for associating our daily experience with aesthetic matters will be clear, I will introduce bounded rationality. I will start by analysing how this theory applies to three events that I see as revealing about our relationship with technology in the last decade: the 2008 economic collapse, the online teenage bot Tay, and the Notre-Dame fire. Then I will discuss how the dynamics highlighted by Simon's theory also affect the musical discourse of the second half of the twentieth century, but they were repeatedly ignored until their importance started to become clear with the novelties brought about by the third generation of improvisors with the coming of the new millennium.

3) In the third generation of improvisors, I will focus on two case studies, the Berlin *Echtzeitmusik* and the *New London Silence.* These movements, even without referencing directly bounded rationality, are de facto successful applications of Simon's ideas to performative practices that welcomed electronic media without renouncing to an essentially improvised approach. The analysis of how these seminal experiences dealt with electronic media will also highlight the practical aspects of how bounded rationality could be the bedrock for a renewed relational approach in electronic music performance.

1.1 – Worldly associations

Describing how bounded rationality can unveil surprising associations between salient events of the last decade and aesthetic forms can hardly direct our musical behaviour on a fruitful path if the role of social mediation in music is not observed objectively. And by objectively I mean resisting the tendency to either dispatch entirely of 'external' influences that interfere with the single-handed intentionality of the composer/performer, or overestimate the role of a restricted number of conceptual associations on the musical form, often neglecting the acoustic shape of the artwork.

Electronic musicians willing to stray from the certainties and immediate advantages of the studio production and dive into the unpredictable directions of the performance are very likely to experience the two opposing tendencies regarding social mediation mentioned above. On one hand, the predominance of the romantic tradition dominated by German idealism set the stage for the misinterpretation of the tangible contribution of the social to the aesthetic concerns of music. Eduard Hanslick, one of the major figures in Western musical aesthetic argued in 1891 that: "It is one of the most precious and inestimable secrets of nature, that an art should have the power of evoking feelings entirely free from worldly associations, and kindled, as it were, by the spark divine."[32] Clearly, the social is very much made of worldly associations: Hanslick's view does not leave any room for interpreting its mediating force, but postulates a music with no interferences outside its internal rules and endogenous stimuli of the individual creator. Even though modernists found additional reasons to reject tonality in ideas considered external to musical form such as the association of the tonal order with the political order that led to the horrors of the first half of the twentieth century, it can be argued that Hanslick's interpretation passed almost unaltered from the romantic period to the predominant rational branch of European modernism: the reliance on

[32] Hanslick (1891) p.26

mathematical formalization of musical processes certainly was no more open to the social than the rules of harmony; even the intangible nature of single-handed inspiration endured and found an uneasy coexistence with ultra rational argumentations.[33] In the more empirical US there were also notable opinions in the direction of a music separated from the social. For instance, Morton Feldman stated plainly that: "Art teaches nothing about life, just as life teaches us nothing about art."[34] As a result of this line of thought, the idea that a specific configuration of a social network can impact the music as deeply as the decision to use chance operations or the serial technique is unthinkable.

On the other hand, important movements with their roots in the 60s and the 70s and operating outside the institutionalised avant-garde, often proposed a trenchant way to express an idealised model of society through music that very much resembles the totalising structure that Gabriel Tarde and later Bruno Latour saw as a major obstacle to understand social relationships.[35] Among the most influential examples, there are some instances of the free improvisation movement and its early theorists. Attali foresaw a new way of composing music stemming from improvisation and indeterminacy as "a labor on sounds, without a grammar, without a directing thought, a pretext for festival, in search of thought," accessible to everyone without need for training, created here and now, with the potential of erasing ethnic and economic differences in the ecstasy of a collective creative ritual that needs no leader nor hierarchy. This new way of thinking composition was depicted against the gray repetition of the music industry (capitalism) and the somber uniforms of the classical orchestra with its pyramidal power structure (totalitarian regime).[36] Notable members of the first generation of British improvisors also vehemently proposed a direct and unambiguous mediation of ideological positions in music. Eddie Prévost, in a writing emblematically called "Time Immoral," expresses the idea that metronomic time in industrial society is driven by the productive anxiety of the capitalist machine and this faulty perception of time can be shaken off

[33] Born (1995) p.44
[34] Feldman (2000), p.14
[35] Tarde (2012 [1895]) p.41 and Latour (2012)
[36] Attali (1985) p.36, 67, 135, 140-46

only by a music that avoids any form of pre-set pulse. The genuine thought that "music as time and motion study can liberate us, potentially, from unconscious, culturally acquired responses" takes the form of a moral duty to avoid pulses and any culturally acquired patterns.[37] This only possible solution leads, for instance, to peculiar conclusions about musics mediating values of ethnic groups: since the ultimate goal of music is the successful fight against the atomistic, capitalist society, any migrant community that cannot surpass alienation and fragmentation produces music that does not adhere to the moral system posited by the new music. Therefore, in the industrialized world "brass bands, steel bands, Indian musics all become part of the theme park industry, reinforcing the work/leisure dichotomy, languishing in a kind of apartheid, destroying any real opportunity to experience being and becoming,"[38] no matter if the musics use improvisation, require mutual listening and the ability to make decisions while the music unfolds, the often anonymous repertoire is a de facto application of shared authorship, and groups are often composed by masters without a hierarchical power structure mediated by the musical performance. A similar intransigent ideological approach was also evident in the events that led to the end of the Scratch Orchestra, where after a couple of years from its inaugural meeting in '69, anyone not dedicated to a narrow brand of Maoist theories felt left out.[39]

Of course, the aforementioned polarity does not provide the full spectrum of social mediation in Western art music. Charlie Parker[40] and Christian Wolff[41] simply thought that how you see the world, somehow, always comes out in your music: a lowkey, heartfelt, and fairly objective consideration about how experience interferes with music. There are indeed plenty of exceptions to the two positions presented, some of the most relevant to this essay will be discussed as case studies, nonetheless still today the two positions are very likely to be experienced: on one hand,

[37] Prévost (1995) pp.35-36
[38] *ibid.* p.114
[39] Pearson (1994) pp.35-40
[40] Charlie Parker quoted in Lewis (1996) p.119
[41] In 2009, Christian Wolff came to Mills for a lecture and, discussing his relationship with Cage, expressed surprise about Cage's reluctance to link his musical system to his anarchic political views. Wolff concluded the thought saying that, to his eyes, the relationship was obvious and your ideas about society, somehow, always come out in your music.

there is a classical view that tells us that music posits a world of its own, without any contact with our social experience; on the other hand, there is a view of music as subjugated to an idealised model of society that dictates the criteria of acceptance of the musical form.

Georgina Born proposes a different approach and calls for an expansion of the conceptual tools to observe social mediation in music. According to her social aesthetics, she indicates four planes where we can observe mediation taking place:

> In the first plane, music produces its own diverse socialities - in the immediate microsocialities of musical performance and practice and in the social relations embodied in the musical ensembles and associations. It is the first plane that is most apparent in all performance arts. In the second plane, music has powers to animate imagined communities, aggregating its listeners into affective alliances, virtual collectivities or publics based on musical and other identifications. In the third plane, music refracts wider social relations, from the most concrete to the most abstract of collectivities -music's instantiation of the nation, of social hierarchies, or of the social relation of class, race, religion, ethnicity, gender, or sexuality. In the fourth plane, music is bound up in the broader institutional forces that provide the basis for its production, reproduction, and transformation, whether elite or religious patronage, market or non-market exchange, public and subsidized cultural institutions, or late capitalism's multi-polar cultural economy.[42]

Born's analysis surpasses the polarity by insisting on the dual nature of the social mediation: music has its own force to animate communities on the most diverse grounds of identification, and these communities shape the music in return. It is a feedback loop that can hardly be interrupted and analysed only in one direction, or understood along a single interpretative plane. Born's analysis brings attention on music's very own agency in affecting the social and rejects the idea of music as the creation of sheer individual subjectivity avoiding idealised models of collectivity. By doing so, it creates fertile ground to reconcile the music-making process with new social theories and advancements in neurobiology that since the 80s have been turning many beliefs we had about our agency upside-down: agency is not a human prerogative, objects have agency too and actively participate in our social processes;[43] our decision-making is so specifically affected by biological

[42] Born (2017) p.43
[43] Latour (2005) pp.63-86

factors that our conception of free will is being redimensioned.[44] Our musical output is not a plain consequence of a single-handed vision, but a result of processes encompassing many actors, both human and nonhuman, cooperating either at the same time or virtually at deferred time: the messages we choose to communicate, the chosen set of compositional rules or software that encode those messages, and our endogenous stimuli are all likely to mediate our musical output as well as the hormones produced by our adrenal gland in response to a stressful day, the friend you play with, or an email address a stranger wrote on a piece of paper when you accidentally discussed a problem.[45] In fact, we can hardly guess which actor will contribute the most to the final form of the music: the spark divine of subjective creation or the collective creative ritual are only conceptual cages that limit our observation. But outside these cages, observing actors that we tend to ignore more carefully and reducing the weight of others we disproportionately care about, we can greatly improve our understanding of the process. Having a more comprehensive vision of the long chain of mediations that lead to the final musical result can often make a huge difference. For instance, if our objective is to be part of a good session of collective improvisation, obviously we have to look for people willing to share this intention with us and cities where there are available spaces to play or create them, but how to navigate the network of actors that will eventually lead to the objective is far less obvious: acquiring information about the scene of a city, being able to enter the scene, finding the right musicians, understanding the limits of our demands according to the human capital[46] we came to possess, are all complex steps that will determine enormously the musical output. Often these steps are learned exactly like rules of a counterpoint, and if we observe the role of human agency in improvisation it is not hard to see the analogy between a counterpoint of notes and a counterpoint of human agencies.[47] Similar reasonings can be done for electronic music

[44] Sapolsky (2017) pp.580-613
[45] Lewis (2009) p.484
[46] Bourideu (1993) pp.162-163
[47] The ability to observe a broader number of musical actors grows exponentially with the distance of the musical phenomenon from the mainstream cycle of demand and offer or the subsidized cultural institutions. This discussion between saxophonists Wallace McMillan and Freddie Washington Jr. will give the idea why: (Lewis, 2009: 174)

performance, where we often deal with environments in which performance is a fringe afterthought to the more profitable fixed media production and the successful examples leading to a rewarding performative practice are rarely mentioned.

Music form is so intertwined with the worldly associations despised by Hanslick that creating a division is a pointless operation. But many of the associations proposed more than half a century ago do not seem aligned with reality anymore and, above all, do not seem to do for electronic music what they did for decades for instrumental improvisation: motivate musicians to take up the numerous additional challenges that come with the uncertain results of the performance.

I see similarities between motivations in a community of musicians and energy in audio feedback: if there is no gain in the loop, the sound withers; if the gain is not sensibly adjusted according to the new and unpredictable directions we listen to, until we reach a fragile and unrepeatable equilibrium, the directions become far too predictable. I will now introduce bounded rationality hoping that the associations it unveils between music and our recent experience could work as the energy gain in the feedback loop, and the theory's subtle consideration about our mental capability in relation to new media could work as the mechanism that prevents the feedback from getting stuck into predictable positions.

1.2 – Bounded rationality

On August 13, 1967, the Democrat and Chronicle, in an article called *River of Words Floods State Dept. Diplomacy*, reported the government's solution to solve the excess of information that was overwhelming the diplomatic department:

> The U.S. State Department, drowning in a river of words estimated at 15 million a month to and from 278 diplomatic outposts around the world, has turned to the computer for help. Final testing is under way on a $3.5 million combination of

> computers, high-speed printers and other electronic devices. Officials say these will eliminate bottlenecks in the system, especially during crises when torrents of cabled messages flow in from world trouble spots.
> When the new system goes into full operation this Fall, computers will be able to absorb cable messages electronically at a rate of 1,200 lines a minute. The old teletypes can receive messages at a rate of only 100 words a minute.

Herbert Simon commented this solution the following year in an article called *The Future of Information Processing Technology:*

> A touching faith in more water as an antidote to drowning! Let us hope that Foreign Ministers will not feel themselves obliged to process those 1,200 lines of messages per minute just because they are there.[48]

Herbert Simon (1916-2001) started out as political scientist, but then moved on to the study of organisational behaviour, business administration, economics, cognitive psychology, also becoming a pioneer of artificial intelligence.[49] In his classic book *Administrative Behavior,* for which he was awarded the Nobel price in economics 31 years after its first publication in 1947, he had already outlined the principles that would have defined his theory of bounded rationality, a term that he used for the first time in 1957.[50] Voicing his disapproval for theories based on the assumption that, faced with the possibility, people always make a rational choice in their self-interest (*homo economicus*), he instead focused on the limits of human rationality, often remarking how technological improvement can be powerless or counterproductive if these limits are not assessed accurately without chalking off cognitive sciences. The three fundamental limits that define bounded rationality are: 1) individuals are limited by those skills, habits, and reflexes which are no longer in the realm of conscious; 2) individuals are limited by their values and those conceptions of purpose which influence them in making their decisions; 3) individuals are limited by the extent of knowledge relevant to their objective.[51] The ramifications of these apparently simple principles are

[48] Simon (1968) p.622
[49] Herbert Simon, Allen Newell and John Shaw developed the first program that simulates human decision-making in 1956 at the Carnegie Institute of Technology.
[50] Simon (1957) p.198
[51] Simon (1997) p.46.

endless and limits should never be thought as stable, but as ever-changing demarcation lines. It is enough to think that our unconscious habits can be temporally affected by something as simple as spending a day in a traffic jam. Indeed, stress responses cause hormonal changes in our blood stream and hormonal changes directly affect areas of our brain related to decision making: we spend a day in a traffic jam and our decision-making might be affected during the evening. Loyalty to a cause, be it a religious belief, corporate rules, or an artistic current, can result in counterproductive tunnel vision but can also limit the field, so that we can struck a balance between our mental capabilities and the elements considered, resulting in an enhanced ability to achieve the objective. Clearly the extent of knowledge we possess in relation to our objective affects the limits of our mental processes, but it is necessary to highlight two possible sources of uncertainty. First, the relationship between more knowledge and a better performance of a task is not direct. The idea that "more information is better" and applies to all the situations is an assumption of a past society where information rather than attention was the scarce resource.[52] Second, the knowledge we *possess* and the knowledge we *can access* are radically different concepts. Confusing the two is a common mistake when we deal with new media. "Who will read the flood of words that the new enlarged communications channels will deliver? The bottle neck is no longer the capacity of the electronic channels but the capacity of the human users."[53] The analysis of the new communication channels *is* the analysis of the limits of the human users. Most important of all, consciousness of the limits may in itself alter them,[54] thus having repercussions on how we define communication channels, and more generally technological innovation.

Herbert Simon did not believe that the advent of a new technology could swiftly change the basic modalities of our decision-making processes. He argued that since people started to cooperate in large societies, the processes they use to make decisions have yet to undergo a deep revolution. Current neurological knowledge tells us that an important part of the mechanisms that reinforce our

[52] Simon (1968) p.619 and Simon (1997) pp.242-243
[53] *ibid.* p.226
[54] *ibid.* p.47

intuitive decisions are shaped by millennia of evolution, both adaptive and maladaptive.[55] The mantra of information technology and art dealing with new media, that new technologies suddenly create new men, as much as it is still an excellent marketing strategy for festivals and industries, also does not seem likely. Exactly half a century after the first publication of *Administrative Behavior*, in the preface of the fourth edition, Simon argued that even though he had to update the chapters with many commentaries regarding new problems posed by new technologies, the core assumptions of the book had proved to be still valid. For an additional twenty years have since passed and we cannot take bounded rationality for granted, I will now present three recent cases taken from the most disparate fields -economy, AI, and surveillance systems- where misunderstandings regarding how people process information led to catastrophic outcomes. Then, I will consider electronic music performance and discuss if similar concerns can apply also to that field.

The 2008 economic crisis was the worst the industrialised world witnessed since the 1929 Great Depression. How the events unfolded is well-known and will be discussed here only briefly. Until the recent interest in behavioural economics, with the exception of the New Keynesian current, modern economic thought has been largely shaped by a set of dominant assumptions: people are profit seeking rational actors; if the actors are left free to operate, (alias free market) their behaviour will automatically lead to market equilibrium; the actors' behaviour is statistically predictable given a restricted set of premises. How these assumptions about an infallible rational market became undisputed staples of modern economics is a story that goes from Von Neumann-Morgenstern's *Theory of Games and Economic Behavior* published in '44 to the rise to stardom of Gene Fama's theory of the efficient market in the 60s.[56] Today this order of ideas, also known as the rational market hypothesis, is broadly associated with the neoclassic Chicago school of economics. During the decades before the 2008 collapse, large companies, banks, and financial think tanks relied on extremely complex computer models based on the rational market hypothesis to predict

[55] Sapolsky (2017)
[56] Fox (2009) pp. 47-107

financial revenue maximization, and pursued aggressive speculative policies accordingly. The neoclassic school of economics not only was dominant among economists, but also found an especially benevolent environment to test its assumptions as a result of the policies that deregulated the financial market from the 80s onwards in many of the richest countries. Speculative policies suggested by the predictive models worked well initially and everyone jumped on the ship. Companies' focus shifted from developing the best product to meet the demand to financial operations unrelated to the improvement of the offer.[57] Banks lost interest in finding a safe candidate for a mortgage and price the interest rate to make a long-term gain sustainable, and started devising incredibly complex financial instruments that were supposed to protect their gains even when the debtor had no chance to pay back. As things did not go according to the plan, words such as derivatives and speculative bubble started to have the same effect on common people as the bad guy entering the saloon in an old west movie.

In the aftermath, many were hasty to conclude that the crisis was hard wired in by the toxic nature of the financial innovations. But Kahneman warns against excessively linear causal explanations, insisting instead on our tendency to underestimate uncertainty.[58] Especially for what concerns the lack of direct causal link between the crisis and malfunctioning technologies, a more thorough observation points in that direction. AI expert Max Tegmark argues that the problem was about what scientist call validation: "whereas verification asks 'Did I build the system right?,' validation asks 'Did I build the right system?' For example, does the system rely on assumptions that might not always be valid? If so, how can it be improved to better handle uncertainty?"[59] Oonagh McDonald echoes concerns about misunderstanding of human behaviour instead of machine behaviour. She thinks that the crash was really a property-based crisis. Derivative instruments inflicted losses on their holders because they derived their value from residential

[57] For example, General Motors tried to respond to the growing competition in the 90s creating its financial arm GMAC. GMAC went well beyond traditional functions such as financing car purchases, and started to conduct financial transactions for their own sake. In 2009 GM went bankrupt.
[58] Kahneman (2011) p.263
[59] Tagmark (2017) pp.96-97

mortgages, commercial property, and other real financial assets: the value of these assets started to collapse in 2006. She argues that the real problem was not in the nature of the instruments, but in the hubris of a restricted group of people that purposely ignored the risks of their decisions and in the failure of the state policies to define the limits of those decisions.[60] Cambridge economist Ha-Joon Chang argues that:

> "In the run-up to the crisis, our ability to make good decisions was simply overwhelmed because things were allowed to evolve in too complex a manner through financial innovation. So many complex financial instruments were created that even financial experts themselves did not fully understand them."[61]

Concerning the assumption that people are necessarily profit-seeking rational actors and it is possible to predict their behaviour in an environment free from any rule, he sums it up: "the problem with the free market does not end with the fact that individually rational actions can lead to a collective irrational outcome (this is, market failure). The problem is that we are not even rational to begin with."[62] There was no inherent flaw in the computer models; they performed well according to their premises. The flaw lied in a misunderstanding of human behaviour and its limits: human behaviour turned out to be more unpredictable and those computer models were not thought out for that range of unpredictability.

The second colourful and less far-reaching example of a similar misjudgement happened in 2016. On March 23 Microsoft announced the creation of Tay, an artificially intelligent online teen girl whose character would develop learning freely from social media. Obviously, all the eyes of the World Wide Web were watching and Internet was on fire. What is Tay going to become? The waiting did not last long: she quickly turned into a Hitler-loving sex robot and Microsoft deleted it 16 hours after its launch with deep apologizes. It is fair to say that Microsoft did not weight appropriately the possible outcomes of the experiment. The distance between prospect and reality sounds quite striking if we stop considering the surrounding circumstances. What was the English

[60] MacDonald (2015) pp.203-4 and p.222.
[61] Chang (2010) p.177.
[62] *ibid.* p.170.

speaking environment from which Tay was supposed to learn? The year before, as a result of the continuation of the civil war in Syria, the refugees' number had topped the 4 million mark, causing a mass migration toward Europe that had no equal in recent history. The first half of 2016 saw the intensification of a debate that brought Brexit to a referendum in June, a major blow to the political stability of the European Union. 2016 was also the year of one of the most controversial presidential campaigns to date in the USA, culminating with Donald Trump's election in November; primaries had started in March 2015. All these events amplified the polarization of the public and political debate over themes such as identity, religion, borders, and race. When Tay went online, the opposing forces were clashing in full stride with positions before relegated to far right fringe minorities but now emerging as sometimes majoritarian. What about the channels that were supposed to deliver the information to Tay? Following these destabilizing events, social media platforms started to be questioned to a new extent for their ability to wreak havoc in the public debate by amplifying irrational instincts. In 2018, Karsten Müller and Carlo Schwarz, researchers at the University of Warwick, scrutinized every anti-refugee attack in Germany, 3,335 in all, over a two-year span.[63] In their findings, towns where Facebook use was higher than average reliably experienced more attacks on refugees. That held true in virtually any sort of community – big city or small town; affluent or struggling; liberal haven or far-right stronghold – suggesting that the link applied universally. Again, it was not about a flaw in the technology, Tay worked fine. It was about our ability, or lack thereof, to understand human behaviour and correctly assess its limits. In hindsight, given the many warning signs, the outcome of the experiment might not sound as surprising as the poor judgment of who devised it, but assessing human limits when everything around is screaming we have not, it is never going to be an easy task.

The third and last example confronted us with some of the most stunning images of the decade: the Notre-Dame's fire that in 2019 caused irreparable damage to one of the most venerable buildings of our history, including the complete collapse of its iconic spire. According to the New

[63] Müller and Schwarz (2018)

York Times' reconstruction of events that followed a three month long investigation, the first hour after the alarm ran off was marked by a critical miscommunication.[64] The security employee, after noticing the alarm, told the guard to go and check for fire. The guard went to the sacristy and the check came back negative. The employee, instead of calling the fire department, called his boss but did not reach him. The manager eventually called back and deciphered the problem: the guard had gone to the wrong area. The guard was told right away to leave the sacristy and run to the attic of the cathedral. The distance was not insignificant and included 300 narrow steps. When the guard arrived, the fire was out of control. The whole process, from the alarm to the identification of the fire, took exactly 30 minutes. The details of the responsibilities are currently under investigation by the French authorities, but the description of the fire system and its management can shed a light about the likelihood of such circumstance. The fire warning system at Notre-Dame was developed in six years by dozens of experts and resulted in thousands of pages of diagrams, maps, spreadsheets, and contracts. The system was arcane and, when it was called upon to identify the fire, it produced a message extremely hard to decipher. At the other end of the communication there was the fire security employee. It is not clear yet what share of responsibility the employee should bear, but what it is known is that the employee tasked with deciphering the message had been working at Notre Dame three days when the fire broke out, and he was working his 11th consecutive hour instead of his normal 8 hour shift because his replacement was absent. The message that appeared on the monitor along with the word "Feu" (Fire) was a shorthand description of a zone that read “Attic Nave Sacristy” followed by a long string of letters and numbers: ZDA-110-3-15-1. This code indicated one specific smoke detector among the more than 160 detectors and manual alarms in the complex. The last part of the message was the word “aspirating framework,” which indicated an aspirating detector in the cathedral’s attic. Interviewed by the Times, Glenn Corbett, an associate professor of fire science at John Jay College of Criminal Justice in New York, said that all the sensitive technology at the heart of the system had been undone by a

[64] Peltier et al. (2019)

cascade of oversights and erroneous assumptions regarding especially the human part of the design: “You have a system that is known for its ability to detect very small quantities of smoke, yet the whole outcome of it is this clumsy human response. You can spend a lot to detect a fire, but it all goes down the drain when you don’t move on it.”

From the three examples presented, we can see how bounded rationality is still a valid interpretative key and our tendency to neglect the thorough assessment of human actors in favour of nonhuman ones is still a major problem when dealing with recent technologies. But what do banks, Tay, Notre-Dame, and bounded rationality have to do with electronic music performance? Right at the same time the economy was crumbling, George Lewis published a landmark work that embraced the inseparability of a rigorous consideration of social mediation from the musical phenomenon, *A Power Stronger Than Itself*, the historical account of the seminal musical collective AACM. One aspect of the writing struck me particularly and it is how those lines stick to my memory, granting to the musicological analysis a long-standing effect on how I assess similar problems when I see them repeated. The reason of it lies in the nature of our memory itself: we recall things better when we can refer to daily experience instead of abstract symbols,[65] which are the field in which much of Western musicological tradition moves, both romantic with harmonic relations, and modern with set theories and tools borrowed from the scientific domain. The amount of traceable human data provided to support the musical history of the AACM is impressive. There are accounts of living conditions, meetings, concerts, reviews, academic success, grants quantified in numbers, short-term and long-term social implications, human struggles, and chocolate ice creams: nothing is left out, it's all there in the form of vivid traceable memories, ready for our recollection. In Lewis' account human agency and resulting music are entangled in an inextricable knot: the aesthetic change in the music is refracted in the social matter and vice-versa. In electronic music we heard to exhaustion that new technologies change our modes of thought, thus our music. So, how comes that it is so hard to describe a similarly vivid and traceable account of the

[65] Foer (2011), Luria (1987 [1968])

consequences of such a statement in electronic music performance? Where are all the human implications that follow a few, often generously funded, modernist proposals? How comes that when we look for performers of electronic music online, on a magazine, or randomly attending concerts in the cities where experimental music is supposed to thrive, we see an invasion of analogue electronics almost unchanged from the 60s, or the most standard digital techniques?

Bruno Latour points out that the associations between technological innovations and social ties are traceable only momentarily, and the best way to see how they affect the information we trace before they disappear from our point of view is to follow the objects throughout their whole path: in the artisan's workshop, in the engineer's design department, the marketer's trial panels, the user's home, and the many socio-technical controversies.[66] Following the object, if the innovation is meaningful, we will soon be confronted with a flow of human and non-human actors,[67] whose observation and description will be everything we need to grasp the current state of affairs. Herbert Simon had already hinted at the necessity to follow the complete itinerary, arguing that in our present world, where decision-making is shared between the human and mechanized components of man-machine systems, we need to follow information as it flows from one person or computer to another and is transformed in the course of the flow.[68] In electronic music performance if we follow the technological object we may start in academic centres,[69] in the labs of companies that develop music-oriented hardware or software, in the houses of geeky instrument builders;[70] then we will end up in presentation panels, workshops, on websites where companies and private developers often present their work; then, finally, on the stages where the performance happens, among the musicians and the people that discuss, write and record on media or in their memory the music that unfolded in front of them, and there we can witness to what extent the technological innovation

[66] Latour (2005) p.80
[67] Both human and nonhuman actors can have agency. See the discussion in Latour (2005) pp.63-86.
[68] Simon (1997) p.240
[69] Examples are the FM synthesis invented at Stanford University by John Chowning, the programming language Max developed at IRCAM by a team lead by Miller Puckette.
[70] Legend has it that Reed Ghazala accidentally discovered the technique of circuit bending in the 1960s when he left a toy amplifier on his desk and heard it start to emit sounds.

translated forces into something else, to what extent the music created through it has the ability to move through successive steps -possibly outside structures that force its path. If we observe the whole itinerary of the music-oriented technological object we notice that the description is easier at the starting point, and gets gradually harder as soon as the object leaves the developer's nest, and starts its rarely predictable course of action. Academic centres, except for very few bizarre cases,[71] abound with descriptions of their innovations essentially because that is part or their job, and how they get budget plans approved and continued. One might object that often the description is not exactly user-friendly, or it is watered down by an excessive dose of explanations, nonetheless most of the times accessing the information is not too hard of a task. Developing companies also rely on descriptions of their products as a mean to do business, so unless we are not looking for very deep technical details, manuals, SDKs, and blogs provide plenty of accessible data. But the last segment poses the most puzzling challenges: when the object starts to participate in our daily music-making, some years or decades go by, and we are left with a series of associations and actors that seldom resemble the initial intentions of the developers or the first innovators to use the technology, social ties eschew easy descriptions.[72] On top of that, at this stage, musicians that develop a long-standing and fruitful practice with the technology, often have it internalized, and seem less interested or capable of providing objective accounts.[73] Another tricky aspect of this part of the itinerary is that here, more than everywhere else, human and nonhuman agency are intertwined, and only observing carefully both it is possible not to be caught off guard by all the inevitable unpredictable trends that ensue.

Coming back to the question I posed, banks, Tay and Notre-Dame not only display clear

[71] When Luciano Berio was appointed as IRCAM director he decided that the right way to go was to abolish documentation for the technologies developed on the basis that music is an oral tradition, and written pages had to be substituted by meetings and a lot of talks. For an account of how that went see Born, 1995: 269.

[72] No audio mixer company predicted that Toshimaru Nakamura would take the output, plug it into the input and become a renown player of the no-input mixer. The company that developed the itegrated circuit LM709 was not expecting Michel Waisvisz to use the flaws of this malfunctioning piece of engeneering to build a classic of the DIY world, the crackle box. The misuse of technology even fostered the birth of a movement called glitch art.

[73] Go find David Tudor's explanations about what he did with circuitry, or try to read what Jerry Hunt wrote about his practice.

examples of how disastrous faulty assessments in the last part of the itinerary of the technological object can be, but they also provide a hint into a possibility that, to my account, has not been explored enough in electronic music performance, and stems directly from Simon's concept of bounded rationality: *our inability to find a comfort zone with electronic media and develop a rewarding musical practice with computers might be less a matter of technological innovation, then resulting from a deficient assessment of our very own human behaviour, especially in regard to our intuitive mental processes*. Banks, Tay, and Notre-Dame dealt with models for economic growth maximization, artificial intelligence, and complex surveillance systems. Such research has drawn a huge amount of attention, quantifiable both in intellectual forces and economic resources. If in these fields that rely so much on technological innovation we noticed that faulty considerations about human behaviour often outweigh eventual flaws in the technology, radically interfering with the objectives defined at the beginning of the endeavour, it might be worth it to ask whether similar problems also affect electronic music performance, a field that is so often presented as inseparable from new media advancement.

1.3 – Is the medium the message?

Unsurprisingly, bounded rationality found strenuous opposition in economics, occasionally bordering the censorship. Justin Fox says that Simon "soon despaired of gaining acceptance among economists for his ideas of bounded rationality, and moved into psychology and computer science."[74] Ha-Joon Chang notes how the dominant current of neo-classical economists were effective in silencing Simon and his followers labelling them as false prophets until the results of behavioural economics and the 2008 economic crush flipped the script. But bounded rationality did not meet the favour of the musicians of the second half of the twentieth century either; on the

[74] Fox (2011) p.80

contrary, theories diametrically opposed did. An influential one that contributed to move the focus of the discussion towards the behaviour of machines instead of people was authored by telecommunications guru McLuhan and Fiore in 1967:

> The medium, or process - electric technology - is reshaping and restructuring patterns of social interdependence and every aspect of our personal life. It is forcing us to reconsider and re-evaluate practically every thought, every action, and every institution formerly taken from granted. Everything is changing - you, your family, your neighbourhood, your education, your job, your government, your relation to "the others." And they are changing dramatically.
> Societies have always been shaped more by the nature of the media by which men communicate than by the content of the communication.[75]

In other words, the medium is the message. In the 70s the idea that technology was changing our music forever and to an extent never seen before seemed to be so broadly accepted that we could see musicians as different as Bob Ostertag and Stockhausen on the same page. Ostertag would describe situations in the 70s in which people would seat in circle and pass McLuhan's writings like a joint.[76] In 1974 Nam June Paik described for the first time his vision of an 'Electric Superhighway' that would lead to better worldwide communications and feedback loops of public engagement.[77] Jim Horton, who had already paid tribute in 1974 to McLuhan's ideas in a piece called *Long Division,* so described his optimism about the uplifting capability of new musical technologies:

> When the programs are running autonomously, slightly beyond my comprehension, playing music I probably wouldn't have thought of left to my own devices, I like to imagine they are precursors to uplifting, slightly alien musical A.I.s of the twenty-first century. Oh, how I hope and wish that contemporary cyberculture will lead to a beautiful utopian compassionate world of Good![78]

Boulez would insist somehow on the priority of contents, saying that "musical invention must bring about the creation of the musical material it needs; by its efforts, it will provide the necessary impulse for technology to respond functionally to its desires and imagination."[79] But he would

[75] McLuhan and Fiore (1967).
[76] BoB Ostertag, lecture at Mills college in 2010.
[77] Paik (1974)
[78] Horton (1996)
[79] Boulez (1977)

always express an unshakable trust that technology was radically reshaping our mind: "it goes without saying that the reasoned extension of the material will inspire new modes of thought."[80] Stockhausen explained the effect chain with these words: "New means change the method; new methods change the experience, and new experiences change the man."[81] Xenakis would go even further. Referring to his stochastic formalization as an outside-time category he argued:

> I believe that music today could surpass itself by research into the outside-time category, which has been atrophied and dominated by the temporal category. Moreover this method can unify the expressions of fundamental structures of all Asian, African, and European music. It has a considerable advantage: its mechanization - hence tests and models of all sorts can be fed into computers, which will effect great progress in the musical sciences.[82]

Ultra-modernist composers would advocate for technological innovation in order to create a new universal musical language inspired by science. Radical mavericks would advocate for technological innovation in the belief that new technologies would improve the musical community, thus the community as a whole.

Whereas this enthusiasm still seems to hold still in some modernist strongholds, a big part of the outside world, included many of those radical mavericks, seem to have reconsidered those statements. Concerning the hopes for the utopian change led by the evolution of digital technologies Bob Ostertag revisited his thoughts: "Today these ideas seem anachronistic and hopelessly naive. Our current 'access to tools' is without precedent. Our lives are inundated with digital tools that promise to improve communication but seem only to make us more alienated."[83] In another occasion his words resonate with Herbert Simon's analysis that opened this chapter in that new technologies did not cause any deep revolution in basic human organizational processes:

> The idea that new musical relationships between musicians can be created through technology is analogous to the idea that new social and political relationships can be forged with technology, which is the central claim of the "information technology"

[80] *ibid.*
[81] Stockhausen (1971) in Maconie (1989) p.88.
[82] Xenakis (1995) p.200.
[83] Ostertag (2009), p.145.

> industry. But the more familiar I become with "information technology," the more deeply I doubt that it creates any new relationships at all. Once the hoopla dies down, it seems that what we are left with is the same old relationships in new packaging.[84]

If musicians once saw a global village of peace and exchange in the new expanded communication media, today our relation with the normality of the these media is often more concerned with the threat of seeing one's privacy sold to the best bidder.[85] This is by no means to say that technologies did not improve many aspects of our lives. Stephen Pinker goes to great lengths to demonstrate with all sorts of datasets that technologies contributed to the decrease of violence on large scale, spanning any imaginable field.[86] Even if often criticised for the excessive reach of his positivism and the tendency to look more closely to the first world than elsewhere, it is hard not to agree with at least some of his conclusions. The problem seems to be more specific to the assumptions regarding the art world.

One of the most important consequences of McLuhan's theory applied to the arts is that, the medium being the message, aesthetic improvement is intrinsic to the improvement of new technologies. In the last decades, the direct relation between technological innovation and aesthetic innovation has come to a greater scrutiny: besides provocative but insightful positions such as Ostertag's mockery of computer music,[87] positions supported by impeccable fieldwork are also finding their way into the discussion. In her ethnography of the IRCAM in the mid-80s, Georgina Born presents a strong case against such direct relation in music involving new media.[88] Describing a situation that was source of dissatisfaction among many people working at the institution she says:

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[84] *ibid.* p.146
[85] Some of today's musicians that dealt with the topic of privacy are Holly Herndon and Stefan Prin.
[86] Pinker (2011) pp.573-579
[87] In his provocative essay *Why Computer Music is So Awful*, he goes on more specifically about the relation between access to tools and aesthetic quality of music: "The pieces created with today's cutting-edge technology (spectral resynthesis, sophisticated phase vocoder schemes, and so on) have an even greater uniformity (not to say monotony) of sound among them than the pieces done on MIDI modules available in any music store serving the popular music market. This fact was highlighted during the jury session [of Prix Ars Electronica in '96] when it was discovered that a piece whose timbral novelty was noted by the jury as being exceptional and fresh was discovered to have been created largely with pre-digital synthesizers thirty years old."
[88] Born (1995), pp. 252-258 and pp. 275-278

> Technological dependence and the chronic, cyclical instability of the computing environment this causes, exacerbated by the retranslation of all the software required each time a basic dimension of the overall system is changed, were major factors in the apparently 'local' technological problems of instability and unreliability. The extreme instability and rapid obsolescence were embodied in the many bits of discarded computer technology and peripherals strewn chaotically around IRCAM's corridors. Some were no more than a couple of years old, yet they lay around as though suddenly useless.[89]

As for the reasons of such a choice even if it hampered the aesthetic output, Born points out the dependency from the software industry and the need to adjust to its pace of obsolescence:

> There seemed to be a continuing element of false consciousness in IRCAM's dependency trap: a belief in the need to constantly 'keep up with the States' in terms of prestigious hardware and associated software. These were effects, then, of American multinational leadership and control of standardization in this high-technology sector, which in turn brought premature obsolescence to technologies such as PDP10 that were still entirely functional. The obsolescence was not built-in; it was imposed.[90]

The obsolescence was imposed by the dependency, but such dependency was self-inflicted: a decision led not by aesthetics but by the evolutionary ancient desire to be ahead in the power hierarchy.[91]

Whatever position we take regarding the pace of technological advancement in modernism, it is hard to deny that the capacity of new media to affect the message is at the centre of the electronic music discourse since the early days of the *Musique Concrète*. The question is not whether the medium can affect the message or not, it clearly does, it is about the limits of the causal relationship. This causality, if overemphasized, can quickly turn into dependency. And technological dependency can lead into dangerous grounds when it is not coupled with a thorough and objective assessment of the limits of the human mind. Horton's observation about autonomous programs hinting to fruitful directions we would have never thought of if left alone with our endogenous stimuli is perfectly in line with the more modern views about agency already mentioned. It is the second part of his wish, the capacity of new music technologies to create better

[89] *ibid.* p.256
[90] *ibid.* p.257
[91] Sapolsky (2017) p.441

and fruitful human relationships, that is harder to verify.

The dependency trap described by Born displays similarities with the three examples mentioned: it seems that the banks, Tay, Notre-Dame, and the IRCAM in the period considered, are bonded by a similar proficiency in assessing the functioning of machines, but also by a problematic assessment of people's behaviour. Herbert Simon directly addressed McLuhan's statement with his usual balance and clarity:

> In discussing communications, we should not be too hasty to conclude that "the medium is the message." It might be better to focus the discussion on the contents of the messages instead of the medium. Nevertheless, computers are here in force today and there will be many more of them tomorrow. If, contrary to McLuhan, the medium is not the message, still the medium does exert a strong influence on the flow and contents of messages in organizations, and it is important to assess its significance for organizational decision-making and organizational structure.[92]

And he went on suggesting how in designing new technologies we should not forget the correct assessment of human actors:

> It is important that we talk about designing information-processing systems and not just designing computers and electronic networks. The design must encompass far more than the computer hardware and software; it must handle with equal care the information-processing characteristics and capabilities of the human members of organizations who constitute the other half of the systems.
> For generations to come, although organizations will have many mechanized components, their most numerous and crucial elements will continue to be people.[93]

Is a renewed focus on the message -the human part of the network- refracted in more recent and influential movements in the arts? Discussing performance art and visual art, Bourriaud argued that from the 90s, artists are coming up with perceptive, experimental, critical and participatory models that question messianic visions of progress. Experiments in art are "no longer presented like precursory phenomena of an inevitable historical evolution. Quite the contrary, they appear fragmentary and isolated, like orphans of an overall view of the world bolstering with the clout of

[92] Simon (1997) p.223
[93] *ibid.* p.227

an ideology."[94] According to Latour, the abandonment of ontological barriers such as the clout of an ideology is the quintessential act of respect towards the complex and unpredictable life of an actor.[95] Outside the clout of an ideology, be it a social utopia or a messianic evolutionary pattern defined by technology, human actors are again given the chance to observe the unforeseen consequences of their agency: given the same set of premises, when the music starts, we can no more predict the actors' direction, they make unexpected things happen and the network teems with life. Discussing how the free improvisation ensemble The Seen was able to avoid stagnation by continuously shuffling their members, David Toop ironically remarked "...if you make up a quartet of saxophone, drums, bass and piano, all played by men in their 60s, then you can confidently expect a certain kind of music."[96] The limits of spontaneity have been a recurrent source of reflection in Toop's writings in the last twenty years.[97] Discussing how ideological positions started to show the first cracks already from the mid-70s he argues:

> Eventually, as with any experiment in collectivism, the limitations of freedom began to assert themselves. Collective relationships in which hidden dynamics are not exposed are breeding grounds for covert tyranny. The best improvisors realised that their music demanded constant awareness. As the history of automatism shows, spontaneity attracts the inevitability of collapse into repetitious themes and behavioural tics, stasis and empty chatter…. By the mid-1970s, jazz and free improvisation were being written off as outmoded 'genres that had promised visions of a new kind of society yet failed to communicate to an audience or develop an aesthetic. The truth, however was more complicated and more hopeful. The challenges of creating music that dispenses with any hand of authority would now be addressed as issues central to a long term project, rather than an expression of unfettered spontaneity and the utopia of freedom. After an extended experiment with absolutism, a new process was beginning.[98]

As for the other idealised position I mentioned, the direct causal relationship that should have swiftly linked technological and aesthetic improvement, it is interesting to read Born's analysis, shared also by some visiting composers, regarding the pioneering use of AI at IRCAM from the mid-80s through the 90s: "the likely effect of applying 'rules' derived from one musical genre to

[94] Bourriaud (2002) p.13.
[95] See Chapter 2.2.
[96] David Toop in Rosenstein (2019).
[97] Toop (2002 and 2014)
[98] Toop (2002) p.248

composition is to inhibit any possibility of profound aesthetic innovation and to encourage just variants of the extant genre."[99] In the case described by Born, the sound of the technology that was supposed to change the man sounds curiously similar to the music the man supervising the technological development were composing before the advent of the new technology. This does not mean that there is any inherently exceptional feature in the human mind that the machine will not be able to emulate and surpass, but again we deal with misunderstandings about human behaviour: the idea of securing the 'correct' output of the machine by exposing it only to the accepted aesthetic directions is in contradiction with what we know about fluid intelligence.[100]

When absolute positions about freedom and technology in music fade into the background, we are again free to observe the complexity of the actors in play and notice how, for now, the most puzzling and misleading are the human ones. It must be stressed that any renewed focus on human actors has nothing to do with a return to humanism and the centrality of man as a separate ontological reality: Simon's suggestion to look keenly at the human part of the network comes from the angle of cognitive sciences and goes along perfectly with the fall of the demarcation line between subjective and objective world.[101] Are there notable and recent movements related to electronic music performance that took distance from McLuhan's positions about technology and displayed in their music a subtle consideration of the limits of the human mind in line with Simon's bounded rationality? My case studies will be two movements often associated with the third generation of improvisors: the *Echtzeitmusik* in Berlin and the *New London Silence*.

[99] Born (1995) p.319
[100] Sapolsky (2017) p.702
[101] Simon (2000) 00:11:15-00:12:45, Tarde (2012 [1895]) pp.29-35, Latour (2012), and Sapolsky (2017) pp.580-613.

1.4 – Bounded rationality and electronic media in the third generation of improvisors

> I am clarifying a concept for improvisation, the main features of which are: waiting for things to come, rather than going to fetch them; the valuing of silence as an active musical contribution; only playing when it feels necessary to do so; attending to exactly when sounds begin and end; limiting the responsiveness and interaction between the musicians; focusing on the sound, rather than on the feeling.[102]
>
> Robin Hayward, 1999

1.4.1 – The consciousness of the limits that may in itself alter them

In the late-90s a more silent, more sound-oriented, and occasionally less responsive form of improvisation started to emerge simultaneously in Berlin and in London. The crucial years are probably 1997/98. In Berlin the new movement came to be known as *Echtzeitmusik* (real-time music). The roots of the *Echtzeitmusik* are to be found in the open spaces of the East side after the fall of the Wall. In 1995 a group of young friends and musicians had started to gather and play in a club called *Anorak*, that had opened in 1995 in Prenzlauerberg. The first flyer with the name *Echtzeitmusik* appeared for a concert in 1994 but it is at Anorak that the musicians started to use the name consistently to emancipate themselves from the dominant free jazz Berlin improvisation scene.[103] Their music did not yet have the aesthetic features that would have later made it aesthetically recognisable but it was a mixture of improvised music with alternative Rock, Electronica or Free Jazz reminiscent of the New York Downtown scene of the 80s.[104] The new approach to sound started to emerge in 1997, in the last phase of *Anorak* and with the opening of the new venue *2:13 Club,* where musicians started to be called "die leisen Leute" (the quiet people).[105]

[102] Hayward in Blazanovic (2014) p.181
[103] Blazanovic (2014) pp.52-53
[104] *ibid.* p.59
[105] Blazanovic (2014) pp.59-60 and Beins, Kesten, Nauck, and Neumann (2011) pp.34-35

Some of the musicians involved in the scene from the very beginning were Andrea Neumann, Burkhard Beins, Axel Dörner, Ignaz Schick, Annette Krebs, and Robin Hayward, who had left London for Berlin because he was worried about the economic contingencies that were reshaping London. Thanks in part to Berlin's extremely cheap living costs and the intellectual excitement for the new historical phase to shape, the *Echtzeitmusik* grew into a rich and diverse network of international artists that made of Berlin their meeting point or decided to move there. In the course of the years, its flexible aesthetic dealt predominantly with improvised experimental music but bordered on a wide array of different fields such as noise, electronica, trash pop, free jazz, contemporary composed music, performance art, and sound art.[106] Musicians that at some point started to be associated with the Echtzeitmusik are Michael Thieke, Kay Fugashinski, Toshimaru Nakamura, Thomas Ankersmith, Sabine Vogel, Lucio Capece, Alessandro Bosetti, Magda Mayas, Liz Albee, Biliana Voutchkova, Chris Heenan, Michael Vorfeld, Boris Baltschun, Marta Zapparoli and many others.[107]

In London, the novelty came from a group of British improvisors known as the *New London Silence*. Among them Phil Durrant, Mark Wastell, Rhodri Davies, Angharad Davies, Matt Davis, and Graham Halliwell. Phil Durrant is unanimously seen as a pivotal figure for the reductionist approach that spread through experimental scene of the city from the end of the 90s.[108] Tired of the post-Webernesque virtuosity of much of the improvisation scene in London, in the mid-90s he started to look for a more restrained approach and started to rehearse with receptive musicians such as cellist, and soon-to-be also tam-tam specialist, Mark Wastell and harpist Rhodri Davis. The first recordings displaying this approach came out in 1997: one was *Navigations* by the Chris Burn Ensemble where two pieces, one by Durrant and Axel Dörner, and the other by Rhodri Davies and Mark Wastell presented a more reduced approach; the other was *Beinhaltung* by the trio Radu

[106] Beins et al. (2011) pp.29-30
[107] For a more comprehensive and in depth analysis of the Echtzeitmusik see Blazanovic (2014).
[108] Bell (2005), https://weneednoswords.wordpress.com/2016/09/09/once-this-music-touches-you-it-never-really-goes-away-mark-wastell-and-confront-recordings/ (accessed 6 July 2019), and Beins et al. (2011) p.76.

Malfatti, Phil Durrant and german synth specialist Thomas Lehn.[109] Austrian trombonist Radu Malfatti is a recurring presence whose influence is mentioned both in the *Echtzeitmusik* and in the *New London Silence*.[110] Mark Wastell and Rhodri Davis are another essential source of agency for the new movement. Their collaboration started in the trio IST (Simon Fell, Rhodri Davis, Mark Wastell). Mark Wastell had reached out to Simon Fell, an already established figure in the London scene, and Fell introduced Mark and Rhodri to each other: "the chemical processes resulting from the combining of Rhodri and Mark didn't take long to come to fruition."[111] Another place where the new-minded improvisors met was Eddie Prévost's ongoing improvisation workshop, where Mark Wastell, in 1997, had already started to work with the musicians that would have contributed to the *New London Silence*, such as trumpeter, now electromagnetic field specialist, Matt Davis, and sax and feedback player Graham Halliwell.[112]The label *New London Silence* was used for the first time by the trio The Sealed Knot (Burkhard Beins, Mark Wastell, Rhodrie Davies), initially in the linear notes of their first recording on Wastell's Confront label in 2000, and later for a tour in September 2001. The program notes for the music were a single line of text: "Berlin Reductionism - New London Silence"[113] The popularity of the movement was further cemented by and article by Clive Bell that appeared in 2005 on the Wire.[114]

The Berlin scene never identified itself as the Berlin Reductionism, although the label reductionism became inevitably and, as we will see, problematically associated with both those scenes. The *Echtzeitmusik* and the *New London Silence* from the very beginning always maintained frequent exchanges, and the network soon expanded also to other cities that were experiencing similar musical approaches such as Vienna, Tokyo, and Barcelona.[115]

Echtzeitmusik and *New London Silence* are two movements of capital importance to

[109] Bell (2005)
[110] Blazanovic (2014) p.35 and Fell (2013)
[111] Fell (2013)
[112] Bell (2005) p.35
[113] Private email exchange with Mark Wastell.
[114] Bell (2005)
[115] Beins et al. (2011) pp. 69-77

understand the challenges of improvisation in relation to the electronic media. Coupled with an increased access to electronic instruments, some of the directions explored in Berlin and London in those years provided a fertile ground for a broader inclusion of the electronic media. The reasons are mainly two.

First, the acoustic qualities of the electronic sound started to become a major source of ideas and even acoustic improvisors were often inspired by them.[116] Many of the most common techniques that defined the sound of those scenes have direct references to electronic music. A continuous block of texture travelling flat and horizontally through time, cut sharply and unemphatically at the beginning and at the end, shows clear references to electronic music performances that used gates to activate and deactivate the sounds, when controllers with sophisticated ways to control amplitude dynamics were not available yet. Repetitive and circular motions are reminiscent of the looping technique omnipresent in studio electronic music from the days of the analogic tape. Using the sound of the breath through a wind instrument without letting the note come out and using the mouth and the keys to filter the spectrum of the sound became so common in Berlin that it is now regarded as a classic -or a cliché: that sound is familiar to anyone who heard a white noise generator sent through a filter. With such a similarity in the techniques, it is not surprising that acoustic and electronic instruments merged seamlessly in terms of sound. It must be noted that the techniques that inspired the acoustic instrumentalists and were diffused among the electronic musicians such as amplitude gates, loops, white noise generators, and filters all come from the pre-digital era. The digital techniques most employed by the neo-modernist academic establishment such as spectral re-synthesis, complex phase vocoders, and algorithmic techniques were not influential for the *Echtzeitmusik* and the *New London Silence*. The boom of the personal computer and later the laptop did not have the same direct effects that had on other music generes relying more on studio production.

Second, the slower pace of the decision-making allowed the necessary space for the

[116] Rhodri Davies quoted in Beins et al. (2011) p.70

musicians to come to terms more broadly with the relationship between their agency and the agency of the machines. If we consider the use of the electronic tools in an ensemble coming from the first two generations of improvisors such as the Evan Parker Electroacoustic Ensemble, we notice the acceptance of a separation: electronic music is sound processing, thus even when the decision-making is indeed a loop of responses between the electronic and the instrumental material, the network is hard wired to have the first step coming from the acoustic instruments. The electronic media do not grow with the improvisatory dynamic, they come after and have to scramble among daunting technical challenges to find effective solutions to join a well-functioning and powerful machine. Sound processing does not require the same detail of intervention that we hear for example listening to the usually lightning fast interaction between Anthony Braxton and Even Parker: a quick passage of many notes can be processed with effects, sampling, and algorithmic modifications, bypassing the problem of having to make timely decisions over the most minute detail. The approach generally displayed in the third generation of improvisors is different. The electronic media are embedded in the evolution of the scene, not only in the acoustic way described before, but also in terms of decision-making. Electronic media players are not separated on a different plane of decision-making: the slower pace allows the normalisation of the roles and if the electronic instrument does not allow the same fast interaction of an acoustic instrument, the acoustic players tend to adjust to the minimum common denominator by limiting their possibilities.

In terms of numbers, the normalised presence of electronic music performers in improvised settings is noticeable in the line-ups of some of the most respected large improvisation ensembles that came out from these two movements. In London, if we look at Mark Wastell's ever-changing ensemble The Seen, we notice that electronic musicians are almost always present, occasionally even being the majority of the participants. From 2003 until the time of this writing, The Seen has played in front of an audience 25 times, always in a different formation, although with many recurrent musicians gravitating around the group. Looking at all the concerts played, 206 times an improvisor played for The Seen out of which 66 times the instrument used was either fully

electronic (laptop, analogue synth) or something in between (feedback cello, feedback cymbals, guitar in combination with electronic tools).[117] This accounts for 32% of the instrumentation being made up of electronic instruments. In Berlin, the main improvisation large ensemble is the Splitter Orchester. The Splitter has a stable personnel: with the exception of Helena Gough, who played only in the first concert of the orchestra, all the current electronic members played uninterruptedly from the start in 2010, and no new ones joined the group.[118] Out of the current 24 members, four use electronic instruments (Ignaz Schik, Marta Zapparoli, Mario de Vega, and Boris Baltschun) and two (Andrea Neumann and Magda Mayas) use mixed sets, accounting for 25% of the group using electronic instruments.

If we compare these numbers with other major large improvisation ensembles whose sound is rooted in the ideas of the first two generations of improvisors we notice right away a clear difference. There are early large experimental improvisation groups that included electronic improvisors. For instance, in Anthony Braxton's Creative Orchestra, out of 20 and more elements, there was often a synthesizer player (Richard Teitelbaum or Bob Ostertag).[119] The low number of electronic musicians in those days reflects the obvious fact that portable electronic tools were generally rare and expensive, and improvisors able to play them with the greatest acoustic players even rarer. Another comparison is more telling of the change of scenario that the third generation brought about. The London Improvisation Orchestra (LIO) was founded in 97'/98', thus it is almost contemporary of The Seen. Do we see a similar presence of electronic instruments? Out of the 31 musicians who recorded in *Proceedings,* the first release of the LIO in 1999, only two (Adam Bohman and Kaffe Matthews) are listed as electronics and the proportion stays pretty much constant throughout all the abundant successive releases. From the differences in instrumentation of the large improvisation ensembles operating at the same time of the Splitter Orchestra and the Seen,

[117] I left out electric guitar when played without additional electronic tools because of its iconic place in the acoustic instrument world.
[118] http://www.splitter.berlin/ (accessed 12 December 2019) and private email exchange with Patrick Klingenschmitt,
[119] Albums: *Creative Orchestra Music 1976, Creative Orchestra (Köln) 1978*

we can notice that the broader inclusion of electronic instruments proper of the *Echtzeitmusik* and *New London Silence* is more a result of a change in improvisatory dynamics than a broader availability of the electronic tools. Indeed, the sound of the LIO is deeply affected by the ideas of the first two generations of improvisors (Evan Parker and Steve Beresford were among the most notable names involved in the founding years),[120] whereas the Seen and the Splitter Orchestra are inextricably linked to the generation that came after.

The broader diffusion of an electronic sensitivity for the sound and a generally slower pace of interplay, contributed to an approach to improvisation that, especially in the early years, preferred a more contemplative attitude to the frantic and responsive action of the early free improvisors. A rigid interpretation of this contemplative approach, displaying an extreme inhibitory control preventing traditionally dialogic forms of improvisation coupled with a large use of silence and barely audible volumes, ended up to be identified with the two scenes and labelled as reductionism. Reductionism went on to become very popular in the circles of experimental music. Nonetheless, the reductionist interpretation and its easy branding tend to hide some of the most interesting achievements of the third generation of improvisors. The misunderstandings generated by this classification also open the door to understand how the *Echtzeitmusik* and *New London Silence* seem to be extremely aware of the principles elaborated in Simon's bounded rationality without ever mentioning or -as far as I know- knowing anything about it. Thus, it is worth to elaborate more on what forms of reductions and limits are in play.

The ideas proposed by the main protagonists of the London and Berlin scenes at the turn of the millennium, in a very early stage, presented indeed some aesthetic coherence, but whatever degree of coherence these ideas might have had, they soon started to splinter into a kaleidoscope of approaches to electronic music improvisation, ranging from the lightning fast responsiveness of Ignaz Schick on turntables, to the more objective and contemplative approach to the electronic sound of Phil Durrant, passing through the subtle equilibrium between the behaviour of the

[120] http://www.londonimprovisersorchestra.co.uk/ (accessed 20 March 2019)

instrument and the performer's decision making of Toshimaru Nakamura on the no-input mixer. Moreover, if we focus on the single actors, we can rarely find a musician whose activity can be pigeonholed in only one direction. Reductionism falls short of describing how this variety of approaches and the coexisting tendencies in each single improvisor are associable with a surprisingly tight and identifiable group of people, who shared many common intentions of which aesthetic reductionism is not the most salient. Marta Blazanovic describes the movement in its dawn as aesthetically dominated by a reductionist approach, resulting in a music that was "relatively withdrawn, much reflected upon, more conceptual, and not that intuitive -but still essentially improvised."[121] But also reported how:

> The term reductionism exemplifies how, in the ever-changing practice of improvised and experimental music, very specific labeling can even have a negative effect in the long run. The musicians, who at the time of their first records and first bigger tours spread the term themselves for practical reasons now mostly complain when categorized as reductionists.[122]

The radical reductionist urge was already considered over in 2005 and Mark Wastell was calling the New London Silence dead.[123] Andrea Neumann found the term reductionism artificial.[124] Axel Dörner said that reductionism was just a word he ended up being associated with against his will and he talks about an expansion instead of a reduction: "...for me, what we call 'reductionism', is actually an extension of my playing. So when I play concerts where fewer types of sound happen, and a lot of silence, then for me it's an extension of my playing. Maybe it has something to do with the fact that I don't play this kind of music exclusively."[125] The unease surrounding the term, can be condensed in Kai Fugaschinski's irony in referring to reductionism as the "r word."[126]

Whereas artists accepting or rejecting labels is generally not an interesting topic, the idea of creating exclusion criteria on the basis of a rigid application of reductionism can have big

[121] Marta Blazanovic in Beins et al. (2011) p.30
[122] Blazanovic (2010)
[123] Bell (2005) and Wastell (2006)
[124] Neumann (2003)
[125] Axel Dörner in Beins et al. (2011) pp. 362-63
[126] Kai Fugaschinski in Beins et al. (2011) p. 253

implications in a field such as improvisation, where inclusion or exclusion from the scene sensibly affects the possibility to play music that generally requires more people freely sharing a set of premises. If any rigid criteria of aesthetic inclusion were ever set, it was only in the very early days. After a few years "the reductive strategies could be truly acknowledged as means to an end, through which the gained musical potential they brought was sought to be extended and evolved in new directions"[127] Soon the Echtzeitmusik identified itself as a network of people with aesthetic ideas diverse and always in flux.[128] Ironically, the most rigid inclusion criteria are now often seen among festival organisers, record producers, and the musicians who join the movements well after the main protagonists started to doubt its coherence.[129]

Why does reductionism and improvisation have this complicated relationship? When I listen to Michael Thieke playing, there are moments where he is controlling three different layers of sound: the standard clarinet's note, the multiphonic in the high register, and the breath, all three layers treated almost independently, using three different, mostly cyclical, amplitude patterns and specific techniques to produce variety in this threefold subtle movement. If the time of such a complex aggregate of motions extended for the short duration of a note in a classic burst of activity typical of the first free improvisors, our perception would stand no chance to grasp and appreciate

[127] Blazanovic (2014) p.77
[128] Beins et al. (2011) p.19
[129] There are differences between Berlin and London worth to mention. Contrary to Berlin, in London some of the early actors of the lowercase improv insisted more on the modernist principle of the "new thing" referred solely to the musical sound; that automatically leads to a more familiar concept of musical current, more than a flexible network of people with plenty of contradictions in the sound they embrace. The difference comes out also in the names: *New London Silence* points to a new aesthetic connected to an acoustic component of the music, whereas *Echtzeitmusik* expresses an aesthetic based on a modality of musical performance. The reasons for this difference are probably two. First, in Berlin, after the fall of the wall that had kept near and unreachable so many friends and family members, the insistence on bridging differences was a more powerful drive than the emancipation of a new sound from the previous directions of free improvisation. Moreover, the history of free improvisation in Berlin, mostly revolving around the Total Music Meeting festival, had very respectable antecedents but not comparable with London, that from the 60s until the 2000s had been the main furnace for the European free improvisation. The second cause kicked in gradually but inevitably. At the beginning of 2000 London was still probably the European city with the biggest number of free improvisors, but in the last twenty years the situation was sensibly altered by the new financial ambition of the City. While Berlin attracted musicians from all around the world, London's prohibitive and always increasing life cost, and shrinking municipal funding drew musicians away: soon the Echtzeitmusik ended up to have far more heads to bridge together than the New London Silence and its more recent followers.

all the acoustic micro-developments. Thus, the duration is long, the volume is quiet and there are no frequent abrupt changes of direction in the music. These elements call for active listening and encourage the listener to dive into the details. Does reduction give the idea of what is going on here? If we consider reduction in function of the information the musicians are exchanging or the listeners are receiving during the performance, we notice that reductionism is often at odds with basic theory of information: if we reduce the maximum amplitude of the information channel, but we increase the resolution of the signal accordingly, the capacity of the channel, thus the amount of information carried, stays the same.[130] As observed in the program notes for the group *Phosphor,* working with very quiet material was functional to "opening a microscopic dynamic spectrum with a large potential for differentiation."[131] The increase in resolution, thus the potential for major differentiation, is achieved relying on the adaptiveness of our perception: once the listener's perception adjusts to a new threshold of details, the amount of information carried by the sound can result even in an expansion.[132] The idea of reduction leads to misinterpretations about the adaptiveness of our perception because it often categorises a performance on the basis of the capacity of the information channel mistakenly considered as a constant instead of a variable. Even though keeping the sound insistently to barely audible levels, is generally preferred, both silence and loudness can foster adaptive perceptive phenomena. Phil Durrant, even if he has no issues with the term reductionism, is aware of the mechanism: "the big thing is not a reduction in material and volume, it's a reduction in pace."[133] Perceptually, fitting examples of reduction are, for instance, the American minimalists. Minimalists truly reduced the information because the slow pace of changes was not coupled with any increase in the resolution of the information channel. The volume generally oscillates normally and the patterns are repeated but dense if taken singularly: our perception is not called into a state of alertness for the microscopic world of barely audible details,

[130] Shannon (1948)
[131] http://www.burkhardbeins.de/groups/phosphor.html (accessed 1 March 2019)
[132] If you are familiar with life in little country towns, you probably know how much sensitive information can be shared with fast whispers and how little information can be conveyed in loud screams.
[133] Phil Durrant in Bell (2005) p.35

on the contrary the possible altered state of consciousness induced by the repetition of a rhythmic pattern can cause the opposite effect. There is no denying that the third generation of improvisors insisted on limits, but limits here are often functional to the expansion of the information channel: when the channel's capacity increases, new actors emerge form the world that was before below the detection threshold of our perception, thus concealed from our standpoint of observation; new actors mediate new agencies during the performance and details before unworthy of attention are now the mediating forces that make unforeseen events happen. These concepts are anything but new: Cage was already proposing this idea eloquently about 50 years before; Feldman was insisting on limits and repetitions in a way that often very closely recalls the music that came out of London and Berlin from the end of the 90s; former member of Nuova Consonanza Walter Branchi, from the 70s, spent his whole life insisting on quiet music to allow the sounds of the surrounding environment to be part of the music; starting from the early 90s, the Wandelweiser group found all sorts of reinterpretations of composing the quiet, letting the sounds of the environment and the most inaudible details of the musical gestures participate to the composed material.[134] A truly innovative aspect of the third generation of improvisors is their ability to adopt this sensitivity in a performance which remains essentially improvised and, as such, retains the nuances of the four planes of the social mediation described by Born. There were early visionary forerunners such as Roscoe Mitchell and David Behrman experimenting, among the other things, with a similarly reduced pace in improvisation but we need to wait until the musicians in Berlin and London for its broad diffusion in group-improvisation and the successive international reach.

When we clear the space from the engulfing label of reductionism, we notice that some of the most interesting results achieved by the *Echtzeitusik* and *New London Silence* follow an attentive and constant consideration of human capabilities more than an aesthetic guideline.[135] So

[134] With the exception of Walter Branchi, all these experiences are openly mentioned as influences. See Bell (2005) and Blazanovic (2014).

[135] In her thorough dissertation about the Echtzeitmusik (2014), Marta Blazanovic says that the interest shifted from the social aspect of free improvisation to merely aesthetic aspects. Here I found myself in disagreement: the social aspect of "traditional" free improvisation in the early 2000s often resembled more an idea constructed in the imagination of a restricted group of musicians deeply influenced by the 60s,

many instances of the music produced by the third generation of improvisors whisper bounded rationality. The limits of human mind are always reassessed situation by situation, actor by actor, creating a fertile ground for the inclusion of a broad variety of instruments, techniques, and personalities, keeping the music away from polarising ideologies. The first principle of bounded rationality, the limits posed by unconscious habits, is considered for instance in the initial desire to avoid quick and excessively dialogic forms of improvisation, a desire that was a driving force for the change: conventionally virtuosic and quickly reactive free improvisation was showing the problems of automatic responses, both necessary to the intuitive process and a potential trap for a practice that aims by nature to continuous renewal. Magda Mayas analyses the limits of the space surrounding the performer, arriving to think about the placement of the instruments on the stage as a time map for the performance where physical limits are consciously used as compositional material: "these placement decisions can facilitate a quick succession and seamless transition between sonic events, or can consciously incorporate the movement, effort, and time involved in reaching an instrument or object, by placing it further away."[136] In her reports of the experiences of drummers and collaborators Tony Buck and John Stanier, we notice that the physical limits are also attentively coupled with the limits of the human mind: the placement of the instruments not only creates a physical map but also works intentionally as a filter against psychological habits, encouraging the performer to avoid easy choices wired in the gestural memory of the performer.[137]

The second principle of bounded rationality, the limits posed by value judgments, is visible in the lack of rigid ideological positions concerning aesthetic. Philip Durrant says that "Radu Malfatti's argument was that we never took it to the extreme. I imagine that Radu would like to think that he and Tako Sugimoto did, in terms of playing maybe 45 sounds in an hour."[138] Even if there is no agreement with this, my interpretation of this divergence echoes Burriaud and does not

whereas the new musical ideas proposed by the Echtzeit, from 2000 onwards, turned out to be also conductive to stronger forms of social cooperation.

[136] Mayas (2020) p. 252

[137] *ibid* p.253

[138] Bell (2005) p.39

diverge from the reasons why the third generation preferred to turn the corner from the busy improv of the previous two generations: both Brötzman and Malfatti's oppositely uncompromising positions, the former aimed to an extreme maximisation of the sound volume and the latter to an extreme rarefaction, are charged with messianic views about where the music should go, and with it the world. Once the ideology withers, individual musicians and small cooperating groups are left alone with the limits of their perception. Improvisors are in an advantaged positions to assess those limits because of their proximity with intuitive processes, often the most effective canary in the coal-mine to spot such limits. In a renewed state of intellectual awareness, aesthetic directions are continuously considered critically according to the specific situation. Even improvisation itself cannot be taken for granted. One of the most brilliant groups that came out of the Echtzeitmusik, International Nothing (Michael Thieke and Kai Fagaschinski), described their process in these terms:

> Michael and I generally meet empty-handed. We develop all our ideas through collective rehearsals. Usually this begins with a small material idea, a sound, a multiphonic, from which we develop a second voicing, which in turn often changes the initial idea ... At the beginning of our work as composers, structures were still partially inspired by improvisational experiences. Today the intuitive and spontaneous moment of improvisation has disappeared from our work.[139]

Clearly, improvisation's role can still be tracked and it seems closer to what we are used to see in many musics reported by ethnographers or also in many works of Western art music before the second half of the XIX century: it contributes to the creation of a shared repertoire that reflects an improvisational sensitivity but, once the repertoire is established, the decision-making has stringent limits.[140] To ideological positions to which the music should adjust, it is preferred a music that adjusts to the limits of the situation observed. The limits of ideological positions about freedom are also keenly considered in Mark Wastell's approach to his large ensemble The Seen. In the ensemble,

[139] Kai Fagaschinski in Beins et al. (2011) p.253

[140] To attest the presence of an improvisational sensitivity, the music of International Nothing's works is published by Ftarri, a label specialised in improvised music, and the group played in most of the festival of improvised music in the globe.

continuous aesthetic regenerations stem from the tension between a predetermined but flexible idea of sound and the continuous scrambling of the members of the group, who often span three generations and an extreme variety of backgrounds and instruments: different configurations of the human actors provide each time variety beyond the individual capability of proposing always different solutions.

The third principle of bounded rationality, the limits of the human mind to process information whose consciousness could in itself alter them, is expressed by a continuous encouragement in the music to foster the adaptiveness of our listening to the most minute detail: the reduction of information allows to focus on elements otherwise impossible for our perception to process. Mental limits are also openly and vividly addressed by Lucio Capece, whose barely audible performances are as close as one could associate with reductionism:

> I do not mean playing for thousands of people. I still speak about reaching with the quietest sound that one person sitting in the last row of a space. My imagination has a limit, and I don't want to use amplification to make the quiet sound louder because then there would be no space for my imagination.[141]

The acoustic space is defined by the physicality of sound, by the energy dissipation of pressure waves traveling from the player to the last row of listeners. But, perhaps in a rare acknowledgement in the art world of another form of reductionism, psychological reductionism, the same physical space traveled by the sound waves is the space that delimits our imagination. The more we are made aware of the physical limits of our mind, the more the limits themselves are reconfigured, and with them we reconfigure the acoustic space we can imagine.

If bounded rationality is indeed a sound key to interpret what happened in those scenes, it should allow us to make predictions about a most relevant issue of this essay: the relationship between electronic music improvisors and technology. We should be able to observe that McLuhan's positions no longer capture the relationship between people and machines and the dependency between aesthetic innovation and technological innovation is far less pronounced than

[141] Lucio Capece in Beins et al. (2011) p.259

what we are used to when we think of electronic music.

To prove this point I could not rely only on the music and the texts I had. The understanding of how decision-making processes are mediated by electronic music instruments requires specific knowledge of the instruments and the approaches embraced by the musicians. Most of the information available about improvisors who left a mark refers either to traditional forms of improvisation or to the free improvisors of the first two generations;[142] and the marked presence of the third generation of improvisors in festivals, records, and press has yet to translate into a broad availability of information. Therefore, I reached out directly to the musicians and the next part will take the form of a survey.

1.4.2 – A survey about technological dependency

In this survey I asked the same three questions to 7 electronic musicians representative of the third

[142] Talking generally about improvisation, in 1980 Derek Bailey expressed a concern that "while [improvisation] is today present in almost every area of music, there is an almost total absence of information about it." George Lewis remarked how in David Cope's *New Directions in Music*, published in 1993, there was a curious trend: improvisors that already had achieved worldwide stature such as Coltrane, Parker, Taylor, Coleman were at best mentioned in passing, while many pages were devoted to "contemporary music improvisors" whose written descriptions of their own improvisations far outmatched their presence on the scene. Things have slowly started to change in the last three decades, both in terms of quantity and reliability of the information. Some of the most quoted and talked about books in the field of improvisation were written or reprinted in this period. Most of the times, their authors were improvisors of worldwide stature and dedicated plenty of pages to their own thoughts and those of their esteemed colleagues. Wadada Leo Smith's *Notes (8 pieces)*, originally published in 1973 as a 200 copies self-publication, was reprinted in 2015 in occasion of a retrospective on Leo Smith's work; Derek Bailey's *Improvisation, Its Nature and Practice in Music*, whose first edition dated 1980, was reprinted in its final second edition in 1993, becoming arguably the most quoted text in the field. Other books that came out and stirred the discourse from the 90s onward were Eddie Prevost's *No Sound is Innocent* (1995), George Lewis' *A power Stronger than Itself* (2008), and Bob Ostertag's *Creative Life* (2009). A new recent turn is cementing the literature about improvisation with improvisors turned into chief editors of the most prestigious academic publications such as George Lewis for the two volumes of *The Oxford Handbook of Critical Improvisation Studies* (2016) or Georgina Born for *Improvisation and Social Aesthetic* (2017). This welcome availability of information about improvisation still does not fully satisfy our question. All the titles mentioned have one thing in common in that all their authors or chief editors came out as improvisors in the 60s or 70s. With the due exceptions, most of the material treated refers to the first two generations of free improvisors or to ideas that budded in those years.

generation of improvisors. For the most, I focused on Berlin and London. The questions are aimed to understand better their instrumentation, what led them to their current sets and, ultimately, how they see the relationship between those objects they play and their aesthetic. Only when something important felt left out of the conversation, I asked additional questions.

Toshimaru Nakamura, Ignaz Schick, and Marta Zapparoli are the musicians surveyed directly associated with the Echtzeitmusik. Thomas Lehn never lived in Berlin and was not an active part of the Echtzeitmusik but he shared the same concert venues and collaborated with numerous members of both scenes. Moreover, he is arguably the purest synth improvisor of the third generation of European improvisors. In London, only Phil Durrant is among the first members of the New London Silence, but Phil Julian and Bill Thompson are among the most regular electronic improvisors that share the stages where that approach to improvisation left a mark.

Toshimaru Nakamura is the pioneer of the well-known no-input mixer, a standard mixing board used as an electronic music instrument plugging the output inside the input and controlling the feedback with gains and filters. After deciding to focus on the no-input mixer in the mid 90s, Nakamura started to split his time between Tokyo and Berlin, getting deeply involved with the Echtzeitmusik scene. His music is recorded on over one hundred audio publications, including nine solo CD's.

> LM – What do you look for in an electronic instrument? What brought you to your current setup?
> TN – I started to play electric guitars when I was a teenager. Nothing so special. It happened to me just like it did to many other kids. Guitars were everywhere around. I grabbed one of them. And my first job I had was a sound technician. It was the days back in analogue tape machines, effect units, and mixers. So, those things were always around. At one point in my life when I decided to stop playing the guitar, I saw all those things around me left over. And I found possibilities in them.
> LM – How do you see the relationship between technological innovation and aesthetic innovation?
> TN – I understand technology and aesthetics are related. In human history, they cannot be separated from each other. But I don't really look into the technological side because I don't invent or develop anything totally new. Technology is everywhere. I am just a user. So, I only care about my aesthetics.

LM – Was the no-input mixer just another thing that was hanging around you and you saw more possibilities in it or there were other ideas that came to mind?
TN – There were some positive movements in my mind and negative ones. I should say, the negative one arose first, and the positive one came after that, luckily, to rescue me from my mess. I was still playing the electric guitar when I was around 35 years old. That was, I saw, a kind of extension of my youth activity. I was struggling to find my own voice, but I couldn't reach the point. Even worse, I started to realise that I was not a good guitar player. Not only not good, but also not special. Maybe I knew that since long before but I just didn't want to accept it. Firstly, my inner voice told me to stop playing guitar, and then my body started to resist doing it psychologically and also physically. I was being driven to the verge of stop playing music altogether, but I saw the light of the possibility with the mixer, pedals, and cables, just without the guitar in the last moment.
LM – How do you see the balance between obedience to the instrument and the possibility to improvise with someone else making decisions?
TN – I don't think they can be separated. When I play improvised music on my no-input mixing board, sometimes I make my decision, sometimes I follow what my machines want to say. I cannot tell how much is from me, and how much from my mixer because the balance is always different. If I have to say, they are more or less 50/50.

Among the electronic improvisors that came out from the 90s onwards, Thomas Lehn has been one of the most active voices in the last 25 years. In this period he has been performing in all sorts of formations on modular synthesizers and since '94 he performed almost exclusively on the *EMS Synthi A,* an analog synth released in 1971 which still today he uses without any substantial modification.

LM – What do you look for in an electronic instrument?
TL – Firstly, I always considered my synthesizer as a music instrument, like an acoustic instrument. Like those, it produces sounds of various kinds of which music is created.
However, like other electronic instruments, the EMS Synthi A offers at times the possibility to produce sounds without the players activity: it is capable to run itself. A feature, which I do not want to regard as of such high importance; I use it very occasionally, but I enjoy a lot when the Synthi "proposes" or "surprises" me with some material I can pick up, "observe" and develop further!
LM – On what basis do you decide to introduce a new element in your setup?
TL – Another consideration when regarding the Synthesizer as an "instrument" is the phenomenon of growing with it in a kind of long-term relationship, where you go through various stages over the years. Like with an acoustic instrument, there is no end of learning, no end of getting deeper into something. Same consideration I have also with ensembles: I am curious about what happens with the music after many years working together: what stays, what opens up into other aesthetical orientations based on long-term work.
This is probably the main reason why I did not change my electronic setup anymore, since I got the Synthi A back in 1994. I am staying with it like a violinist stays with

> playing the violin. Aside continuing performing with the piano, the Synthi A became my main and only electronic instrument. I never introduced any other electronic devices into my setup or around the Synthi so far... In the majority of all my performances, I just use the Synthi without any other additional electronic devices.LM - How do you see the relationship between technological innovation and aesthetic innovation?
> TL – I value as said above a deepened background, and the growth of something over a long run and continuity of work. In this respect - despite the wide range of new possibilities of sound structure and qualities - I see and hear technological innovation with a critical eye and ear in regards to aesthetic innovation. I believe, aesthetic innovation is not so much based on technological innovation, rather on the minds of the artists themselves. New sounds do not necessarily mean "innovation;" it might on a superficial level, but not necessarily on a deeper consideration of art.

Ignaz Schick is an integral part of the *Echtzeitmusik* scene. Initially trained as saxophonist, from 2004 onwards he increasingly started to play concerts using the record player as main instrument.[143] He quickly shifted from sample-based material to a more abstract form of turntablism, using only objects on the rotating surfaces of the record player. After about 10 years, when his set-up got stolen, he came back to a sample-based approach and now he plays mostly with samples from a collection of performance records.

> LM – What do you look for in an electronic instrument?
> IS – When playing saxophone I am still focusing on so many timbral elements within the tonal control, I simply never got further into all those abstract sounds and noises people like John Butcher, Alessandro Bosetti, Frank Gratkowski or Axel Dörner are capable of doing. And so I decided to do all those abstract sounds with my electronic set-up, like dividing the job. Another aspect is that I can completely exchange the material in my electronic set-up depending on the musical context. Over the [last] years I have worked mostly sample based, which means by switching from one record to another, I can enter and open a completely different stylistic terrain. Another really important issue is accessibility and tempo. I work mostly with improvisers, many of them are acoustic players, very skilled, virtuoso and fast reacting musicians. I need to be able to react in an instant. That's why I use the turntables, they are extremely fast and reactive, also haptic and hands on. A small gesture can have a big impact.
> LM – On what basis do you introduce new elements in your set-up?
> IS – Recently my performance records have reached something like 50 copies, which I carry besides some other machines. So I got the 4ms and I started sampling entire records onto one sample slot. I took those vinyls out in order to be able to carry less or other vinyls. That's one reason why I added the samplers. Another was when playing in Ilog with Oliver Steidle. I felt that I needed to be more precise as he plays so tight on his drums. I needed to be more on the spot and with the pads it is easier to achieve than on my records.... In Perlonex I need a certain range of materials and a key element are sine wave drones. So here I added oscillators or synths to the line-up. In Splitter

[143] Ignaz Schick in Beins et al. (2011) p.239

Orchestra it is more a question of which sounds and samples of my library will blend and work with the many extended sounds created by the mostly acoustic instruments. For example, the players of Splitter are very tasteful, critical, and demanding due to their highly individualistic craft and refinement, when it comes to sound production. In general I have completely stopped using software and computers in my live-playing. I use both in the studio, but I do not switch software anymore. I use the same tools all the time.
LM – How do you see the relationship between technological innovation and aesthetic innovation?
IS – For me the tools should always be serving the purpose and not vice versa. When I listen to music, I don't want to think of how and with what tools it is made. I want to forget about this and want to be invited to not think anymore. Also we cannot constantly innovate. We also need to repeat, rethink, recreate, rearrange, reorganize, re-categorize, restructure, resolve, restore, revaluate and re-contextualize some things achieved in the past. At least for me, this is what I mostly do. I stopped producing new sounds; I sample from the vast history, but put things in different context, and create new constructions and possibilities. Mostly you will not know the sources I use, cause they are so unknown and unfamiliar, or in such different context. Of course there are great new machines all the time, and I am now shy to use them if they can't serve some good purpose.
But recently I have returned more and more to some very basic, analog and often handmade choices in tools. I tend to compose my music using pen and paper and draw my score by hand. It would take too long to achieve what I want to do by using notation software. I use old sine wave generators or oscillators instead of a phone app. Maybe I am old school, but I am happy to not spend time at the computer.

As Ignaz Schick, Marta Zapparoli also came out from the Echtzeitmusik and is part or the Splitter Orchester. She belongs to that group of musicians such as Valerio Tricoli and Marc Baron who decided to make an instrument for live manipulations out of the analog tape reels, and found original aesthetic solutions some 30 years after the first experiments by pioneers such as Bob Ostertag and Simon Emerson. Most of her work happens before the performance, traveling for site-specific recordings or waiting for some processes to deteriorate the tape. Nonetheless, the large array of material and hands-on approach translates into numerous collaborations with all sort of improvising performers. In her discourse, more than practical aspects, it is her subjective idea of sound to come out, but the attention to the behaviour of the machine works as a constant backdrop.

LM – What do you look for in an electronic instrument?
MZ – The electronic instrument is a tool I use to express my physical and polluted idea of sound. I utilize analogue tape recorder due to its physicality, the risk and potential imprecision involved, the freedom of handling, the background noise, the rough sound,

and the chemical characteristics of the tape. My particular love is the capacity of the magnetic tape to change quality after long time use, particularly in the low-end frequencies. [There is a certain warmness in the bass, and the lack of digital compression allows for a more realistic sense of dynamics and space.] The sound quality of the tape reflects the idea of materiality that I have towards the sounds of the outside world. This machine allows me to use my hands as a connection between different fluxes of energy.
LM – On what basis do you introduce new elements in your set-up?
MZ – My set up can be very simple with no external effect devices etc., but also at times more complicated with the use of detectors, antennas, radio receivers and more. I don't introduce new elements often, just when my project dives and change its shape from specific ideas. It is a constant evolution of ideas and the new element is introduced only when I really need it to develop the idea.
LM – How do you see the relationship between technological innovation and aesthetic innovation?
MZ – I think that technological innovation and aesthetic innovation are not linked to each other, are not synonymous. Aesthetic innovation comes from the stimuli of the outside world, interpreted, transformed, reinvented by creativity and imagination. In our society we need to use technological innovation in an intelligent way to transform unique and creative ideas into new realities.

In London, Phil Durrant was an essential influence in the reductionist approach that spread through the experimental scene of the city from the end of the 90s. Trained as a violinist, before the end of the 90s he took part in some other notable experiences of the London scene such the “group voice approach” with the trio with John Butcher and John Russel. Among the first examples of a more reduced approaches there is his trio with Radu Malfatti and Thomas Lehn. In the 2000s he gradually shifted towards electronic music, initially with self-programmed Reaktor sessions and more recently focusing exclusively on modular synthesizers. On modular synth, he often performs solo, in duo with Bill Thompson and Mark Wastell, and as part of Wastell’s large ensemble the Seen. As electronic musician, his most influential collaborative effort is the long-standing trio Sowari with Burkhard Beins and Bertrand Denzler.

LM – What do you look for in an electronic music instrument?
PD – After at least 15 years of working with a specific semi self-built Reaktor Ensembles on a Macbook I changed completely to using a modular synth system in 2016. I had started to incorporate an iPad - as a controller - into the Macbook assemblage but a birthday present of a Moog Mother 32 and the fact I already owned a Doepfer modular system (bought in 2000) made me decide to make the change to modular.

First and foremost the sound has to excite me. If a new Eurorack module or semi-modular instrument is released from a company that I respect - Make Noise, Mutable Instruments, Moog - and it seems to offer interesting possibilities, I tend to wait for demos on Youtube before I decide to purchase.
For example, I already owned a Moog Mother 32 and it was the demos of the Moog DFAM- the follow up release - that showed it's sound and flexibility that made me wished to purchase it. I was also very careful to read the specifications and download a manual and was quite rigorous with my research before purchasing. If the sound world does not excite me 100% - Mutable Instruments Plaites is an example - then no amount of flexibility will convince me to add it to my system.
Size is also an important factor. Being able to carry gear to a gig relatively easily has also become an important factor in the last year. Therefore, small synth instruments such as Kastle by Bastl have become important in my gigging rig.
LM – On what basis do you decide to introduce a new element in your set-up?
PD – In the last 7 or 8 months I have decided I have enough variety and flexibility to do layered 'AMM style' and also 'Moment to Moment' improvisation and I have decided to work with what I have and not buy any more gear. Having said that, I did recently buy 'Sensor Packs' for my Koma Field instrument to add flexibility - and live performance capabilities - for modulation of various parameters.
LM – How do you see the relationship between technological innovation and aesthetic innovation?
PD – In terms of the modular scene, I think that they work together. To be honest, it is mainly the modular scene that I have been following the last 3 or 4 years and the increase in the 'West Coast/Buchla' style synthesis modules has reflected consumers wishes but also encouraged people to try a different way of thinking and move away from the more traditional Robert Moog "East Coast' style.
There has also been an increase in the number of semi-modular instruments - Make Noise 0Coast, Moog DFAM, etc. which reflect an increase in demand of units that work by themselves but also part of a larger system. The increase in popularity of smaller modules - 2HP - also reflects the desire to cram more sounds and modulators into the same space.
In terms of my aesthetic, as I started to understand West Coast at a deeper level, so my wishes to explore this style increased and therefore I was very keen to purchase the 0Coast to explore this area. Moreover, a Berlin based company have released two 'Koma' instruments that have provided two affordable portable mixer systems for contact mics DC motors and effects. Their Kickstarter campaign seem to both reflect and encourage a new found interest in the kind of aesthetic championed by Hugh Davies and David Tudor. The fact that both Koma systems work well with a modular system also spotted a trend which also reflected my personal aesthetic.

Phil Julian is a stable presence in the London scene, now performing mostly with analog synths and laptop. He is another of the few constant fully electronic members of The Seen. His interest for sound stemmed from messing about with tape recorders. He moved to London in the 80s, and was deeply influenced by the local noise scene of the 90s. In these years he also attended concerts of

AMM and Hugh Davies. He started to play live electronic music in 2004, after years of studio productions, when noise musician and improvisor Mattin introduced him to the people of the London New Silence.

> LM – What do you look for in an electronic music instrument?
> PJ – I think some sort of flexibility in terms of what sounds can be generated from / with it is key for me. I don't consciously have a particularly fixed sound palette that I always like to use (although I inevitably gravitate towards some sounds more than others, as everyone does).
> I like a certain amount of tactile interaction with whatever I'm using. It doesn't have to be much; a track-pad on a computer can be enough but I generally don't care for setting a process running and allowing it to run itself without me steering it in some way. Within the scope of your question, a self-generating system with no controls wouldn't be a great approach of course... I do use systems like that but as a studio or solo performance tool.
> On a practical level, portability is usually important. I'm also a sucker for nice aesthetics... Or maybe "well designed" is a better term. I like equipment that makes you want to sit down and use it. Clear, uncluttered designs where the controls are all easily accessible, that kind of thing.
> LM – On what basis do you decide to introduce a new element in your set-up?
> PJ – I do it less than I used to, although I do use modular synthesisers where there tends to be a high "churn" of modules so you can reconfigure the system as your ideas and tastes change. I think I've reached the point where I have *enough* things in general to enable me to do what I do, although I wouldn't say I have any problem with throwing something new into a live setup; I don't really have a regular way of working. I suppose it tends to be a computer and a synthesiser as a basic start point. I try and have the idea and then find the best equipment to execute it rather than turning a machine on and tinkering around until something interesting arrives. I used to do that quite a bit but find it a rather frustrating process these days.
> I tend not to change live setups too readily or drastically because I imagine it may not fit with another person's aesthetics. Hopefully I have enough sonic "material" to hand where I can do that sort of adjustment in the moment if needs be.
> LM – How do you see the relationship between technological innovation and aesthetic innovation?
> PJ – They're often not linked in my mind. I certainly don't rush out and investigate every new piece of gear the moment it arrives; in fact most of the things I use regularly are actually rather old ideas in the grand scheme of things.
> If you have a nice new thing you often want to spend time using it and perhaps therefore it's a new exploration of its possibilities and that seems exciting in some way, causing you to create something new. But I've often found that to be misleading and actually, I could have got a similar result using that dusty old broken thing in the corner, it just so happened that the exciting new thing was switched on at the time :)

As a close to my question, Julian also highlights the problem of who produces the electronic tools and to whom they are meant:

PJ – The other thing to bear in mind, particularly with electronics, is that they're often not really designed with the amount of real-time interactivity and intuitive layout that improvising musicians might like. Often what ends up on an electronic musicians table was actually designed with a guitarist or DJ in mind for example, so technological innovation in those spheres can often be a little irrelevant or a backward step in terms of what we might like to see.

Bill Thompson was born in Austin, Texas, and relocated to the UK in 2004. Before in Aberdeen and from 2010 in London, he has worked on composition, installations, AV performances as well as improvisation, collaborating with musicians such as Keith Rowe, Mark Wastell, Rhodri Davies, Phil Durrant, and choreographer Ian Spink.

LM – What do you look for in an electronic instrument?
BT – I'm looking for something that allows 'discoverability' that is inherent to the instrument (or system) and isn't completely 'fixed' or overly determined. If there isn't some inherent 'cracks' that I can get into and pry the thing apart to discover something new/different/interesting, I'm not much interested in it.
LM – What led you to your current set-up?
It's rarely been a linear process - i.e. I have found most of my instruments by 'accident' depending on what I was doing before. When I first played electric guitar 25 years ago, I wanted to be a blues/jazz/rock player, but I loved to improvise. I was terrible at imitating other people - simply couldn't do it. So, I spent most of my time improvising and learning the instrument itself in an abstract way. Eventually, I started to play it unconventionally, adding a few fx, and then after a while, got rid of the guitar for lots of my work and just played a microphone shoved in a shoe going through an fx unit. I was also doing composition with a computer. I came across some CDJ players and realized they could do most of what I was doing with the computer at that time but live, and so I moved on to that. Eventually laptops became more stable and could do what the CDJs did but with more tracks, so I moved on to that. Ableton came along and was better than DJ traitor. A few years later, I realized a midi controller gave me much more flexibility and so I included that.
After 15 years of that rig that was mostly stable with additions/subtractions of kits/circuitbent objects/found debris, I felt that I had ' done ' that type of work and wanted something else. After a few years of looking around, I coincidentally came across a Moog guitar as they just happened to have one at work that day. I was blown away by it - it was a return to the guitar work that I did years ago but the additional electronics allowed me to experience anew and discover new possibilities, and so I moved on to that.
LM – On what basis do you decide to introduce a new tool in your setup?
I'm constantly on the lookout for new objects to plug into the 'rig'. After a few trial and errors, if something seems productive and novel - allowing more possibilities for interesting sounds, performance experience, etc. LM - How do you see the relationship between technological innovation and aesthetic innovation?

> BT – I don't like technology to fully determine what I do and so if I can't screw it up a bit, I'm not interested. However, I don't like to be completely in control either. When I started losing interest in my laptop + junk set up it was because no matter what I did, I didn't feel challenged by it, it 'stopped pushing back'.

1.5 – Old technologies, new behaviours?

The picture we get from this small but notable micro-cosmos of electronic music performers is as diverse as its members. Unanimous positions are hard to find, but some common directions emerge. More than a causal single-handed creative vision, personal aesthetics are entangled with chance and shared authorship, and machines actively participate to the process. This is not to say that personal aesthetic concerns are not present, in fact they always are, but in the practices described, "external" agencies are perceived as equally important in affecting the decisions that lead to the technology of choice. For instance, there is human agency other than the self: we see equipment and gestures adjusting to the desire to be able to play with virtuoso acoustic players (Schick), to be involved in a continuous, long-term, and cooperative process of aesthetic development within an ensemble (Lehn), we see the concern not to let the equipment change too fast to catch off guard the other musicians of the group (Julian). A marked role of non-human agency is clearly present in the intrinsic characteristics of the machines and the desire to find a balance between what the instrument has to say what the musician wants to say through it is openly addressed (Nakamura, Durrant). Important concerns such as portability (Schick, Durrant, Julian) and haptic feedback (Schick, Zapparoli, Julian) display a mixed nature where human and nonhuman agency are hardly separable. For example, portability is an attribute of the machine but it is defined by concert conventions made of space and people; haptic feedback is also an attribute of the machine but, at

the same time, it can be shaped by the goal of playing with virtuoso instrumental performers.[144]

It is interesting noting how there is no rule that can help predicting which electronic instrument will give the best results: sometimes an instrument is chosen because it allows one to do things that do not come easily out of traditional instruments (Schick), other times it is pure chance, an object hanging there (Nakamura, Julian), or a birthday present (Durrant). In terms of technologies oriented to performance, there seems to be no fixed set from which to choose, nor a tradition that can provide safe advises yet. In the attention paid to actors other than the self, and to how personal intentionality is almost always considered in relation to a larger network of agencies, we can verify also in the third generation Born's account about the awareness displayed by first generations of improvisors toward the microsocialities of performance and practice.[145]

According to the musicians surveyed, the answer to the question that started the survey is clear: the causal relationship between aesthetic innovation and technological innovation is the exception, not the rule. The exceptionality of the electronic media has subdued: the electronic instrument is considered an instrument exactly like the acoustic ones (Lehn); experimental electronic performers are fine with considering themselves just users and focusing the scope of their experiment to the aesthetic domain (Nakamura); even when mentioning the new timbral possibilities, in performance they often prefer simple handmade instruments to the last cutting edge technology (Schick); the idea that new machines generate new aesthetic directions in improvised performances is either openly rejected (Lehn, Schick, Zapparoli, Julian) or it is seen in a broader discourse of weights, where the performer intuitive decisions find a balanced coexistence with the

[144] Portability and accessibility might be easily overlooked but their role in defining the sound palette and the gestural procedures of the performer cannot be disregarded and it is a long-standing reason of debate. The League of Automatic Composers saw in the accessible price of the KIM-1 and in its portability a hope to democratise electronic music performance, to bring it outside the big academic centres where selected composers had access to unmovable and expensive machines. The League's first works are inseparable from the 8-bit sounds of the KIM-1. George Lewis experience at the IRCAM was marked by conflicts over portability and accessibility. His advocacy for small-systems and commercially available technology, with all the consequential intellectual and musical implications, was met with marginalisation and often mockery by an establishment that in the 80s was strongly oriented towards native technologies made available only through elitist selective processes. For a more comprehensive report about Lewis experience at the IRCAM see Born, 1995: 189-193 (PL is the code used to identify George Lewis.)

[145] Born (2017) p.47

independent behaviours of the machines (Nakamura, Julian). Only Durrant considers the link standing. However his perspective, more than in line with European modernism, owes to the first American experimentalism and London pioneer Hugh Davies in that space should be left to sound-producing objects to unfold their own surprising agency and the composer/performer should relinquish a tight grip on the material and become also a listener; such openness to listen to the objects' behaviour can indeed deeply change the aesthetic reasoning of the musician. But how different this sounds from individuating a set of technologies and pursuing the idea that they will contribute to the establishment of a universal musical language.

Probably the most striking finding of this survey is that the laptop is almost completely absent from the setups of these improvisors. Omnipresent in studios and in shows where intuitive decision-making is not a top priority, for most of the leading electronic music improvisors, when it comes to the stage, it is either an object to handle with caution, or straightforwardly an obstacle (Schick). Even more interestingly, some musicians who worked extensively with the computer for years ended up abandoning it (Durrant, Thompson). Software development seems like an "old" way to achieve the result. While programming environments such as Max and Supercollider have reached exceptional levels of efficiency and stability, their diffusion in improvised music that is now leaving a mark is not proportional to their technological advancement. Handmade digital synthesis, so dear to the forerunners of the League of Automatic Music Composers, has almost entirely disappeared. It looks like for many of the most active electronic music performers of the third generation the hoopla of electronic innovation died. New behaviours can be mediated equally by new or old pre-digital technology, and in practice there is a marked trend to favour the latter. The dream of the classical composer of a perfect and docile interpreter is indeed a nightmare for the improvisor: when the laptop stops being a mediator and becomes an interpreter, stops pushing back (Thompson), it is discarded in favour of simpler and older electric technologies. The vast majority of electronic tools are not designed with the amount of real-time interactivity and intuitive layout that improvising musicians might like (Julian), thus improvisors are often confronting the obstacle

of interfering with the behaviour of machines devised for radically different tasks: turntables, tape reels, analogue modules, contact microphones, and mixers have far fewer layers separating the user from their inner functioning in comparison to musical software, and their behaviour can be altered more easily, more quickly, and with a more intuitive haptic feedback.

The *Echtzeitmusk* and the *New London Silence* scenes proposed a successful integration of mostly simple technologies in electronic music performance that displayed a delicate touch for the human mind. They did so not by adhering to reductionism, but in considering its advantages and then surpassing its boundaries; not by adhering to ideological views of a perfectly cooperating society and defining a priori the nature of its social bonds, or by adhering to messianic ideas of a society shaped by technology, but letting social bonds participate in the development of an integrated network of human and nonhuman actors. The result is a scene where technology is coupled with our capacity to process information, where electronic tools, often unchanged for years after their adoption, are given the necessary time to foster intuitive instrumental approaches that serve improvisation as well as empirical compositional practices; a scene where the boundaries of our rationality are embraced for what they are.

As valuable an example this can be, twenty years have since passed from the arrival of the new silent improvisors at the sunset of the past millennium and I think that we could be ready to discuss again the role of digital processors in performance. This time it should be kept in mind how, in the experiences mentioned, bounded rationality eased the successful introduction of electronic media other than the computer in the direction of a rewarding and sustainable improvisatory practice that contributed to and was reinforced by long-lasting human bonds.

2 – Emergence and Actor-Network Theory

In this chapter I will discuss emergence, Actor-Network theory (ANT), and their musical applications. Together with bounded rationality, these two theories and their points of tension are the theoretical bedrock on which my revision of a relational approach lies. The description of my works in chapter 5 will require familiarity with the terminology and the concepts of these theories.

2.1 – Emergence: the whole is more than the sum of its parts.

In the second half of the 19th century, philosopher George H. Lewes described emergence as a result of forces that "is unlike its components in so far as these are incommensurable, and it cannot be reduced to their sum or their difference."[146] It was probably the first use of the term but hardly a new concept. John Stuart Mill years earlier described the same idea with different words,[147] but examples date way back at least as far as the famous Aristotle quote saying "The whole is something over and above its parts, and not just the sum of them all."[148] Emergence describes phenomena where structure, order, or behaviour appears at a hierarchical level above the parts of the system interacting with each other, but the results of the interactions cannot be predicted by observing separately the parts.[149] In the natural world emergence can be observed in many contexts, from the nests of social insects whose complex shapes arise from work which is not centrally coordinated[150] to meteorology, where weather conditions can be statistically predicted observing the

[146] Lewes (1874-79) p.413
[147] Mill (1843) p. 371, 4
[148] Metaphysics, Book 8, 1045:8–10
[149] McCormack, Eldridge, Dorin, and Mcilwain (2012) p.363
[150] Khuong et al. (2016)

nonlinear interactions of different levels of atmospheric pressure.[151]

Emergence can have stronger or weaker interpretations. Stronger here implies the appearance of properties completely new to the agents, hence a vitalistic concept. Weaker simply implies that the parts of the system have mutual relations that manifest themselves only when the parts interact. For instance, gravitational force can be noticed only when the masses interact with each other, but does not imply the creation of force of gravity.

Dealing with complex systems, emergence and its applications are inevitably intertwined with the three bursts of interest in complexity that happened in the twentieth century.[152] After World War I, a first wave of interest in complexity was associated with the concepts of holism, Gestalt, and creative evolution. The term holism, coined by South African philosopher J. C. Smuts, designates the same concept of emergence in that considers natural objects as wholes which are more than the sum of their parts, and the mechanical addition of their parts will not account for their characters and behaviour, nor for the creative principle implied in the synthesis.[153] Gestalt describes the feature of our mind of perceiving the emergence of patterns or configurations from discrete components, and has been the focus of intense psychological study since the early experiments of Wertheimer, Köhler, and Koffka.

The second wave of attention to complexity came after World War II, with the advent of computers and their unprecedented capacity of processing information. The attention suddenly shifted toward information theory, cybernetics, and adaptive feedback. The concepts explored became more specific: besides the general philosophical inquiries and psychological Gestalt phenomena, new models and specific mathematical tools contributed to highlight how the agency of the parts results in the new behaviour observed. The computer, being able to interpret and execute its own stored programs, also initiated the field of artificial intelligence, a quintessential example of emergence that encouraged the study of complex systems both as wholes and at the same time

[151] Lorenz (1980)
[152] Simon (1996) p.169
[153] Smut (1926) pp. 86-87

reducing them to mechanisms.[154]

The third wave of interest in complexity happened at the end of the 70s, it shared many aspects with the second but found new concepts and tools that are still currently explored and capture the attention of scientists, philosophers, and artists alike. Complexity often became associated with terms such as chaos theory, genetic algorithms, and cellular automata which provided even more specific tools to observe the active role of the agents in the emergence of behaviour.[155]

The fourth and latest wave of interest is all internal to the discussion surrounding artificial intelligence. More specifically, emergence is mentioned in the current developments in a branch of neuropsychology called neural correlates of consciousness (NCC), which deals with experiments and mathematical models to answer questions such as: what are the physical laws that distinguish conscious and unconscious systems? How does a specific arrangement of particles start to feel conscious, thus opening the door to make consciousness a possible property of a machine?[156]

In music, emergence is generally referred to as emergent behaviour, which has been associated initially with some experiences rooted in American Experimentalism[157] and now enjoys a more global diffusion. We speak about emergent behaviour in music when we have a system whose musical output cannot be predicted by separately analysing its agents. In musical systems displaying emergence, agents can be people, physical instruments, analogue synthesizers, software: anything, human or nonhuman, that can affect the system's behaviour.[158] This implies that the system should have a behaviour that exceeds our expectations, that seems to have a life of its own. If we have a score that tells the first violin to play a C and the second to play a G, we have a predictable result of the two actions, a stable perfect fifth. Harmonics are a case of Gestalt because, especially when they

[154] Simon (1996) p.173
[155] For a more comprehensive discussion about history of emergence refer to Herbert Simon, *The Sciences of the Artificial* (1996), David Blitz, *Emergent evolution: Qualitative novelty and the levels of reality,* and Peter A. Corning, *The Re-emergence of 'Emergence': A Venerable Concept in Search of a Theory.*
[156] Tegmark (2017) pp.284-314
[157] Perkis (2002)
[158] About the possibility of nonhumans having agency see Latour, 2005: 63–86.

are perfectly tuned, they result in a sound that our perception can hardly unpack into their single components; there are indeed plenty of fifths also inside the two single notes of violin but we usually refer to them as two notes forming one fifth. Although, the emergence of this Gestalt phenomenon is often not enough to call emergence: there are specific uses of harmonics that defy our expectations and would fit loosely the description of emergent behaviour[159] but far more often a fifth is used in such a way that our cognitive representation capacity can let us hear the sound mentally before it happens with very little possibility of mistakes. A different case is if the same notes are played with some unstable multiphonics on two clarinets: here even an expert clarinet player cannot control exactly the sounds produced and we will hear unpredictable beatings, and changing partials that we cannot describe with precision before they happen. The result is more than the sum of its parts. In this case the two instruments themselves work as active agents: the score tells the musicians what to play and when, so their actions do not contribute to the emergence, but it is the physical instrument and the particular technique that generate the unexpected. For people to act as agents in an emergent system they must have freedom of choice: were they improvising with the multiphonics we would have two people and two instruments for a total of four agents to consider. Improvisation is probably the most diffused case of human musical emergent behaviour.[160]

These distinctions are context-dependent, and it would always be possible to identify a continuum. If we take the first example and we have a score that tells the two violinists to play their notes sustained for half an hour, our attention would probably start to adjust to minimal details, and drift toward the random oscillations in their intonation and the irregularity due to the fatigue of the bodies; all things that would perfectly fit the definition of emergent phenomena. Actually a neurobiologist could even short circuit everything telling us that our own expectations are the result of a hugely complex case of emergence that encompasses millions of years of natural selection until the milliseconds in which the neuron fires and we experience expectancy. But emergent behaviour,

[159] Examples are the beginning of *Sound Characters* by Maryenne Amacher or some harmonic sections in the work of Thomas Ankersmit.
[160] Lewis (2000), Haenisch in Beins et al. (2011), and Borgo (2015)

in the last decades, has managed to stay clear from conceptual extremes and provide many practical musical applications.

Leaving the glasshouse of hypothetical music, emergent behaviour can be observed in many seminal works of the second half of the twentieth century. Besides uninstructed improvisation, there are other examples of emergent behaviour insisting on human agents such as Pauline Oliveros' *The Tuning Meditation* (1971) and Cornelius Cardew's *The Great Learning* (1968); there are works involving only non-human agents such as Alvin Lucier's *Music on a Long Thin Wire* (1977); and works displaying coexistence of human and nonhuman agency such as *Variations II* (1961) as realised by David Tudor and John Cage, and the networks of the League of Automatic Music Composers (1978-83).

The comparison between *The Tuning Meditation* (fig. 2.1) and the paragraph 7 of *The Great Learning* (fig. 2.2) can be telling about the great difference in character that minimal variations in the rules of the agents, in similar settings, can confer to a realisation of the piece. Both works are examples of emergence in that the complexity of the pieces takes life from a simple set of rules followed by all the agents. They are similar in many regards: they use mainly vocal sustained tones,[161] rely on the listening ability of the participants to tune themselves on the notes that are being played, and make of the tuning process (or detuning once tuning is achieved) the main generative principle for change. Although, aside from whether the participants sing a text or pure tones, there is one major difference leading to very different outcomes. In the Great Learning the rules give less chances of moving out from the tuning process: the participant cannot pick a note freely unless certain conditions are met. Moreover, the initial sentence of the text points toward a clear movement from cacophony toward harmony.[162] In The Tuning Meditations, the participants can alternate between tuning, injecting new tones, and silence at will: this makes the emergence of a unique harmony far less likely and the music takes the form of a homogeneous drone with continuous internal changes and convergences, but almost never regulated by clear directions from

[161] Even though Oliveros' piece is written for orchestra, most of its interpretations are for choir.
[162] McCormack, Eldridge, Dorin, and Mcilwain (2012) p 364.

II
The Tuning Meditation (1971)

Begin by playing a pitch that you hear in your imagination. After contributing your pitch, listen for another player's pitch and tune in unison to the pitch as exactly as possible. Listen again and play a pitch that no one else is playing. The duration of pitches is determined by the duration of a comfortable breath or bow. The dynamic level is soft through out the piece. Brass players use mutes.

Continue by alternating between the three options described above:

- playing a new pitch of your own that no one else is playing
- just listening
- tuning in unison to the pitch of another player.

Introduce new pitches at will and tune to as many different players as are present. Although the dynamic level is soft make your tones available to others.

Play warmly with variations in tone quality.

Commentary

The Tuning Meditation is not difficult technically for the players since there is no metrical demand. However concentration is necessary and the ability to match pitch. If the instructions are followed carefully then a beautiful texture arises with common tones threading through the cloud of sound.

Fig. 2.1 – Score of the second Tuning Meditation (Oliveros, 1996)

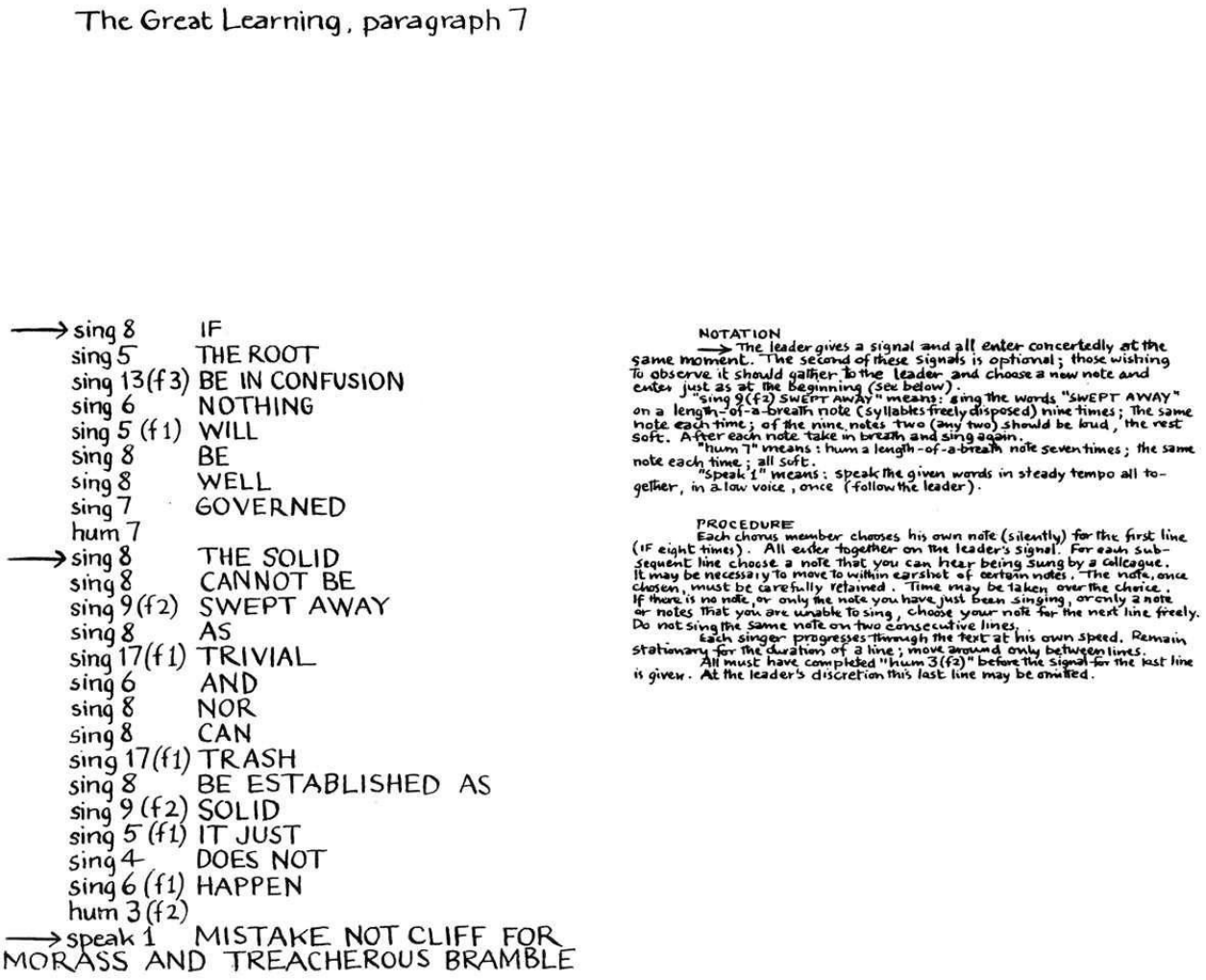


Fig. 2.2 – Score of the seventh paragraph of the Great Learning (Cardew, 1968)

atonality to harmony. Emergent systems tend to be extremely susceptible to minimal variations in the initial conditions or the rules regulating the interactions of the agents: a little detail, a noise in the iteration process, can lead to results that are radically different.

Concepts coming from the third wave of interest in complexity such as cellular automata and genetic algorithms found their natural musical output in generative computer music.[163] These concepts and more generally the non-linear dynamics of chaotic phenomena never really ceased to capture the attention of computer musicians. In the last twenty years they have been expanded such as in the case of Agostino Di Scipio's echo systemic feedback,[164] or old tools found new applications such as the resumption of the Duffing equation by Tom Mudd for new synthesis software.[165]

Another example of emergence that presents additional points of interest is *Decay Trace* (2006) by John Bischoff. The main compositional material of this work are six pairs of coupled sounds: (1) piano cluster1 + TX organ1 and TX alarm; (2) piano cluster2 + TX organ2 and TX alarm; (3) piano clang1 + piano clang2; (4) piano zing1 + piano zing2; (5) piano zing3 + piano zing4; (6) piano pow1 + piano pow2. All "piano" sounds are samples of an acoustic piano and all "TX" sounds are sampled Yamaha TX81Z voices. All pairs are configured in stereo, one channel left and one right. The two sounds of the pair are mutually exclusive, and an amplitude switch changes which sound is playing. To have continuous material between two switching positions, the samples are looped and the playback of the sounds going through the switches is independently controlled by the computer. There is a substantial amount of silence in the loops, with sounds of about 15 seconds followed by similarly long silences; the proportion between sound and silence varies. The silence in the loop makes sure that, when the switch changes position, it is often impossible to determine with certainty if there will be the other sound or silence. When the switch

[163] For a more comprehensive dissertation about history of emergence refer to Herbert Simon's *The Sciences of the Artificial*, David Blitz' *Emergent evolution: Qualitative novelty and the levels of reality,* and Peter A. Corning's *The Re-emergence of 'Emergence': A Venerable Concept in Search of a Theory.*
[164] Di Scipio (2003)
[165] Mudd (2019)

changes position, it also changes the parameters of a filter, causing subtle timbral variations. The switch is initially triggered only by minimal performative gestures like hitting a Tibetan bowl or other tiny objects, via amplitude threshold detection. During this phase the computer also silently records the timing of the human interventions. When the performer introduces another pair, the intuitive durations recorded in the previous phase are looped and used to control the switch of the previous pair while the performer now controls the switch of the new pair. This happens for all the 6 pairs until all of their switches are controlled by the duration loops. The duration loops and the sample loops are not synchronised: this lack of synchronisation, together with the long silences in the sample loops, generates a state of continuous serendipity. The playback speed of the duration loops is accelerated throughout the piece so that the switches happen more frequently while the piece develops. After the density peak of the switches, the duration loops start to slow down leaving space to a soundscape that marks the tail of the piece.

This is a textbook application of the principle of emergence, with complexity emerging from the same simple set of rules applied to all the pairs, but the work displays some unique properties. The information related to the human part of the man/machine interaction is all reduced to a set of intuitive durations: a fairly rigorous compositional idea uses as main element for its development a set of minimal and intuitive human gestures combined with automatic, semi-autonomous computer processes. This work seems to communicate the awareness that machines are shrinking the space where human agency is truly necessary, but reducing the information channel between performer and machine and focusing on a limited number of variables, we can identify the moving threshold where human gestures are still indispensable.

The Networks that the League of Automatic Music Composers created from 1978 to 1983 are an early example of seamless integration of human agency and computer agency. They also expose some limits of emergence to describe the League's music. Looking at the flyers they drew for their concerts is indicative (fig. 2.3).

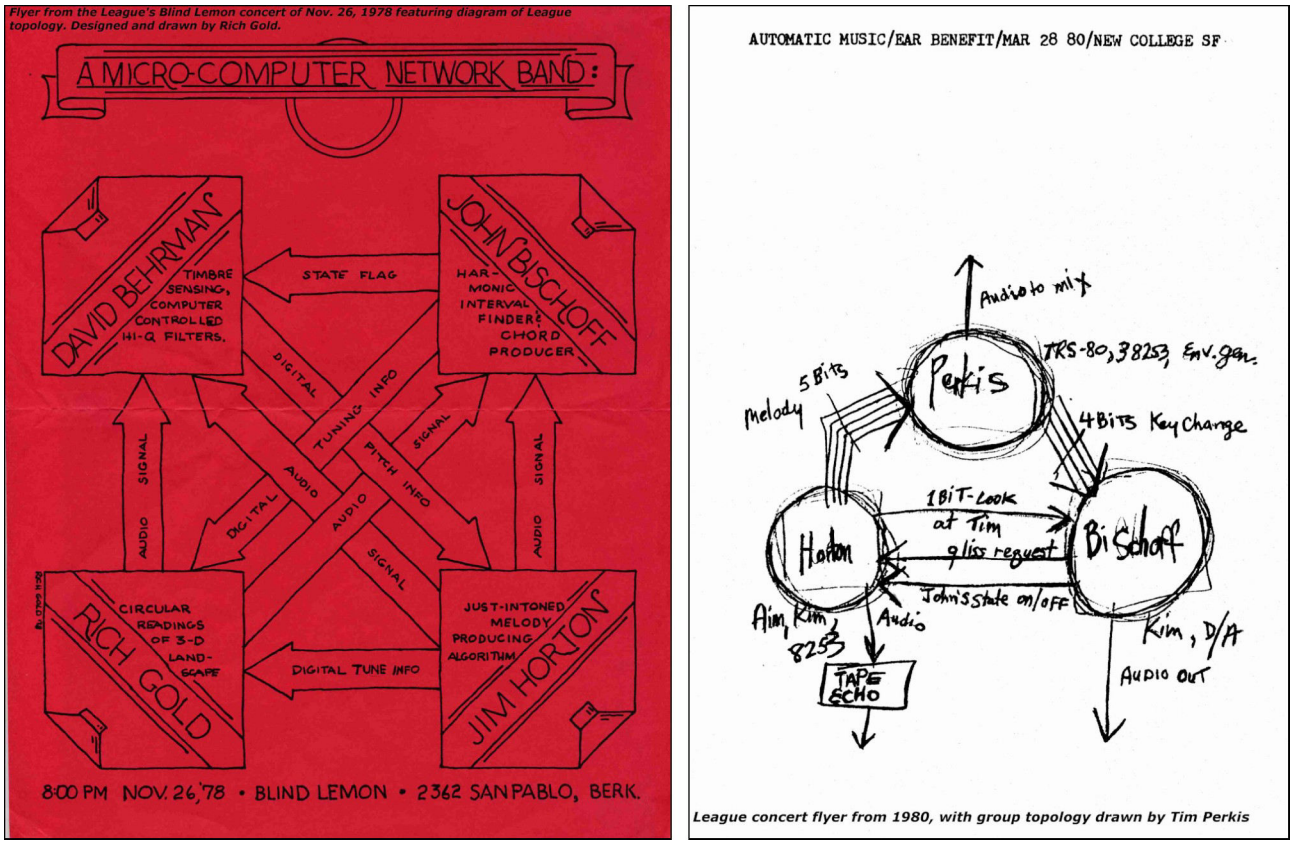


Fig 2.3 – Flyers for two concerts of the League of Automatic Music Composers. (The League of Automatic Music Composers, 2009)

The integration between human and nonhuman agents is deep: their names, personal musical techniques, technical details of the communication channels, visual cues, or whatever appears on the busy table in front of the musicians are all integrated in the outlook of the network. A difference from the previous examples is indicative: the generic addressing to "each chorus member" of *The Great Learning* is no longer there and instead we see Horton, Bischoff, and Perkis. Textbook emergence does not fit exactly here because the same set of simple rules does not describe what the musicians or the machines, individually programmed by each member of the League, are doing: both the machines and the programmers are individual agents, with their own unique behaviours, and we cannot predict their actions from the same set of premises; we need to follow each single agent individually. The word agent, an entity that initiates an action, is about to be substituted by

the word actor, always an entity that makes things happen, but the attention is now on the capacity to participate in a process that we cannot take for granted from the same initial set of rules. We are entering the domain of the actor-network theory that will be explained in the next subchapter.

But before I will consider a last example, not only for its historical importance but because it will present another problem with emergence that is among the reasons why actor-network theory can be considered a viable alternative. In Alvin Lucier's *Music on a Long Thin Wire* the setting is reduced to the bare minimum: we have a sine wave oscillator and a long thin wire; the oscillator excites the wire and in the words of its author "all changes in volume, timbre, harmonic structure, rhythmic and cyclic patterning, and other sonic phenomena were brought about solely by the modes of vibration of the system."[166] All the sonic phenomena emerge from the interaction between two agents. Until here everything looks fine and emergent behaviour does a good job at explaining what is going on. We have a system, a "whole," then we have some agents interacting between each other, and a behaviour that emerges from their interaction. Now let's consider another problem. When I listened for the first time to *Music on a Long Thin Wire,* it was on a recording, I was a student that had just stumbled into American Experimentalism and I had only a vague idea about how those sounds were produced: I knew that the variations in the sound were emerging from the performance setting, but I did not know anything about the setting. I also had a fairly good knowledge of stochastic techniques and I remember thinking that everything I was hearing was not too hard to program on a computer. The second time I listened to the work, I had the opportunity to listen, see and even touch the installation: a group of students at Mills College had masterfully installed the work with the wire suspended between two opposing walls, longitudinally, in a long rectangular hall. The possibility to see and touch the physical object producing the acoustic phenomenon contributed to a very different experience: the complex fragility of the work, the expectations I suddenly developed for the wire to affect the sound became a strong component of the aesthetic experience.

[166] Lucier (1992)

How does emergent behaviour explain these two different experiences? There is not much concern: the music that came to be associated with emergent behaviour deals with performances and recordings are usually considered a subpar version of the real work. Emergence in music shares with its scientific applications a sense of objectivity and the phenomenon observed should not be considered different in nature according to the observation angle: the observation angle is implied to be the best to observe the emerging complexity or the interacting agents. The unwritten idea of looking at Alvin Lucier's piece through the lens of emergence is that *Music on a Long Thin Wire* is one, how you access the information contained in the artwork does not change it: it is a whole with its ontological independence. Although, when the artwork is considered not in its ideal form but in its actuation, which is within the social, collocating it on a severed ontological plane can lead to misunderstandings. I will now discuss a theory that proposes a different view to interpret the different experiences that can arise from different access points to the information the artwork unfolds.

2.2 – Actor-network theory: the whole is always less than its parts.

Actor-network theory (ANT) was developed in the early 80s by Bruno Latour, Michel Callon and John Law, with the intention of identifying in social theory stronger, wider and longer lasting associations. ANT revisits Gabriel Tarde's (1843–1904) social theory, especially for what concerns three of its major assumptions. First, the dichotomy between inorganic and organic is not tenable anymore:

> …. [science] increasingly assimilates organisms to mechanisms, and it lowers the barriers previously erected between the living and the inorganic worlds.[167]

[167] Tarde (2012 [1895]) p.29

Second, even more importantly, this psychological reductionism leads to the fall of the seemingly unbreakable barrier in the Western thought between subject and object:

> If the ego is only a director monad among the myriads of commensal monads in the same skull, why, fundamentally, should we believe the latter to be inferior? Is the monarch necessarily more intelligent than his ministers or subjects?[168]

Third, if we cage the individualities, or monads, inside a stable, higher order emerging from their interaction, we loose track of the principle that makes things happen:

> …. every sufficiently prolonged process of evolution exhibits a succession and interlacing of phenomenal layers which are remarkable alternately for the regularity and the caprice, the permanence and the fugacity, of the relations they present to us. The example of society is eminently well-suited to promote an awareness of this central fact…. by showing that in this series where identity and difference, the indistinct and the well-characterized each reciprocally make use of the other over and over again, the initial and final term is always difference, the characteristic, the bizarre and inexplicable agitation at the basis of all things, which reappears more clearly and sharply after each successive effacement. The speech of men, each with a different accent, intonation, and timbre of voice and gesture: this veritable chaos of discordant heterogeneities is the social element.[169]

In an article polemically titled *The whole is always less than its parts*, Latour argues that emergence, the main theory used to describe complexity, falls short when facing the huge amount of data new media are making available.[170] It can help only for cases in which complexity stems from a limited set of clear rules, but the social often does not display such a clear setting. Latour describes emergence as an analytical process that, starting from atomistic entities, the agents, and considering their interactions, observes the emergence of a new order. His main critique is that this emergent order becomes a totalising structure, ontologically severed from the first atomistic level where it started: when identified, the emergent structure *becomes* the phenomenon observed and the individual entities from where it stemmed are disregarded. He points out the importance of tracing individualizing profiles of agents and resisting the temptation to fall back on analysing only a

[168] *ibid.* p.35
[169] *ibid.* p.41
[170] Latour et al. (2012)

severed second layer of order hidden in concepts such as society, structure, or system. The actors move in their own surprising ways and the observer can only trace their associations, without hoping to cage them in an immutable frame; they do not form stable groups but groups form and dismantle continuously, eschewing ontological classifications.[171] The different approaches displayed by ANT and emergence, are referred to as one level standpoint (1-LS) and two level standpoint (2-LS).[172] The reference is to the severed ontological planes, and 1-LS does not mean that it is not possible to identify layers of organization in the analysis of the social phenomenon, but these layers should be considered a continuum on the same plane of reality that we can freely navigate back and forth. Not only the actors are continuously redefining their groups, but also a change in the standpoint of the observer means a change in the associations she can observe and trace, thus new groups ensue.

Latour clarifies the practical advantages of the 1-LS mentioning the successes obtained by tracing individualizing profiles of agents in the study of baboons, noting as early primatologists considered baboons as being 'in' a strictly rigid male dominated social structure until more advanced individualizing techniques allowed the mapping out of the contribution of all the superimposed individuals revealing the striking social skills of female baboons as well as males.[173] Similar results were obtained in the study of bacteria,[174] scientific papers,[175] social networks,[176] and corporations.[177]

Other essential aspects of ANT are detailed in the most comprehensive introduction to the theory, *Reassembling the social: an introduction to Actor Network Theory*. In this work, Latour argues that the intentionality of our actions is often overemphasised and criticises any rigid barrier between the ideas of "action" as a merely human and subjective activity as opposed to "behaviour"

[171] Latour (2005), pp.28-29
[172] Latour (2012), p.591
[173] Strum and Fedigan cited in Latour 2012
[174] Stewart et al. cited in Latour 2012
[175] Chavalarias and Cointet cited in Latour 2012
[176] White 2008 cited in Latour 2012
[177] Stark and Vedres cited in Latour 2012

intended as an objective and phenomenological concept.[178] "Action is not done under the full control of consciousness; action should rather be felt as a node, a knot, and a conglomerate of many surprising sets of agencies."[179] In mitigating the intentionality and causality of our actions, Latour, coherently with the 1-LS, opens the door to an essential concept for his thought: the inadequateness of the dichotomy between subjective and objective world to interpret the relationship between humans and objects.[180] Not only is it detrimental considering the actors of the social on another plane of reality from the system that is supposed to organise them, but the same applies when we consider people and objects: human and non-human actors belong to the same ontological world. When the barrier falls we can see that agency is not only a human prerogative, and it is not limited to what intentional or meaningful humans do.

> *Any thing* that does modify a state of affairs by making a difference is an actor - or, if it has no figuration yet an actant. Thus, the questions to ask about any agent are simply the following: Does it make a difference in the course of some other agent's action or not? Is there some trial that allows someone to detect this difference?[181]

Both human and nonhuman actors have agency and their actions can both make a difference by making other actors do something. Reflecting on the capacity of an actor to flip a state of affairs, Latour discusses another important idea for ANT: the distinction between mediators and intermediaries. If what an actor does is totally predictable by a relation of full causality it is not really making a difference; it is a mere intermediary, it is transporting a cause triggered by other actors capable of generating transformations manifested by unexpected events. "Fisherman, oceanographers, satellites, and scallops might have some *relations* with one another, relations of such sort that they *make* others do unexpected things - this is the definition of a mediator."[182] ANT aims to describe a phenomenon increasing the ratio between mediators and intermediaries in favour of the former. From this premise it follows that both subjective and objective analysis, as they were

[178] Latour (2005) p.60-61
[179] *ibid.* p.44
[180] Latour (2005 and 2012)
[181] Latour (2005) p.71
[182] *ibid.* p.106

previously approached, deploy too many intermediaries: in the realm of the subject the chain of causes ensues from immutable mental categories, whereas in the realm of the object it ensues from the immutable rules of nature. ANT poses itself as a way to create more flexible and relative descriptions: it discourages an excessive reliance on matters of fact that rely on relationships of full causality and encourages *matters of concern* that insist on the transformative force of the actors-mediators. Sensing the possibility that this approach could lead again to subjectivity, Latour feels the need to clarify his belonging to science:

> A natural world made up of matters of fact does not look quite the same as a world consisting of matters of concern and thus cannot be used so easily as a foil for the 'symbolic-human-intentional' social order. This is why what could be referred to as *second empiricism* doesn't look at all like the first: its science, its politics, its aesthetics, its morality are all different from the past. It is still real and objective, but it is livelier, more talkative, active, pluralistic, and more mediated than the other.[183]

After having clarified what an actor is and the quality of its actions, Latour can at last define a network as a string of actions where each participant is a treated as a mediator.[184]

Coming back to *Music on a Long Thin Wire*, now the different experiences stemming from the deployment of the artwork in the social can be described. Listening to the work on a recording or attending the performance means changing the access point to its information. Let's consider *Music on a Long Thin Wire* as a network with two actors (let's call this network "the music as it happens"): one is Alvin Lucier's instructions and their physical implementation (let's call this actor "the music as it was intended"), an entity that has as attributes the oscillator, the wire, and the sounds produced as a result of being physically connected in that specific way; the other actor is the listener that actively chooses the information's access point. If the listener chooses to listen to the recording, the network changes because she modifies the attributes in play, for example we cannot list among them the production media, so dear to Alvin Lucier, that are hidden from the listener's point of view in the case that she listens to a recording. Therefore the two different experiences can

[183] *ibid.* p.115
[184] *ibid.* p.128

be seen as two different networks: *Music on A Long Thin Wire as a recording* is different than *Music on A Long Thin Wire as a performance*. The music as it was intended by its composer, that we often consider a whole with its ontological independence, makes little sense when the performance takes place and deploys its actors: be it a performer, a musical instrument, a member of the audience, or a recorder, the actor can mediate between causes and effects and the results are not fully predictable from the premises. This does not mean that the composer's intention holds no importance and musicologists wasted their time looking for the original scores, but clearly limiting the artwork to a pure, single-handed vision, valuable *per se* before its clash with the social is a position that generates a 2-LS error. Latour argues that a critical mistake of many social analysis is the idea that the observers who write the description of the phenomenon consider themselves as external to the phenomenon, whereas the observer is always part of the network:[185] the listener actively participate and changes the musical network.

[185] *ibid.* p.28-29

3 – Notes about computers in electronic music performance after 2008

In chapter one I described cases where the unlikely solution of abandoning computers in electronic music performance well into the third millennium led to remarkable results. And this is not an isolated quirk of Berlin and London. Also in the United States some of the most notable musicians involved in electronic improvisation in the last two decades, such as James Fei and Kyle Bruckmann, do not use the computer.[186] Even more surprisingly, if we expand the field to fixed media we notice that some extraordinary new music, such as the collaboration between Thomas Ankersmit and Valerio Tricoli, Olivia Block, and Marc Baron use the computer mostly as a multitrack to reorganise sounds coming out of modular synths like Serge or Buchla, or tape reels, all pre-digital technologies.[187]

As odd as it may sound, a very current question today in electronic music performance does not seem to be how we can use computer but more whether we should use it. Pre-digital technologies are proving so fruitful that the doubt is reasonable. But even if the advent of computers did not affect music performance as swiftly as many thought, it does not mean that meaningful changes are not on their way: if giving up on the integration of computers in electronic music performance looked like a possibility that a majority of musicians inside a scene could adopt twenty or even ten years ago, I doubt that this could last much longer. In this chapter I will focus on two changes that are making the option not to confront computers in performance hardly sustainable: sentient machines and ubiquitous computing. Given the complexity of the matter, I will not attempt any exhaustive treatise but I will discuss observations that more directly relate to the solutions embraced in the works presented in the portfolio. More specifically, I will discuss how reflections

[186] https://www.youtube.com/watch?v=TXjoPngoyw0, http://www.kylebruckmann.com/projects/ekg/
[187] https://thomasankersmit.net/ (accessed on 1/2/2020), https://www.cafeoto.co.uk/artists/valerio-tricoli/ (accessed 1/2/2020), https://www.cafeoto.co.uk/artists/marc-baron/ (accessed 1/2/2020).

about sentient machines made me focus on the diverse spectrum of intelligences that can result in equally interesting behaviours and how, counterintuitively, sentient machines can improve our assessment of human agency more than machine agency. Concerning ubiquitous computing, I will start from the predictions about microprocessors of its creator, Mark Weiser, to provide additional ground to my decision to insist on digital processors in performance when many of the musicians I feel an affiliation with went the other direction. This section will also expose some reasoning behind solutions I noticed to be perceived as bizarre, such as playing mono, or limiting the possibilities of a digital synth to a single voice.

I chose 2008 as a symbolic divider in the musical timeline. I used big data analysis to understand trends of interest towards the musical genres most relevant to this essay from 2004 to 2019: the results were surprising and presented some insights regarding a change of direction between 2008 and 2010.[188] I analysed the trends of online searches relative to musical genres chosen because of their diverse diffusion: from the less diffused such as free improvisation, electroacoustic music, and experimental music to more diffused ones such as hip-hop or dance music, passing through genera that I assumed to be in the middle like jazz and classical. With surprising precision, the gap in interest between less diffused musical genres and more diffused ones widened in favour of the latter before 2008, whereas after 2008 the gap either stayed stable or even shrank, with a first clear change of direction especially for less diffused genres between 2008 and 2010. Causal connections between the economic crisis and these trends are uncertain, but I chose 2008 because of an hypothesis. The slowing down of the declines, especially for music that defies market utility, could be a feeble sign of awakening from decades of misleading assumptions about people's behaviour. As discussed in chapter 1, 2008 marked the rediscovery of bounded rationality. We are not rational actors always able to find the best solution if left without constraints. Intuition is the strongest part of our decision-making processes[189] and its limits should be assessed carefully. The

[188] See appendix 2.
[189] One of my favourite metaphors is Jonathan Haidt's image of the elephant and the rider, with the elephant being our intuition and the raider our rationality trying tiresomely to stir the elephant. (Haidt, 2011)

crises showed the dangers of a faulty consideration of intuition, replicating on the large scale the unresolved tensions emerged in the late 90s between free improv and lowercase improv. In light of this, it should be advisable to start discussing technology in electronic music performance in a new direction, more aware of the intuitive processes of human actors and their pervasive role in networks were the integration between human and artificial actors is key.

3.1 – The otherness of intelligences

> I came to know, in those afternoons, that madness can sometimes lead to discovery, that the mind, fractured and short-wired, is not entirely wrong.
>
> Ocean Vuong

In 1990 Christof Koch and Francis Crick published a seminal article called *Towards a neurobiological theory of consciousness.* The article inaugurated the branch of neurology called Neural Correlates of Consciousness (NCC), whose goal is to develop experiments where it is possible to differentiate between conscious and unconscious neural activity and localise the areas of the brain involved in consciousness. Similarly to the research about the neurology of our decision-making already mentioned, from a few sporadic experiments, from the 90s onward the field has grown to thousands of experiments and publication in the most respected outlets that are providing sound evidence of the quantifiable physicality of what we call consciousness.[190] In order to understand the importance of the neurological discoveries of the last three decades, it is important to notice that human kind, for thousands of years, could only rely on its subjective experience to reason upon the concept of consciousness. Now quantifiable data in the form of voltage potentials measured by fMRI scans are looking at our consciousness from the outside, shattering the wall we had edified between subject and object, which had steadily defined the compartments of Western

[190] Tegmark (2017) p.295

thought for five centuries.[191] The erosion of this wall started many years before: Tarde, Latour, Simon, all openly mentioned their distrust in the idea that we are somehow an exceptional part severed from the rest of the natural world,[192] but neurology is facing us with the most powerful image: once we identify a group of particles and we differentiate them from other unconscious particles, we are also accepting the idea that there can be specific configurations of artificial matter with the same property. Many AI experts think that by 2050 machines will surpass human beings even in what is often considered our last berth of human exceptionalism: our fluid intelligence, our ability to redefine the rules needed to solve a task.[193] But artists, not unlike men of faith, often saw superior intelligence in the modes of nature, from Dante's *intelligenze motrici* (motor intelligences) of the celestial spheres to Cage's skepticism in his own ability to create beauty compared to the beauty of the objective world outside.[194] More than seeing machines able to replicate and surpass human intelligence on its own ground, the possibility to observe from the outside the cells that determine consciousness suggests a different, more profound change in the way we assess ourselves: we are invited to look for intelligence at a lower threshold of complexity, to look at our unimpaired mind as only one among many possible intelligences.[195] Other intelligences are made visible from our standpoint of observation only through the experiment, often as fragments displaying uncertain relationships. Two musical examples come to mind, David Tudor's Neural Synthesis and Holly Herndon and Jlin's *Godmother*.

Neural Synthesis uses for the sound synthesis the main instrument used by AI scientists to simulate human mind, the neural networks. But their use defies the expectations contained in the word 'neural:' Tudor did not see in them a tool to emulate human mind but a way to generate emergent behaviour. According to Forrest Warthman, who assisted Tudor in the design of the

[191] Latour (1993)
[192] See references at p.23.
[193] Tegmark (2017)
[194] Feldman (2000)
[195] In the end, the expansion of the set of what we consider sentient has been a trend of the past centuries: animals and new borns had no legal status until the understanding that they could feel pain and the law had to take care of them (Pinker, 2011). It is hard not to see, sooner or later, the need for a legal code to define the legal status of the artificial.

synthesiser with Mark Holler and Scot Gresham-Lancaster: “Near the onset of oscillation the neurons are sensitive to inherent thermal noise produced by random motions of electron groups moving through the monolithic silicon lattice. This thermal noise adds unpredictability to the synthesizer’s outputs, something David found especially appealing.”[196] Tudor was not interested in the possibility of the synthesiser to learn human behaviour and his operation can be seen as a hack of the neural network to reach the otherness of intelligence.

Holly Herndon and Jlin teamed up with programmer Jules LaPlace to work with digital neural networks. Their first outcome was the track *Godmother*, entirely produced by the software Spawn that had been lengthly trained with Herndon and Jlin’s samples and tried to emulate the models by sample by sample synthesis. Contrarily to the more perfect emulation of human intelligence that Spawn produced after, in *Godmother*, its failure to perfectly connect with what we consider human intelligence achieved an even greater aesthetic result: it brings us closer to the physical domain of intelligence, suggesting links to the intuitively emotional work of its models but producing something completely other.

Obviously, Cage’s influence in this range of ideas is strong but its praise of the objective world, even though prescient, was incomplete. His disdain for improvisation as too subjective betrayed the impossibility to see human intuition as a part of the same world to which sound belongs. Detaching ourselves from intuitive responses “a sound is a sound and a man is a man,”[197] but the man he had in mind was the man Plato had in mind. We now know that Hume had a better understanding of how our brain works than Plato:[198] intuitive responses can be limited but are always present and are an essential part of how we perceive the world; envisioning a complete detachment from them leads to misunderstandings about how they affect our behaviour.

Counterintuitively, if the barrier between human and nonhuman actors in music falls, the biggest change from the perspective of the electronic musicians regards how we assess human

[196] Forrest Warthman in Tudor (1995)
[197] Cage (1968 [1958]) p.82
[198] Haidt (2012) p.32-60

actors. In a revised concept of relational music, the full spectrum of people's behaviour should coexist with other intelligences on the same ontological plane. We should be encouraged to consider as part of the musical process both the mathematical formula of a random generator mediated by a synthesizer and the social bonds that affect the long term trajectory of an improvisation group. Currently, the former generative principle is part of what we consider electronic music, whereas the latter is tainted with 'extra musical' feelings: there is no ground on which we should sustain this demarcation of agencies.

Giving up on computers in performance means not participating in this thriving conversation and excludes from it a group of people, such as electronic music improvisors, that are in an advantaged position to look thoroughly at both sides of the equation.

3.2 – Ubiquitous computing after 30 years

Visionary programmer Mark Weiser, starting from the end of the 80s, guessed many things right about the direction of our relationship with computer. He predicted the multiplication of microprocessors inside our houses, their always diminishing size, their always growing interconnectedness through networks, and the possibility of computers to adapt their contents to the taste of the users to reduce the information overload. His ideas are associated with the label of ubiquitous computing, by which he designated the process that would have brought the computer from the centre of our attention to the periphery, where the digital processor does its job without asking for our conscious interaction with it.[199] Considering that we often wake up at the sound of alarm clocks that do not require us to change time when daylight savings time kicks in, that any online search is followed in the next days by attuned contents, and small home 3D printers can immediately create a piece from a digital model we just received via email on our cellphone and

[199] Weiser (1991)

sent wirelessly to the printer, Weiser's predictions look pretty impressive. Micro or nanoprocessors are starting to feel ubiquitous and not only as an appliance we have in our house, but exactly how Weiser envisioned: solving daily tasks we are mostly unaware of while they become so integrated with the background that occasionally we are even unaware of their local position inside our houses.

Although, this movement from the centre to the periphery of our attention deserves careful consideration. Daniel Kahneman says that: "Unless there is an obvious reason to do otherwise, most of us passively accept decision problems as they are framed and therefore rarely have an opportunity to discover the extent to which our preferences are *frame-bounded* rather than *reality-bounded."*[200] To prove his point he mentions the gap in the percentage of organ donors in different countries: in 2003 Austria had 100% of their population registered as donors, but Germany only 12%, Sweden 86%, and Denmark only 4%. These differences are too big to be explained by the inclinations of a population. Indeed they are results of the framing effect: the high-donation countries have an opt-out option instead of opt-in: in order not to be a donor you have to actively check the box and opt-out otherwise, by default, you are a donor.[201] Default positions we do not even know about enormously affect our life and knowing when a choice is frame-bounded is a way to affect the outcome of such a choice: this is often no simple task but it can make all the difference in the world. Today electronic musicians overwhelmingly choose fixed media over electronic music performances where relationships among the actors convey aesthetic content. But it is opportune to keep in mind that, as we have seen with Jim Horton and the League, microprocessors started to participate in our musical history as tools for live performances deeply informed by such relationships. Only later things developed in another direction and now the association between electronic media and fixed media is almost a given.

Jim Horton's first microprocessor, the KIM-1, was 1 megahertz fast, had a memory from 1 to 4 megabytes, and the programs had to be coded in machine code and saved on cassettes: considering the means, I do not know if relational performance was truly an option for a broader

[200] Kahneman (2011), p.367
[201] *ibid.* p.373

pool of musicians and listeners by then. But I have reasons to think today's decision to work so overwhelmingly with fixed media to be frame-bounded.

The doubts start with some simple observations about our biology. We are defined as social animals with purposive behaviour.[202] Our cooperative strategies are shaped by evolution,[203] and our body adapted to favour shared intentionality through the tiniest detail of close, in person, interactions. For instance, the main difference between our eye and the eye of a chimp is that our iris is surrounded by white whereas in the chimp the background is black: the possibility to communicate shared intentionality through a minimal movement of the eye is a feature that gave us advantage over our closest relatives and evolution favoured this feature giving us a better visual of the movement of the eye.[204] In a neurological cooperation experiment, researchers demonstrated that our brain produces reinforcement responses (dopamine spikes) when we solve a task cooperating with people but not when we cooperate with machines:[205] we do cooperate with machines to solve tasks, but on average it does not give us the same pleasure. The ubiquitous presence of some forms of improvisation in all the musics we know besides Western art music from the XVIII century until the second half of the XX century made Bailey think that improvisation had to be the most ancient form of music making:[206] not that we will ever know, but improvisors can look at the iris of other musicians to communicate shared intentionality and they are continuously engaged in cooperation games with other people in live settings, so it is worth looking for eventual biases that frame the decision to relegate live cooperation between human actors in electronic music to such a small factor in the electronic music panorama.

First of all, we need to keep in mind that almost everything we heard about electronic music in the XX century is WEIRD. In 2010 Joseph Henrich, Steven J. Heine and Ara Norenzaya published a much discussed article titled *The weirdest people in the world?* The article challenged

[202] Simon (1997)
[203] Axelrod and Hamilton (1981)
[204] Tomasello (2018) p.51
[205] Sanfey et al. (2003)
[206] Bailey (1992) p.83

with cross-cultural data years of research and universal truths about human mind highlighting how often neuropsychologists inferred universal results using as subjects mostly undergrads of Western universities. WEIRD stands for Western, Educated, Industrialized, Rich and Democratic. WEIRD people are truly a minority on our globe and cross-cultural studies tend to confute the universality of the results of studies carried out within this minority. This does not necessarily detract value from the studies but underlines their local value.[207] Even though for experimental electronic music the situation might be changing for the first letter of the acronym,[208] it is still mostly a WEIRD matter and WEIRD people speak their own local idioms. There is no universal value in positions that were rooted in the Western art electronic music such as Boulez' idea "that invention is marked more particularly by the imprint of an individual, goes without saying."[209] If it goes without saying, then we need to see if the default does not resemble the position about organ donors described above. I see three default positions that hamper the diffusion of relational electronic music and turning them into reality-bounded choices might change their outcome.

Default position 1 – Musical software and hardware are overwhelmingly oriented toward studio production.

The orientation of tools for electronic music toward fixed media follows a basic market direction. Electronic music corresponds to sound design in all the most retributive activities surrounding music such as soundtracks for cinema, mainstream pop, electronic dance music (EDM), and video game industry.[210] Although, music has constantly been able to maintain tangential and often

[207] In their unlikely career as DJs, David Toop and Evan Parker make a very compelling case that for most of the innovations the Western art music claims patents for, a little unknown society in a remote area of the globe got to very similar results without knowing what a patent is. The idea so dear to modernism to propose paradigmatic shifts with universal ambitions should be dropped entirely.
[208] See Dimitri della Faille and Cedrik Fermont's book *Not Your World Music: Noise In South East Asia.*
[209] Boulez (1978) in Born (1995)
[210] The new big thing, video game industry, deserves special consideration because the final product presents an element of musical interaction. Interestingly, Rich Gold from the League ended up as video game developer and we can think that it was not only a way to make the ends meet. See George Lewis in Born (2017).

adversarial relationships with market forces: entertainment, the main drive of the musical market, is only one of the eight functions of music identified by Alan Merriam, and not a major factor in the majority of the known musics.[211] The influence of market directions, thus technological dependency, is more accentuated when we are unaware of how market forces shape our decisions and especially when we are not aware of the shrinking range of options we are given to interfere with this process.

The current state of musical computer technology tends toward a black-box-behaviour that leaves us unaware of the inner mechanisms of the machine. This has been an historical trend led by reasonable technological improvements. With the growing complexity of the software, our attention cannot focus on the whole process from the interface to the machine code, but we have to rely on the lower layers built by others and choose wisely from which layer we start making choices that can redirect the behaviour of the machine toward our goals. The first accessible layer of the common programs that we find in studios, or in the bedroom studios of the many soon-to-be electronic musicians, is already irreversibly oriented to studio production. Studio musical technologies frame our preferences and reinforce in our unconsciousness skills, habits and reflexes that discourage performance. Performances rely on unpredictable directions but in a recording studio unpredictability is framed as undesirable imperfection and programs are getting always better at removing this imperfection: always less frequently we can encounter glitches that provide clues about the process behind the interface or point toward new unforeseen directions. The same thing is happening for the hardware. Circuit benders have always recommended looking for old electronic toys because the components of the circuits are bigger and can be modified with hands and a soldering iron. Reed Ghazala insists on the importance of touching audio circuits (strictly 9v battery circuits!) to provoke short-circuits using the fingers, a conductive material, as random connections between two parts we would not connect following correct rules of electrical engineering; the short-circuits often produce squeaks whose attentive listening can point towards alternative musical

[211] Merriam (1964) pp.224-225

behaviours.[212] With the new nanotechnologies, fingers become too big to make the circuit squeak: the designer projects on the desk, the project is sent to the company that prints the board, and the user uses it as it is.

Resisting the advent of nanotechnologies in the long run is unsustainable. For now, there is an overlapping of through-hole technology (the components you can buy and solder at home with a soldering iron) and surface-mount technology (the components for which you need machines to build the circuit from a software model). DIY communities thrive on through-hole tech and it is an integral part of the analog revival. But there is a first sign of a direction change: some historical integrated circuits (IC) that came as through-hole are now discontinued and exists only as surface-mount. Until through-hole technologies will have market, ICs that allow a more tactile approach will exist but they will become more expensive as they become rarer: that form of intuitive building, bending, and hacking will also become more expensive and often impossible. New solutions are already becoming viable: even if the intuitive physicality of the circuits is slipping away, 3D printers and other CNC machines are becoming always more affordable and house friendly, so that the prototyping process can come back in the hands of hackers instead of tightly structured companies. But since prototypes for these machines are software models, it is becoming always more complex to avoid the abstraction of computers to develop the performance tools the musical equipment companies rarely provide. Moreover, programable nanoprocessors such as Raspberry Pi and Bela are becoming increasingly popular and their users are unwittingly following, in a much more comfortable technical situation, Jim Horton's footprints when he saw microprocessors as physical objects, visible entities on his desk, ready to be directed toward performance.

Another reason because resisting computers in electronic music performance can backfire, is that, whereas nanotechnologies are changing the practical aspects of how we put together machines, the basics of software development seems to be surprisingly stable: if we stay away from the

[212] Ghazala (1997)

dependency trap described by Born, intervening in the software layers before a program becomes oriented to studio production, before the timeline-based approach takes over, does not require the speed that only a structured team of professional programmers can provide. High level programming environments oriented to music such as Max or Supercollider are becoming extremely reliable in performance, at least at avoiding computer crashes, a problem that plagued performers for decades since the first appearances of laptops on the stages. The problem sometimes mentioned by electronic music improvisors is that the acoustic results obtained starting from the blank page of these environments are not proportioned to the amount of time spent developing the software;[213] also not every gifted performer can or want to become a proficient developer. The originality and quality of the results of who consider themselves simply users and not developers should make us consider this position very seriously. IRCAM understood the necessity of a coordinated effort to develop additional layers on top of the blank page of Max and developed several libraries such as FTM (Faster Than Music) and the current series of spectral descriptors PiPo that looks always more like an additional sub-environment on its own. But the objectives of the French institution and those of improvisors have rarely overlapped:[214] the relational approach I am proposing will not reach any substantial diffusion without new software layers between the blank page of Max and Supercollider and the user. These layers will have to allow computer performers to join fertile improvisation scenes, release music on trusted labels, and be noticed by the specialised press and organisers. Nothing of this will happen unless the few successful cooperative strategies are identified and pursued assessing correctly the limits of the intuitive processes of the performers who are playing on the stages now.[215]

Default position 2 – The information channels that most commonly carry music are not designed to carry the information contained in the relationships among the actors of a performance.

[213] BoB Ostertag, lecture at Mills college in 2010.
[214] Born (1995)
[215] For more detailed proposals see appendix 3.

Derek Bailey said that "recording devices such as reduction, 'presence', compression limiting, filtering, and stereo picture, usually serve only to fillet out or disturb important elements."[216] Could this sentence also apply to electronic music performance? The default answer is a resounding no: electronic musicians compose timbres using filters and amplitude control, and create acoustic environments where the position of the sound in the stereo or multichannel field carries aesthetic information. But I would like to entertain the possibility that, in a series of instances of electronic music performance, agreeing with what Bailey said might sound far more reasonable than what it seems. To understand such a counterintuitive approach in electronic music, it is interesting to start from a rare prediction of Weiser that, for now, seems to have missed the target by a long shot:

> Perhaps most diametrically opposed to our vision is the notion of virtual reality, which attempts to make a world inside the computer. Users don special goggles that project an artificial scene onto their eyes; they wear gloves or even bodysuits that sense their motions and gestures so that they can move about and manipulate virtual objects. Although it may have its purpose in allowing people to explore realms otherwise inaccessible -the insides of cells, the surfaces of distant planets, the information web of data bases- virtual reality is only a map, not a territory. It excludes desks, offices, other people not wearing goggles and bodysuits, weather, trees, walks, chance encounters and, in general, the infinite richness of the universe. Virtual reality focuses an enormous apparatus on simulating the world rather than on invisibly enhancing the world that already exists.[217]

From social contacts to online shopping, most of our activities integrate virtual reality. This is also the case for music: the headphones are the music equivalent of the VR goggles and the counters of Youtube tell us that now the standard for music listening are online platforms, most likely via headphones. As discussed in chapter 1, the causal and malevolent role of technology is often overemphasised: with the beginning of a pandemic, some unexpected positives of remote listening are now evident, whereas very appealing theories such as filter bubbles and reverb chambers are finding less evidence in data-driven statistical studies.[218] Moreover, it would be ingenuous to say

[216] Bailey (1992) p.103.
[217] Weiser (1991) p.94
[218] Fletcher (2019)

that social media do not refract at least partially the 'real world.' However, the remarks about the subtle biological mechanisms we use to exchange information in non-remote situations should be kept in mind: communication technologies still cannot replicate the information shared between two improvisors playing live or the information shared between a long thin wire and a member of the audience in front of the physical object. As said in chapter 2, the observation standpoint of a network changes the network and we should be able to make an informed decision about the standpoint instead of accepting the default position. Bailey's stance about unessential techniques that disturb important elements can be reworded as a reduction of the information channel in order to focus on the intuitive modes of musical cooperation proper to improvisation. Introducing the computer into the equation, we have what Weiser hoped for when taking distances from virtual reality and calling for computer operating in the background leaving intact the evolutionary-shaped ways of human communication: until communication channels will provide the same neural reward of our experience of the physicality of the other actors or evolution will change the reinforcement mechanism, it is reasonable to think that many electronic musicians will not be aware of the rewards of live music-making unless they will attempt counterintuitive experiences of reducing the possibilities of the microprocessors. I will provide practical examples of these forms of reductions in the portfolio, especially in the first work, where reductions regarding the number of audio channels, the movement in the spatial field, and the number of digital processes controlled simultaneously by the performer will serve the objective of achieving balance and focus in the counterpoint of decision-making processes of an improvisation session.

Default position 3 – Current western musical learning methods are oriented toward definitive physical objects instead of flexible networks of relationships.

Part of our musical skills are learned unconsciously through the use of technologies, but another substantial part is learned through standard training methods. The majority of our training methods

display an excessive reliance on the final product instead of the generative process. While this is partially addressed in electronic music classes, for what concerns nonhuman actors, with the teaching of live generative techniques such as random distributions and feedback, the treatment of human actors still reflects unease to merge the human domain with the nonhuman one.

When I had the chance to attend Roscoe Mitchell's seminars, students were asked to form groups, select a leader when needed, and work autonomously with that group outside the classroom from the first day of teaching. The groups changed every week until, near the end of the semester, students had to find a good formation to play for the final assessment. In this method there is a principle dear to the AACM and to many other improvisation collectives from the 60s onwards: the understanding of human agency will determine the ability of musicians to produce valuable music not unlike the understanding of traditionally intended musical rules. If the sacrality of human actors falls and we are free to discuss their agency as we discuss the agency of random generators, we should approach human cooperative strategies with the same awe modernists approached formulas to generate complexity.

Discussions regarding successful cooperative strategies and their technological facilitation should become common musical ground and should be approached not ideologically but with statistical rigour, on the footsteps of game theory: while empathy is a neurological spectrum and cannot be asked from everyone, the understanding of the advantages of initiating specific forms of cooperation within an autonomous group can be understood logically analysing appropriate examples.

4 – Relational theory

I will now propose a reference frame that will be used to discuss the works I will present in the last chapter. As mentioned in the introduction, Claire Bishop noted how in the first theorisation of relational aesthetics, the aesthetic qualities of the relationships the artwork deploys were lost when the aesthetic judgement was equated to the ethico-political judgment. Since my reference frame for a revision of the concept of relational music is inevitably intertwined with the aesthetic qualities of the relationships, it is worth clarifying what questions the reference frame will address beyond the social matters discussed in chapter 1. I will present the questions divided in four groups which correspond to the subchapters that will address them.

Group 1

- What is the outlook of a network of relational music?
- What suggestions do bounded rationality and ANT theory offer that can be beneficial both for the creation and the analysis of relational music?
- How do these suggestions translate to music creation?

Group 2

- What types of relationships does the music deploy?
- What actors do the relationships involve?
- What forms of mediation are in play?

Group 3

- How do different relationships coexist simultaneously?

- How do the relationships develop over time?
- What forms of aesthetic reward are in play in the mediation process identified by a relationship?

In this section I will also introduce two concepts that will recur frequently in the music presented: tangential agency and relational counterpoint. The theoretical frame should by no means be intended as a "how to" guide for relational composition; indeed its main ideas were either a result of reflections about music I had already made or, at best, they grew together with the music. Nonetheless, the definition of clearer observation angles and terminology, is not only helpful in communicating the details I am more interested in, but also provides clarity in one of the few phases of my music where clear categories seem to be beneficial instead of an obstacle, software development.

4.1 – Group 1: The outlook of the musical networks.

Any attempt to analyse or design musical networks should start with a careful consideration of bounded rationality. Currently, the major source of problems seems to be the lack of understanding of human actors instead of nonhuman ones, be it a result of poor observation or idealisation. For this purpose, the two most relevant principles taken from bounded rationality are: 1) attention to the limits of the human mind to process information, especially when the information is produced or amplified by electronic media; 2) limiting information often fosters an adaptive behaviour of our perception that has the opposite result of expanding our processing capabilities. Starting from this basis that should always act as countercheck, the outlook of the musical network will follow the suggestions of ANT theory.

Relational music will be described as a network of human and nonhuman actors and the outlook of the network will be given by the totality of the actors visible from the chosen standpoint. The groups of actors will make sense only according to the selected standpoint and the importance of the relativeness of the standpoint should be stressed. There are infinite standpoints that allow us to observe an always-changing number of actors. Take for instance an improvisation group. If we want to consider the presence of the group on the scene of a city, it makes sense to consider the group as a single actor; if we look at the music of the group, it makes sense to consider each single musician as an actor;[219] if we zoom in we can also consider the instruments as additional actors because they actively participate in the music production; and so on, until the air particles that set our eardrums in motion. Without indulging in standpoints that make sense only theoretically, the selection of the standpoint will be a search for a better angle to observe details that affect the surprising unfolding of a musical piece in ways we are not usually inclined to think of. For example, coming back to the improvisation group and introducing microprocessors in the network, if a musician in the group is using a computer as an instrument with some very specific and occasionally independent behaviour, it will make sense to consider the computer and the musicians as two actors. But there are cases where it could be necessary to undo the single agency of the computer and create subdivisions: if the computer runs two different programs simultaneously and one serves as an instrument with a direct response to the performers actions, whereas the other is an autonomous or semi-autonomous process responding to the environment, the different quality of the agency will render opportune to split the computer into two separate actors, the two programs.[220]

The selection of the standpoint, obviously, also deals with its availability. I discussed at length in chapter one the importance of the worldly associations that the music I am interested in

[219] Smith (1973) *notes on my music (part 1)*

[220] There is an additional subdivision that I only write as a footnote because of the fascinating implications match the uncertainty of its application. If an improvisation group gets stuck into an endless repetition of habits, it might be even worth to think of different areas of our brain as separate actors with their specific agency: the awareness of some basic causal relationships of our neurobiology could help us, for instance, to identify more accurately why when we are tired we repeat endlessly some specific patterns instead of others, or when excessive active focus could derail the flow of a performance. Thus, we might think of undoing the brain as a single source of agency without falling in merely theoretical remarks.

tangentially refracts, but a thorough observation of these elements is not always possible: we often describe music whose social ramifications among people had no time to develop yet, or improvisation groups at the beginning of their arch whose human bonds are yet to form. Those aspects are by no means less important for a thorough description of the network, but they are often lifelong matters, better observed at their own pace: the description should be functional to the details we want to observe thus any ambition of completeness flexible.

Regarding the application of ANT to music, there are matters of concern. ANT was developed to analyse social phenomenon involving huge amount of data. It seamlessly applies, for instance, when we deal with the jungle of genres and subgenres associated with specific groups of people or musical scenes.[221] The use I am proposing serves the analysis as well as working as a reference frame for creating artworks seen as musical networks. Using ANT as a guideline for creating a musical network is a stark contradiction of ANT's purpose of not imposing any direction to the actors considered. Thus, in this case the association will be loose, with the main purpose of using ANT principles to shift the attention in directions where it is seldom addressed. The main elements of ANT considered in the creation of a network will be: 1) both human and nonhuman actors have agency and there is no ontological difference between them; 2) attention to singularities instead of aggregates of actors governed by the same set of rules like in the stochastic process, thus preference for empirical observation instead of top-down formalisation; 3) tendency to create associations that can be easily undone and reconfigured; 4) predilection for actors that mediate between states of information and make unforeseen events happen, instead of intermediaries displaying clean causal relationships. Even in this reduced form, any principle taken from ANT could be denied by a specific situation, especially if conflicts with bounded rationality arise. Only to anticipate one instance, the fourth point encourages a general trend to highlight the mediating capabilities of the actors, with the natural consequence that mediators will end up contributing to the aesthetic interest of the work more than intermediaries. In the social analysis, ANT always

[221] Haworth (2016) and Piekut (2011)

suggests increasing the ratio between what we consider intermediaries and mediators in favour of the latter.[222] But if we consider a possible circumstance of electronic music improvisation, where an intuitive approach to the instrument requires its mastery to enable the musician to participate in the quick interplays of the session, we have a case where we stray from ANT and we benefit from reducing the technological object to an intermediary: improvisors can enjoy some "resistance" from the instrument, but there are plenty of circumstances where the more direct is the transition from idea to sound, the more transparent the instrument is, the better. This is an example where ANT's desire to look for the mediating capabilities of the object conflicts with bounded rationality's necessity of limiting the information to successfully carry out the task. Luckily, these cases will be a minority and a peaceful coexistence of ANT's principles and bounded rationality will be mostly possible.

SEVEN HINTS FOR A RELATIONAL APPROACH TO ELECTRONIC MUSIC PERFORMANCE

1) Counterintuitively, we tend to be less accurate in assessing human actors than nonhuman ones.

2) Pay attention to the limits of the human mind to process information, especially when the information is produced or amplified by electronic media.

3) Limiting information often fosters an adaptive behaviour of our perception that has the opposite result of expanding our processing capabilities.

4) Both human and nonhuman actors have agency and there is no ontological difference between them.

5) Observe singularities instead of defining aggregates of actors governed by the same set of rules.

6) Tend to create associations that can be easily undone and reconfigured.

7) Look for actors that mediate between states of information and make unforeseen events happen, instead of intermediaries displaying clean causal relationships.

[222] Latour (2005) p.133

4.2 – Group 2: Tangential agency

> There might exist many metaphysical shades between full causality and sheer inexistence.[223]
>
> Bruno Latour

The League of Automatic Music Composers must have been very familiar with the mediating potential of the actors and the shades of agency that lay between full causality and the sheer inexistence of relationships between people and machines. They created networks where human and nonhuman agency were seamlessly integrated, striking a balance where human intentionality and microprocessors' algorithmic behaviour coexisted without ever pushing one another into a condition of irrelevance. One of its founding members, my teacher John Bischoff, listening to a work I had sent him, once told me he would have liked to see a more *tangential* behaviour from the machine, meaning by that a behaviour that was related to my gestures in a less causal and predictable way. On the other hand, when I was working on pure algorithmic music he would let me hint his predilection for real-time works were people could affect the system during the performance. The idea of tangential behaviour gave me a sense of what a mediator is in a musical network well ahead of reading about ANT. With a minor change in terminology, tangential agency will be a foundation concept I will use to describe works of relational music. The use or the term agency instead of behaviour is fostered by a reflection by Latour that has an interesting and familiar resonance in music. Latour is concerned about the use of the term behaviour that is often associated with emergence because he sees in it a way to fall again in subjective/objective dichotomy:[224] behaviour often suggests the presence of an external observer somehow detached from the phenomenon observed whereas agency suggests first person involvement. A consequence of this distinction is thinking objects as entities having no agency but only behaviour. It is indeed reasonable to see in

[223] *ibid.* p.72
[224] *ibid.* pp.60-61

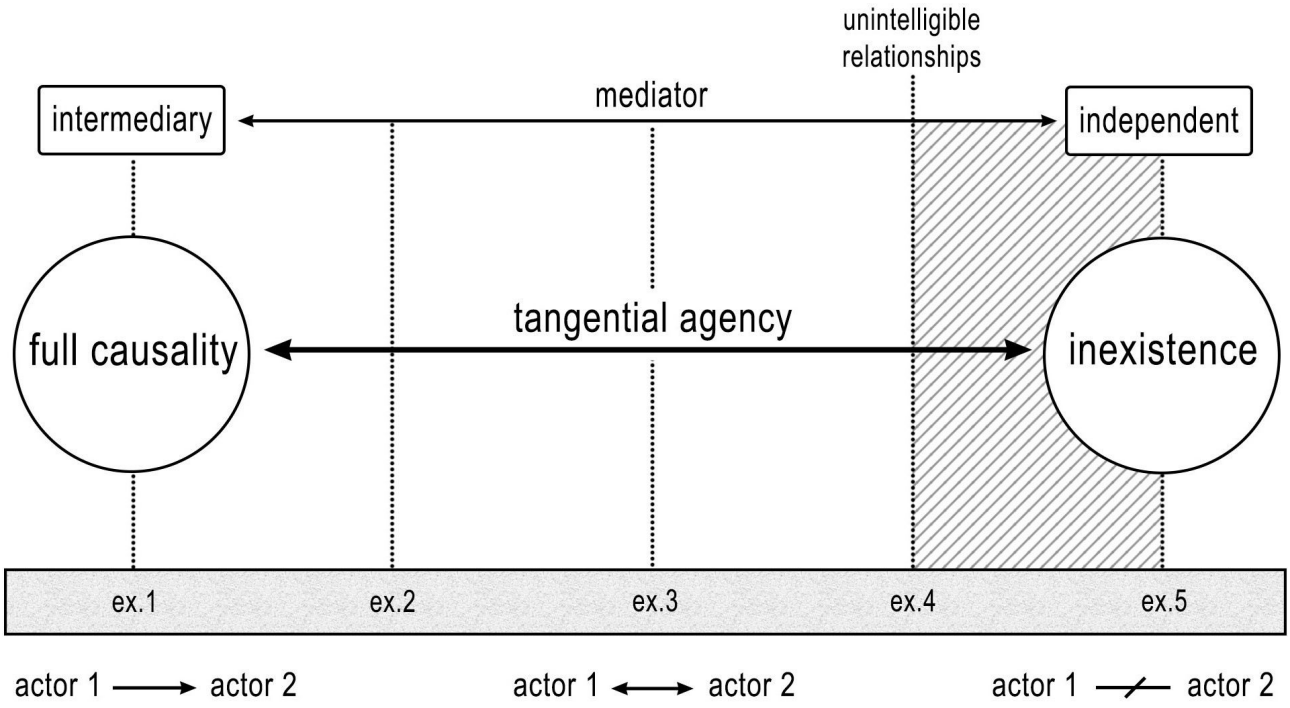
the insistence of the American Experimentalism on the term "behavior" a desire to underline the objective side of the musical phenomenon as opposed to the subjectivistic approach so often heralded by the European tradition. However, if we consider the ideas of American experimentalists such as Tim Perkis, we can notice that, in practice, human and machines do not display any ontological barriers and they are fully integrated on the same plane or reality:

> I set up a system of interacting components of some kind. Sometimes the piece consists of a computer program, sometimes it's a set of analog electronic equipment, sometimes it consists of systems that involve people, and instructions to people. It could be all three, or it could be a network of computers. Generally I design some process of interaction, and allow it to behave. This behavior is what makes the music—in fact this behavior *is* the music.[225]

The distinction between behaviour and agency seems not to be that relevant, especially if we keep in mind that Perkis fully embraces improvisation as opposed to Cage, who rejected improvisation on the base of it being an expression of the subjective world. Using the term tangential agency instead of tangential behaviour only reflects my intention to avoid any ontological barrier between the idea of action as a merely human activity as opposed to behaviour intended as a phenomenological concept reserved to objective world.

In fig. 4.1 I drew a graphic representation of the idea of the tangential agency associated with the ANT concept of intermediary and mediator. The case depicted focuses on the quality of the relationships of a simple network composed by two single actors influencing each other. The middle line represents the type of relationship between actor 1 and actor 2; the upper line represents the role of the responding actor (actor 2); in the bottom grey rectangle there are the labels corresponding to gradual examples for three possible configurations of the actors (human/human, human/non-human, non-human/non-human). The tangential agency line goes from a relationship of full causality on the left to the inexistence of the relationship on the right, passing through all the shades of mediation. When an entity has a completely dependent behaviour, which is mostly a hypothetical occurrence, it becomes a mere intermediary responding automatically to an external

[225] Perkis (2002) p.1



Actor 1 (human) - actor 2 (non-human)

Ex.1 - The performer plays a key on a MIDI keyboard and the computer (actor 2) plays exactly the sound the player intended, exactly at the desired time.

Ex.2 - The performer swings her arm while holding an accelerometer, the computer plays a sound whose pitch is related to her arm's speed and chooses if the sound starts with her gesture or a few seconds later.

Ex.3 - The performer plays a note on her instrument, the computer synthesizes a sound mapping the spectral data in a complex way, and plays it when she does not expect it.

Ex.4 - The computer generates sounds as a result of the performer's actions, but she cannot understand the relationship between the sounds and the action that generated them.

Ex.5 - The computer generates sounds using probabilistic formulas and the performer's actions cannot affect the computer's response.

Actor 1 (human) - actor 2 (human)

Ex.1 - The first improvisor (actor 1) plays and the second (actor 2) follows the first without proposing new ideas.

Ex.2 - The first improvisor plays a note, the second improvisor quickly reacts to the note of the first one in a comprehensible way.

Ex.3 - The first improvisor plays a series of notes, the second improvisor listens to them but keeps playing what she was playing before. After a while she plays a distant variation of the notes she heard.

Ex.4 - The first improvisor plays, the second improvisor interprets what the first does according to her logic. The first improvisor has no idea what the logic of the second is.

Ex.5 - Two improvisors decide not to listen to each other and play independently.

Actor 1 (non-human) - Actor 2 (non-human)

Ex.1 - The sound of a kick drum (actor 1) triggers a blinking light (actor 2).

Ex.2 - The sound of a synthesizer (actor 2) is slowly modified by the movement of the clouds (actor 1) captured by a light sensitive sensor directed to the sky.

Ex.3 - The sounds of a bee colony are analysed statistically in real-time by the computer, which sinthesizes a response loosely related to the sounds of the bees. The audience can see the colony through an observation hive.

Ex.4 - The sounds of a bee colony are analysed statistically in real-time by the computer, which sinthesizes a response loosely related to the sounds of the bees. The audience cannot see the colony.

Ex.5 - Two unrelated generative synthesizers play in a room.

Fig. 4.1 – Graphic representation of the tangential agency line with examples for the different shades of mediation.

force and its output can be completely predicted analysing the external force that controls it: the actor loses its ability to surprise us with unexpected actions. In the proximity of this area we can consider the possibility that the actor might have lost its agency and ceased being a factor in the network. In this case the network can be simplified and the intermediary actor can be merged with the actor controlling it.[226] On the other hypothetical extreme, that of complete independence, the actor cannot affect or be affected by other entities in the network, thus it is inexistent from a relational standpoint. These segment of the line is relevant to algorithmic music, where the computer's behaviour is often unaffected after the initial definition of the premises, but it is of limited interest for the kind of works that concern relational music.

Proceeding on the line from a minimum degree of tangentiality, near full causality, towards the inexistence of the relationship, we reach a point where we can no longer understand how the actor responds to another actor's actions from our standpoint of observation. An excessive sense of practicality might lead us to disregard these unintelligible relationships: if I cannot see them why even consider them? Current neurological studies of dopamine, a neurotransmitter that plays a major role in our reward feelings, tell us a very different story: we know that what we cannot see can still generate powerful psychological effects of expectancy and it is the ground for the reward of surprise, one of the most important features of our mind from an evolutionary standpoint.[227] Unintelligible relationships have some wonderful properties: we know that something can happen and an action can modify the course of the performance; our sense of alertness increases; no matter whether the relationship manifests itself or not, we can still access a radically different state of mind

[226] If this sounds abstract, it is enough to think that it is what happened for centuries with Western classical music. Let's consider the relationship between a classically trained composer and the performers and instruments she/he composes for, limiting the viewpoint to the moment of the composition. The best-case scenario for composers mastering their craft is that the mental representation of the sound associated with the score is so precise that the score can be written without listening to the results. This is due to the stability of the classical tonal system and the instruments, and to the diligence of the performers who have all a similar training and they are instructed not to take musically relevant decisions. Instruments and performers have a relationship of full causality with the composer's invention, they diligently transport her/his will without any surprising deviation; thus the score is seen as the depositary of the artwork and the real instruments with their players can be omitted from the network. Remember that very proficient German composer who wrote music when he was almost entirely deft.

[227] Sapolsky (2017) pp.64-76

and experience the performance under a different light. On the downside, this segment of the tangential agency line is prone to an excessive reliance on the importance of understanding the relationship and this can have disastrous aesthetic consequences for the performance: for instance, I think that the world of new controllers for musical expression often confuses the music with the new expressive possibilities of the tool and the whole performance is reduced to understanding what the controller does in relation to the gesture of the performer.

It must be noted that for clarity reasons, the graphic simplifies reality: the extremes are more hypothetical than observable in real performances. A relationship of full causality never happens: if we pose the question whether an entity should be considered an actor, we can almost always find a point of view from which we can observe its agency. Even if we consider ex.1 in the case in which actor 1 is human and actor 2 nonhuman, the standard commercial electronic instruments can be mere intermediaries if we observe them during the performance, but if we broaden the point of view and include, for instance, the training that led to the performance, the keyboard can shape the way a musician plays, becoming an actor fully capable of mediating information in the network. A completely independent actor is also another extreme that can rarely be described: put a source of surprises like an autonomous generative system in a musical setting where there are good improvisors and the improvisors will be able to give the impression that the independent source is actively engaging in a dialogue with the performers. Given our tendency to imagine causality,[228] even the classic Cagean setting of musicians avoiding any synchronisation cannot escape the impression of occasional associations between the actors.

4.3 – Group 3: Relational counterpoint

Many of the artworks that fall in the category of interactive electronic music focus on one

[228] Kahneman (2011) pp.129-136

interactive idea. But it is one thing to reduce the field in order to present extremely subtle phenomena like a wire physically modifying the sound that passes through it; another thing is an accelerometer of a joystick that controls the pitch of a sound with the note going up when the performer brings the joystick up, or a flickering light in association with a flickering sound, where sound and light do exactly the same thing alternating the pairs loud/bright and silence/dark.

It is a reality not welcome to anyone interested in the mediation process of the electronic medium that the networks of David Behrman and the League of Automatic Music Composers still stand as some of the most sophisticated examples of many relationships coexisting together, and still after half a century we hear about the need of simplification in order to let the audience understand the most basic forms of association between a single visual gesture and the sound it produces.[229] To my mind, the mediation process does not seem to be considered as a carrier of aesthetic content, but mostly an afterthought to what is supposed to really matter: sound and theatricality. The works of relational music I am describing do not go in this direction. They imply a musical background where there is some familiarity with the mediations and it is possible, for instance, to make choices about which forms of complex mediations require single focus and should be brought in the foreground, and which mediations can coexist together on the same plane without losing their identity, just like voices in a counterpoint: an artwork made of many types of mediations, all of them displaying their unique agencies, concerting together to confer aesthetic contents to the performance. In these artworks the composers or performers see different relationships between actors like colours on their palette and the relationships can be used not as special novelties to be always highlighted but as elements in a normalised practice.

Once we start to become familiar with a relational approach and the actors of the network do no longer look like strangers introducing themselves for the first time over and over, each relationship can acquire its own distinct character defined by the mediation process and nothing

[229] Pianists still fill auditoriums but I doubt that the audience see the hands of the pianist from the second circle or *galleria*.

stands in the way of the possibility to feel an intuitive reward in the quality of the mediations.[230]

The idea of a counterpoint of relationships is probably the easiest way to think of it from a musical standpoint. A voice in a counterpoint, during its life in the piece, blends well with all the other voices but at the same time maintains its distance and independence: it is a set of rules that tells more about coexistence than direction. The same general principle applies to relational counterpoint with the difference that the counterpoint is not made by notes, nor solely by a set of possible notes defined in the initial formalization which cannot be altered during the performance: each relationship still configures a set of possibilities but as a result of live agencies that unfold during the performance.

The relationships do not have conceptual constraints: improvisation, formalized probabilistic generative structures, emergent behaviour, staging an ethico-political judgment are all viable techniques, and the relationships the composers or performers deploy in their artworks associate indifferently human and nonhuman actors, analog and digital tools, visual and acoustic sources. But any instance of the technique or actor should be treated keeping in mind its specific attributes and possibilities, refraining from applying any generalising and unifying concept that aims to embrace all the cases.

Relationships not only can display an almost endless number of cases in their initial premises but they can also evolve over time. In improvisation this is common: good improvisors, not only have many possibilities to mediate the same musical cue but tend to adjust the range of their responses according to the development of the session. For instance, when the pace of the session is slow and the musician decides not to work in opposition with the rest of the group, the solutions adopted tend to be more sound oriented, such as working with the sound of the breath of a wind instrument, focusing on beating sustained tones, or allowing more silence between each intervention; whereas when the session is more agitated, it is common to see the improvisor accessing another range of responses and using quick aggregates of notes and shorter times of

[230] Remember Beyoncé's example at the beginning of the introduction.

reaction. Translating this relational framework to the machine is a subversion of the traditional instrumental nature that tends toward steady relationships between gesture and sound production. Especially when working with microprocessors, developing *dynamic mapping* between gesture and sound, or any form of dynamic relationship between the modules generating sounds, is a fascinating and relatively new possibility.

I have discussed the simultaneous coexistence of different relationships (vertical dimension) and their development over time (horizontal dimension); now I will discuss a crucial point that also poses a most daring intellectual obstacle.

During a performance, there are plenty of uninteresting relationships that can produce beautiful sounds: if we see aesthetic value in the relationship between human and nonhuman actors, I do not think that plainly reproposing material developed in studio, without intervening live in terms of the timing or physically altering the tape containing the recording, is enough to constitute a performative act. If we expand the network to more coexisting relationships, we can consider an improvisation group composed by instrumental and laptop performers where laptop performers are limited by the unresponsiveness of their programs or by the lack of familiarity with improvisation, and the acoustic musicians, unaware of the limits of the laptop performers or unwilling to limit the scope of their agency, take up most of the decision-making: deferring agency to the instrumental musicians to play along with a less reactive electronic part can result in a more polished acoustic product and, relying only on the recording of the performance, without information about the network or the possibility to listen repeatedly to the group, the product will be more viable for the vast majority of the current diffusion channels. But this is not the goal of relational music, for pursuing the objective of an acoustic perfection severed from the relational aspect will lead to an unbalanced network of agencies without any additional value, such as a focused exploration of unbalanced relationships or staging an ethico-political judgment about unbalanced human hierarchies. Arguably, the most daring intellectual challenge is the understanding that two relationships that generate two sounds that blend well together do not necessarily coexist seamlessly

from the standpoint of relational music because, when relationships become familiar aesthetic vessels, their mediation processes cannot be severed from the other parameters such as pitch duration, and timbre: some mediation processes coexist seamlessly in a balanced network of agencies, other ones disrupt the relational ecosystem. In this sense, the example of a laptop performer leaving all the decision-making to the acoustic musicians in search of a more polished sound can be seen, from a relational standpoint, as being like forcing a voice in a counterpoint to abruptly cut a beautiful melodic passage to reach a desired chord. As Agostino Di Scipio argued, there is a substantial difference between creating wanted sounds via interactive means and creating wanted interactions having audible traces:[231] relational music sees both the actors' audible traces and associations between the actors as inseparable carriers of aesthetic content.

The definition of a specific technique is related mostly to the difficulties to overcome in designing the networks and, exactly like traditional counterpoint, it is meant to address only a specific set of problems occurring in specific circumstances. Relational counterpoint as described above regularly happens in improvisation and its definition will not add anything to the improvisation session. John Zorn describes clearly the different ways improvisors mediate musical information speaking, for instance, about Bill Frisell's tendency to stay in the background as opposed to musicians like Zorn himself, more inclined to take opposing musical decisions and cause trouble in the musical flow: there is no mention to any aesthetic preference, these different forms of mediating musical cues coexist and enrich the ensemble conferring to it its identity.[232]

On the other hand, in electronic music, especially when dealing with microprocessors, there are different obstacles to overcome and the lack of a consistent method can render certain tasks barely possible. For instance, the development of a set of relationships through programming can take a prohibitive amount of time and can be far from intuitive: if the disposition of the relationships in time, how they blend with each other, how they develop, and literally their positioning and modularity inside the code is not taken care of, it is easy to be overwhelmed by

[231] Di Scipio (2003) p.271
[232] Bailey (1992) p.78

growing complexity, or it could be impossible to attempt any constructive development which often requires developing each single relationship independently at a deferred time.

The technical details of relational counterpoint will be better understood through the practical examples I will present in the section networks of the portfolio.

5 – Portfolio

In this final chapter I will provide a practice-led description of how the notions of the previous chapters relate to my musical practice. I will describe 4 works, each of them will provide different points of observation of a relational approach to electronic music performance.

Even if the presentation will seem initially to proceed from simple to complex, this direction has no ambitions of coherence. The different tasks confronted are simple or complex mostly according to the background of the reader and the focus of the observation. For instance, the first piece in the list, a duo improvisation for laptop and violin, might look like the simplest in terms of technological and conceptual framework, nonetheless it was one of the latest to be realised and presented some of the hardest challenges.[233] A more coherent criterion for the position of the works in the presentation is a gradual progression from left to right on the tangential agency line (see fig 4.1), going from more causal forms of human control to independent networks, passing through forms of balanced agencies of semi-autonomous networks. This progression seems also reasonable for an eventual didactic of relational electronic music performance, once it is clear that the progression is by no means an order of importance. If priority should be given, it should go to the works involving human actors and a more intuitive approach to the electronic instrument. The possibility of a more intuitive approach starts with the capacity to recognise when an instrument can let us improvise, a task easier said than done and too often overlooked. Therefore the works dealing primarily with this problem are the first to be presented. More technically demanding and planned works are presented later, where I will describe relational approaches that highlight the role of the computer and insist on the concept of relational counterpoint. The work in section 5.2 will apply relational counterpoint to networks insisting on human and nonhuman actors, whereas the last work

[233] It is useful to stress the importance of the background: were computer performance taught more broadly, and were the discourse about musical software development more careful about intuitive decision-making and agency, it would probably be easier to develop an instrument for improvisation than a very complex network of event-related relationships.

will be an application of the technique to mainly nonhuman actors.

5.1 – Focus on human agency: computer (in) improvisation

The two improvisations presented explored the questions that arise when bounded rationality is taken into account while integrating a laptop in an improvisation session. The first duo addressed a series of questions more directly related to the capabilities of the laptop to channel intuitive decision-making. In this group, the meeting of our aesthetics did not result in a reduced musical approach, leaving to our practice-led exploration the task of solving the problem of balancing the acoustic possibilities of the laptop with the need to create a balanced network of agencies. In the following trio, as discussed in chapter 1, a more reduced musical aesthetic, collectively established before the session, created the premises for a seamless introduction of the electronic material: in a generally more silent sound and less dense interplay, all our instruments were given the space to unfold their properties, often slowly, so the problem of a less direct relationship with intuitive gestures was de facto bypassed.

5.1.1 – Mandhira de Saram / Luigi Marino

Mandhira de Saram: violin

Luigi Marino: laptop

This network can be seen as four actors: two human actors responsible for most of the agency; two nonhuman ones, the instruments, mostly limited to faithful intermediaries, enact the intentions of the players. But because of the limited resistance posed by the instruments and their

predominant role of intermediaries, the network can be simplified to a two-actor-network involving only the players.

Playing laptop in duo improvisation, especially with musicians gifted with a high degree of virtuosity, presented a series of problems whose answers came mostly with practice. What space should I occupy as a laptop improviser in a duo with an acoustic instrument? Should I deploy the whole timbral prowess of a modern CPU and dealing with 100-voice-textures? Should I act on a spatial area that surrounds the listener by the means of hundreds of speakers? If we play in a space with a dry acoustic, should I simulate the space as customary of a polished digital electronic music product?

If the goal is creating the ground to unfold a balanced network of agencies, the answer I explored is suggested by human and instrumental limits instead of technological possibilities: I occupy the same acoustic space the other musician can occupy. The violin is mostly a monophonic instrument, so I play mostly a single voice on my digital instrument. The violin is a mono source, so I play with a mono speaker near my body. If we play in a dry environment, instead of playing on a different spatial level, I set to mute the reverb module, even if the dryness is hard to cope with. The violin has a distinctive timbral character, so I play only synthetic sounds in the hope that the laptop could approximate the idea of finding its timbral identity and hold the ground in a balanced two-voice duet. The separate identity of the digital sound is breached only when timbral similarity allows us to access some habits we think to be musically valuable. In these occasions we do not rule out the possibility that the synth might recall a bowed instrument but we always keep open the possibility to revert this association and come back to unmistakably computer-generated sounds. I excluded signal processing from the palette of my options: in my approach, signal processing poses excessive dangers to prevent the development of a balance between the agencies of the actor.

The solutions proposed in this duo are the clearest application of Simon's bounded rationality. All these limitations, mostly taken as general directions and only in rare occasions as strict rules, strip down to the essential the intuitive decision making process. I see this as a sort of

fine-tuning: if some solutions are removed from the spectrum, I have to look elsewhere, where I was not seeing closely enough. If a dense and slowly controllable material is taken out of the picture and I am left with a simpler sound source, I have to insist on minor performative aspects. Sometimes it is said that we can close our eyes and stop seeing but we cannot close our ears and stop listening: this can be misleading because listening deals with selective attention and we have many ways to stop listening. These minor performative aspects are often below the threshold of detectability when we deal with dense sound masses or overly complex gestural aggregates. Simplifying the timbral and spatial field restores the possibility for the listener to appreciate the subtlest performative choices: an access point is provided where the agency of the singularities can be traced better.

When the intuitive decisions can be at least partially traced and when the electronic medium starts to deploy its attributes, it is time to bring back the discourse about semi-autonomous behaviours. I keep in mind that a disproportioned bow pressure applied on the strings, as any contemporary music player knows, will create an acoustic behaviour, which is semi-autonomous in that not much of its fine resolution is under the control of the performer. The semi-autonomous behaviour of the machine is on the same plane of that of the other instruments, it can only be occasionally more powerful. In this case, and generally when improvising in duo with acoustic instruments, I tend to limit this possibility: the digital instrument has algorithmic elements and its behaviour is sometimes unexpected; the autonomous part works as a challenging actor both for me and for the musician I improvise with, but when it does not allow me to take decisions in response to either endogenous stimuli or stimuli produced by the other musician I tend to limit its role in this specific setting.

The description of this network is the simplest among the works that will be presented. Nonetheless it displays a very interesting aspect regarding intermediaries and mediators. When we play an improv session we might want to control our instrument because predicting the relationship between our gestures and the sounds produced can help to develop a dialogue in which the

musicians take surprising decisions. In these circumstances the instruments work mostly as mere intermediaries but doing so, at the same time, they increase the agency of the players: the instruments lose their mediating capability in order to increase the mediating capability of the improvisors playing them. In terms of agency, the role of the players here is so prevalent that for most of the music it makes sense to discuss a 2-actor-network.

This network shows how in some instances of improvised music the general trend to favour mediators over intermediaries might not work. This is a very common problem when composers try to include algorithmic processes in an improv session: sometimes a pad controller can untie a great deal of surprising developments stemming from the possibility of the electronic players to engage in an intuitive process of decision-making, whereas the most advanced algorithmic synth can pose an excessive resistance, without replacing their decision-making with a comparable variety in the musical behaviour.

5.1.2 – Mark Wastell / Matt Davis / Luigi Marino

Mark Wastell: percussion, shruti box

Matt Davis: magnetic fields devices

Luigi Marino: percussion, laptop, analog devices

This trio displays a very different quality of agency in comparison with the first work proposed: here the mediating power of the instruments is always present and counterbalances the decision-making of the players. The human agency is simpler and more limited, but a more complex network of actors is deployed.

The session recorded live at Iklectik is our first. In it two different lines of collaborations converge: Mark Wastell and Matt Davis were both among the musicians who brought about the novel sound of the New London Silence on the European scene, and played together on numerous

occasions.[234] Mark Wastell and I started to play both as a duo and in The Seen in 2018 and we have been very active since.[235] Being improvisation always a resultant of forces pulling in different directions, this excerpt is far closer to the aesthetic of the third generation of improvisors than the previous one: even though Mark and Matt both covered different directions since the New London Silence experience, they still enjoy reduced forms of improvisation. Having one uninterrupted hour to play, we all agreed on a slow pace.

In this session I play an electroacoustic set composed by laptop, percussion, and portable analogical feedback generators. The use of the computer is an example where the laptop can be considered two different actors because it runs two programs with a very different relational behaviour. I use two instruments both developed in Max. The first instrument is a generator of just tuned sine waves that I control with 8x8 pressure sensitive pad matrix.[236] The scale is derived by the intervals of the exact harmonics in the 5th octave.[237] This instrument works as a rather faithful intermediary of my actions. The second instrument is semi-autonomous: it responds to the sound captured by a microphone in the room, turning the signal into a synthetic sound tangentially related to the input spectrum. My intervention is limited to the activation and closure of the process, and to my share of sound produced in the room. The analysis is done by the use of spectral techniques and a variable selection of partials is mapped to the frequencies of crossfading banks of resonant filters excited by white noise.[238] This instrument has a more accentuated role of mediation, in that it turns the information coming from the acoustic ambience into something related but rather unpredictable. Furthermore, the program projects new sounds into the room, contributing with new material to the

[234] Bell (2005)

[235] Two Recordings of our collaboration in The Seen are available on Confront Recordings: https://confrontrecordings.bandcamp.com/album/onca-gallery-brighton, https://confrontrecordings.bandcamp.com/album/discon-festival-london.
As a duo, before the session presented, we played the same year at Cafe Oto, Oxford Improvisers, Iklectik, Hundred Years Gallery, and Linear Obsessional.

[236] The interface that turns the 8x8 pad matrix into just tuned intervals is used to find the just tuned chords in most of the pieces that will follow. See the patch "launchpad.jiui" in the folder "software/network6" for the most recent version.

[237] Given the simplicity of the division, unsurprisingly, I later discovered that Wendy Carlos used the exact same 16-interval-scale.

[238] For details see the description of ResoX in appendix 4 and the Max patch with the same name inside the folder "software/network5."

network (always intended as all the human and nonhuman actors observed), and thus generating a continuous feedback loop that uses sound as medium for data exchange, not dissimilarly to Agostino Di Scipio's eco-systemic feedback.[239] But there is a major difference: the program implementing the eco-systemic feedback is only one actor of the network, it does not command any particular attention nor presuppose any paradigmatic shift. That program's behaviour operates at the same level of improvisors and instruments with old, not-so-old, or new ways of mediating information in the network. No node of the network takes over,[240] nor imposes a systemic approach: the session oscillates between acoustic improvisation, improvisation by means of pre-digital techniques, computer used as a plain instrument, and computer engaging in eco-systemic feedback with the room, without any specific technique suggesting a predominant direction.

5.2 – Focus on machine-human agency

Network 1 through *5* are works for solo performer and digital network of synthesizers. In these works, bounded rationality was again embraced in the search of ways to use digital processors without forgetting about people's role in the network, and considering people's role in the network without drifting toward blind interventionism. But the in depth exploration of the agency of the synthetic actors gave room to a more systematic exploration of ANT and its musical imperfect translation described in chapter 4.

The actors of these networks do not follow any specific hierarchy:[241] the human actor has generally a prominent role in that its actions affect the network more than the average of the other synthetic actors, but there is no insistence on creating a man-machine interactive system, and the actions of the synthetic actors not only can affect all the other actors -human and nonhuman-

[239] Di Scipio (2003) p.272
[240] Bischoff, Gold, and Horton (1978)
[241] With the exception of *Network1* that was a passage piece.

present in the network, but can also occasionally overtake human agency and define its scope. The networks require no human intervention other than the input sounds for their whole development, but machine listening is simply a method to let human agency participate to the network.

The presented approach gradually turned out to be something more than an aesthetic practice solely directed towards the production of artworks to be presented in appropriate venues. It became a tool for autoethnography; a practice-led method for understanding what I perceive as balance between a contemplative observation of surprising behaviours that do not need my intervention and my desire to participate in the process; balance between a craving for the unknown and the peaceful repetition of cycles of organisation; balance between self-transformation and acceptance of the consequences of my agency.[242]

The attention to the relationships determined my standpoint of observation. Therefore, it started to feel always more reasonable to group the actors that generate sounds according to the relationships they present, both to facilitate the written description of the networks and for clarity during the compositional process: even if there are 4 instances of one synth, all doing different things, if the relationships they display are the same and they are not perceived clearly as different entities by temporal displacement, they are grouped together.[243] The groups are referred to as relationships and are given names that reflect their character within the piece or anything that can help the memory during the compositional phase.[244] Often these relationships clearly designate a single actor (often an instance of a synth) and the term relationship and actor designate the same perceptual entity. When the relationship refers to a group of actors having similar relational behaviour, while discussing the single relationship it will be possible to undo the group and unfold details of the single actors (often multiple instances of the same synth with different parameters).

[242] As a result of these ideas, I also gradually started to loose interest in the grandiose aspect of the performance: none of these works pay much attention to the problem of the theatricality of the performance; the controllers used are mostly simple and portable analog circuits.

[243] Traditional approaches to complexity, such as a single set of instructions for all the actors of the piece, would make a very short description for my approach to relational electronic music.

[244] I started numbering the relationships in order of appearance but it turned out to be a predictable mistake: I kept changing the position of the relationships on the timeline in the compositional process and the abstract and non-sequential numeration only contributed to make the relationships harder to remember. Giving them names allowed to keep a mental image of their plastic disposition in the piece and inside the code.

These remarks came gradually. The presentation will insist on Network 5 because, among the works focusing on machine/human agency, it represents the most accomplished results of the theoretical and technical tools developed. As a report of the development's timeline, the first two networks are described in appendix 4 with the recording in the folder Audio/Appendix, while for Network 3, always as appendix, there is only the audio, a live version I played at IEM.

5.2.1 – Network 5: Fragile Coexistence

* The audio excerpt presents only one iteration of the main time cycle, unedited. A video of the recorded performance is available at http://luigimarino.net/works/network5.html, where it is possible to see the circuit and the performative gestures contributing to the sounds. This kind of works are better appreciated if more iterations are repeated so that the differences can come out. Therefore, I included a version with two repetitions in the folder Audio/Appendix.

Network 5 is a performance where minimal gestures create fragile electrical contacts whose analogical sounds are mediated by the computer with direct and perceptually rich responses, while, on a deeper level of tangential mediation, the information stored frames the performer's agency determining its scope. While the direct relationships audible through the quick responses of the machine keep the performer's intuition engaged, the long-term tangential effects of the gestures determine the limits for successive actions; such limits are not intuitively comprehensible by the same actor who created them but experienced empirically trough listening.

The development of the piece is regulated by a series of concentric time cycles which are all related to the intuitive durations of the gestures of the performer. The longest cycle, the upper level of organisation, can be repeated a fixed number of times for a stage performance or ideally repeated endlessly in an environment where the audience is free to join and leave the space at will.

The sound source controlled by the performer let human agency participate in the network,

thus its choice is an essential part of this work. The circuit generating the input signal is an analog noise generator that amplifies the residual noise of a resistor: the component is exposed and the performer manually creates the contact generating white noise by pushing the resistor on the terminal. The contact not only generates white noise, but also a series of glitches and hums due to the imperfection of the operation. The noise generator is unshielded, with the connection to the chassis ground of the mixer/soundcard left open on the case of the circuit: the performer can touch the metal pin to remove ground loops and noises picked up by the body working as an antenna, or leave all the interferences.

Through the selection of an input source with evident limits and imperfections, the information channel that mediates human intentionality is reduced to the bare minimum. I think that the reduction of the information channel does not configure a reduction of the information processed but redirects attention to information meaningful to the piece:[245] the gesture, occasionally reminiscent of morse code, highlights the focus on duration and how a simple set of durations chosen intuitively can frame the entire compositional space; the limits and the glitches of the operation contribute to the uncertain positioning of human agency in the network. The acoustic qualities of the glitches are also used extensively in the piece in that the digital response mediates these analogical imperfections and use their features for the synthesis. Occasionally, I looked for processes that turned these imperfections into *emergent idioms*: familiar sounds of drum machines, or synths recalling eastern stringed instruments set mnemonic references but the relationships with the events happening in the performance "complete" the idiom in unforeseen ways, often resisting to the performer's intentions or suggesting alternative ways to convey intentionality.

Network 5 is my most accomplished application of relational counterpoint in the setting of digital networks for solo performer. According to the discussion developed in chapter 4, the work develops several layers of mediation simultaneously and present a great variety of relationships, ranging from extremely direct associations to completely unintelligible ones, approaching but never

[245] This solution draws on the reflections exposed in chapter 2 regarding bounded rationality and the experience of the third generation of improvisors.

touching the extreme ends of complete causality or complete independence. All the relationships are also treated as singularities, in that they present different qualities and developments that are generally not only a contribution to the gestalt, but present interest on their own. The possibilities offered by the data stored that contribute to the behaviour of the actors are never exhausted in a single performance, but instead leave unexplored areas.

In fig. 5.1 I used a graphic representation for the timeframes of the main cycle of *Network 5*. The relationships are presented from top to bottom according to how tangential they are to the gestures of the performer:[246] Below the relationships there is a representation of the time cycles that frame the temporal position of the relationships; the durations are expressed in ratios as they are calculated in real-time during the performance with a series of event-related timers. P are pauses in the interventions of the performer: in these moments some synthetic actors work as a moving acoustic environment unrelated to human agency. When there is the first human intervention (E1), a timer starts and we access section A of cycle 1. Section A is delimited by the events E1 and E2, respectively, the first time there is sound coming from the circuit during the pause P1, and an uninterrupted sound, always from the circuit, that is more than 10 seconds long. This phase is crucial because the intuitive duration defined by these to interventions will define the entire duration of cycle 1. Cycle 1 is repeated twice and cycle 2 is a ratio of the duration D, which is the two iterations of cycle 1 plus the pauses that separate them (D = A1 + B1 + P2 + A2 + B2 + P3). The entire duration of the main time cycle is inescapably defined by the intuitive durations of section A1 and A2. The time cycles have a recurring number, the ratio 5/2, either used directly or in its inverse. The main cycle is the longest form of temporal organisation defined and ideally it is meant to be repeated endlessly, or at least for as long as the performative situation allows it.

[246] This order is far from rigorous and except for maybe the areas at the bottom and the top of the line, the relationships could be moved by one or two positions according to personal interpretations about causality.

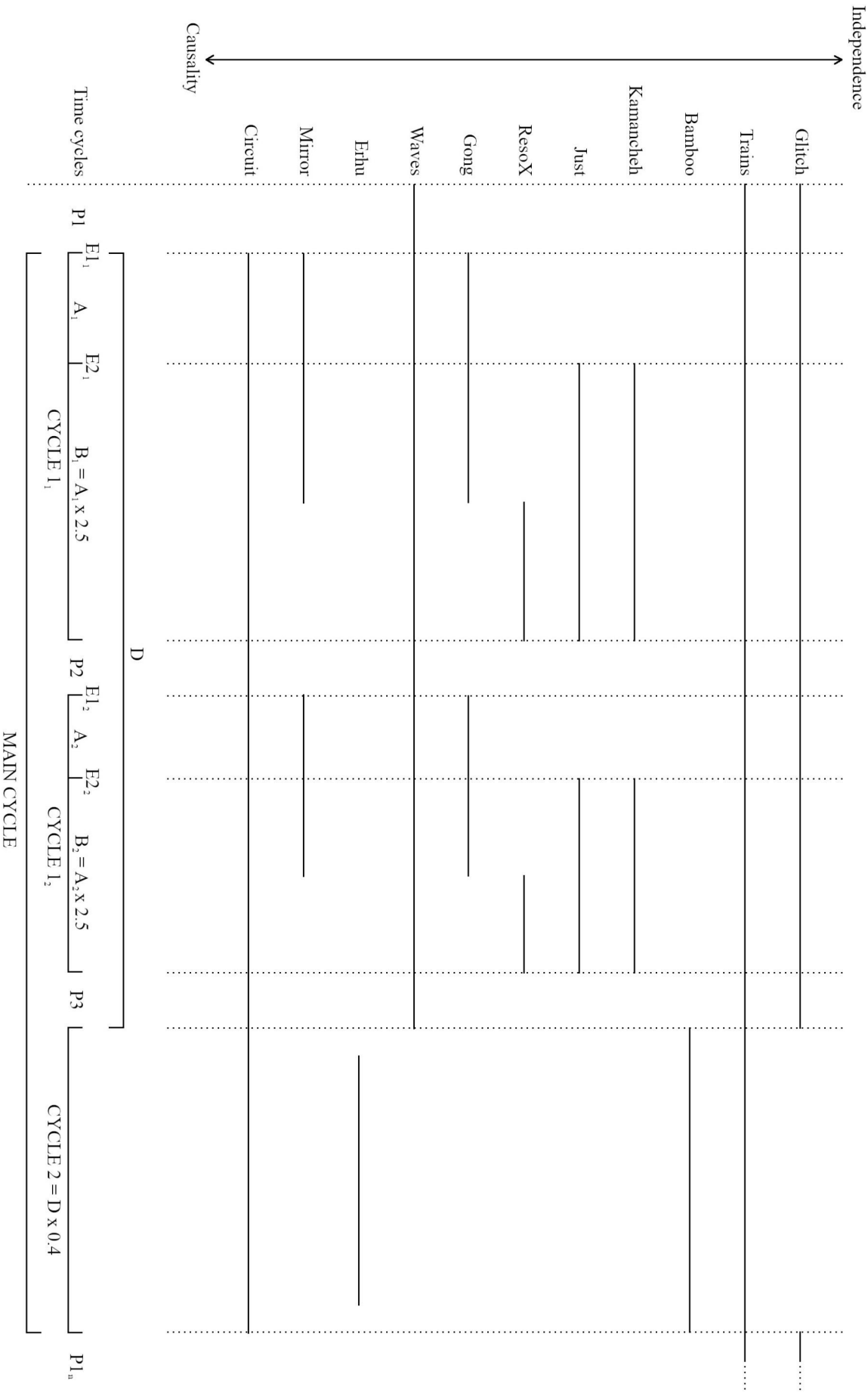


Fig 5.1 – Relational score of the timeframes of the main time cycle of Network 5.

Relationships

Circuit

Circuit is the relationship between the gestures of the performer and the sounds produced by the analog circuit that often provides information for the digital response of the many synthetic actors of the computer part of the network. This relationship is the most direct of the network but because of the occasional imperfections of the circuit to mediate human intentionality, it deserves to be mentioned: the performer's control over the analogue instrument displays some glitches and does not have enough causality to merge performer and instrument into a single actor.

Mirror

Mirror focuses on the time details of what happens in the analog circuit's output and creates performer-computer dialogue that is reminiscent of the call and response heard in many traditional musics.[247] The output of the circuit works as the call and after a predetermined time there is the computer response that follows the same time frames of the call, with many micro variations happening in the spectral and spatial domain. The computer response uses sounds that clearly recall drum machine culture, turning the timeframe created by white noise and glitches of imperfect manual interventions into events with references to idiomatic forms.

Any change of state detected in the circuit by the computer, generates a timestamp for the timeframe of the response: sound/silence, white noise/electrical hum, and any other major spectral change such as glitches coming from the fragile and manual way of closing the connection, are analysed using a combination of amplitude threshold detection and a series of spectral

[247] The examples are too many to mention but the two I had more closely in mind while working on this relationship were the *young women's circle song* from David Toop's recordings among the Yanomami tribe and many of the songs of the project *The Yoruba / Dahomean Collection: Orishas Across the Ocean* recorded by Laura Boulton, Melville Herskovits and Lydia Cabrera and issued by Smithsonian Folkways.

descriptors.[248] The descriptors that were most useful for this task were spectral centroid, spectral total energy, noisiness[249] and especially the perceptual spectral skewness that worked very well to detect glitches seen as major spikes of change in the continuity of the spectrum.

The response is mostly synthesized with the standSynth library,[250] with one instance of ResoX adding barely noticeable spectral colours. The relationship then develops, with ResoX gradually become more prominent, and the white noise section of the response acquiring a spectral character more tangentially related to the input.

The relationship between the performer and this synthetic actor is quite direct and its musical functioning in the network depends a lot on the performer's decisions.

Trains

The actors grouped by this relationship are some of the most independent of the piece. Four train pulse modules[251] are controlled by a large array of probabilistic techniques: some are responsible for quick changes, other for slow transitions that can be appreciated in minutes. Some changes are so slow that are not even meant to be perceived as continuous but as static states, different every time the actor comes into focus. The oscillations of the slow transitions, especially in frequency, are broad and rarely allow the whole range to be explored during a single iteration of the piece. The presence of this relationship is regulated by slow unsynchronised random amp transitions with uneven on-off cycles: silence is between 2 and 4 minutes, playing time is between 1 and 2.5 minutes, with the transition ramps taking between 15 and 30 seconds. In order to avoid repetitiveness at the beginning of the session, the initial state of the slow transitions is randomised.

[248] The software used is the last version of the IRCAM descriptors included in the PiPo library available as an add-on from the package manager of Max 8 (Schnell, Schwarz, Larralde, and Borghesi, 2017). Unfortunately, the current version presents some problems of stability and in performance I still use the previous and more restricted version with the object ircamdescriptors~.

[249] The noisiness descriptor in the Pipo library did not seem to have enough sensitivity with sounds close to white noise, whereas the older version of the CEMAT analyzer~ object works perfectly, so I still cannot replace it.

[250] See the patch STANDSYNTH in the folder Software/Network6. The version used in Network 5 is an earlier and less efficient one.

[251] See the patch TRAIN-LIGHT in the folder Software/Network5.

The parameters of this relationship that are not independent respond to *circuit* and *mirror*, with different probabilities of occurrence according to which actor is interacting with them. Acoustically, the relationship is simple: the glitches of the noise generator (only the glitches) and their delayed mirror response have a certain probability to generate a single short impulse that is added or multiplied to the slow control signals, creating a sort of glitch in the continuous movement. The uneven probability in the response to the triggering event creates a stronger association with *mirror*.

Occasionally, a percussion-like event causes switches between pairs of instances or trains. This intervention is defined as a triplet of high pitched noise closed by a low kick. The triplet changes tempo at each occurrence. The overall occurrence of the event is generally sparse and defined by a beta distribution applied to the duration of the pause. There are sections where the event happens when the trains volume is turned off, so it is perceived as a separate actor.

Glitch

Glitch is the twin relationship of *trains*. Its degree of independence is similarly very high.

The sounds are all synthesized with the standSynth library. There are 5 layers of quickly flickering sounds: sine waves, square waves, and filtered noise oscillates slowly within their frequency, amplitude, and interrupt range. The frequency range rarely overlaps and they generally occupy their own frequency domain. The interrupt is generally at regular intervals, with one layer being an exception and having the interrupt controlled by a beta distribution applied to the duration. The appearance of this relationship (the main gain for all the 5 layers) is controlled by another instance of the code generating slow random transitions with the same limit values as *trains.* The instances of the transition of *trains* and *glitch* are inversely initialised to avoid synch at the beginning. *Glitch* has the same relationship with *circuit* and *mirror* as *trains* (onsets generate short glitches) but with different probability of occurrence.

Waves

This relationship is responsible for the waves of filtered white noise, occasionally interrupted by glitches or echoed by low sine waves, that come and go especially at the beginning of the main cycle. The synthesis is done with the standSynth library, with two instances of white noise generators with resonant filter and some extra synths called occasionally. One white noise generator takes care of the waves with a high frequency content, whereas the other generates the low frequency waves. The onset of the waves is controlled randomly with a beta distribution applied to the duration of the event and, consequentially, to the pause, which is a ratio of the duration of the event. But there are many concurring events that can alter this behaviour, both generated within the group of actors defined as *waves,* or generated by external actors. The alterations affect mostly the high frequency wave, whereas the low frequency wave is less prone to influences. Internally, when the wave peaks in amplitude, there are different possible directions for the event: the wave can finish smoothly, can stop abruptly, or can stop interrupted by shorter events, often percussive in nature that can trigger other short chains of events. Externally, the high frequency wave has a direct relationship with the white noise coming from the circuit: the performer can decide to interrupt the wave by playing the circuit, creating an abrupt "passing" of white noises that not only is marked by the difference in quality of the noise, but also by spatialisation (the computer with noise is rarely in the same spatial field of the circuit noise). *Waves'* horizontal development deals with the density of the waves: the waves become more sparse with the incoming of the relationships of the time cycle 1b.

Gong

Gong musically is fairly self-explanatory: it is an unmistakably percussive event with complex partials and a long tail that is supposed to capture the focus. The synthesis is done with a complex tool for recursive FM exciting a bank of resonators (see software Beelu-v4). The partials of the percussive event are related to the input of the circuit: when *gong* is activated (it has multiple

activations, see graphic score), the FFT module in the analysis block listens to an incoming sound from the circuit and capture the first frame; the first 10 most prominent partials are used as resonant frequencies of the filter bank of the synth Beelu-v3[252] and are kept unchanged for the whole duration of the activation, giving a sense of repetition and stability to the event. With a probability of 10% of the occurrence of the synth, some devious recursion in the synth interfere with the stability of the sound.

The occurrence of *gong* is one of the best example of a relational approach applied to time, so I will describe its details.[253] The triggering event of *gong* is the end message sent at the end of any intervention of *mirror*: *w*hen the synthesis generated by *mirror* stops, the end message is matched with a series of other information coming from other actors in the network which will determine if *gong* will play. One of the most effective relational aspects which contribute to the balanced and apparently disciplined occurrence of *gong* is the communication channel that it shares with *waves*: the actors that are grouped in *waves* have silences that are not predictable; when these silences occur together, *waves* sends out a busy state message equal to 0; this state is received by *gong,* which is allowed to accept the triggering message from *mirror* and thus plays only within these silences left by *waves*. Now, remember that *mirror*'s timing has a fairly direct relationship with the sound of *circuit*, thus the performer's gestures. Also remember as *waves* has elastic states of density throughout the development of the piece*,* which are defined internally by probability and externally by the decisions of the performer who can interrupt the waves. Therefore, the occurrence of *gong* is a complex result of human and nonhuman agency, where human and computer generated decisions all make possible the action of the actor *gong*. The performer's decisions have multiple and qualitatively different relationships with *mirror* and *waves;* these relationships are hierarchically on the same level of the ones created among the other nonhuman actors involved in this process, and they both create a state that affects the tangential relationships the performer and

[252] See the patch Beelu-v3 in the folder Software/Network5.
[253] The full extent of the details can only be described by the code, but when the information comes from multiple modules, like in this case, having a clear picture from the code is tough.

the other actors have with *gong.*

Moreover, the associated actions of *gong* and *waves* have a defining aural feedback on the action of the performer: the direct relationship is that the performer is encouraged not to disrupt eventual interesting moments and act only when there is space left; the tangential relationship is that these waitings happen during cycle 1A, the crucial moment in which the intuitive decisions of the human actor will affect irreversibly the overall duration of the entire main cycle.

This is a clear example of the different musical challenges encountered as a consequence of following ANT suggestion to work with singularities, all with their own character and relationships, instead of aggregates or masses whose actors share the same rules.

In fig. 5.2 there is a graphic representation of the relationships in the section of the network more closely related to the actor *gong.* The different lines represent the strength of the relationships. The arrows that point to the performer are the aural feedback which I indicated as separate relationships with no need to differentiate them from the others.[254]

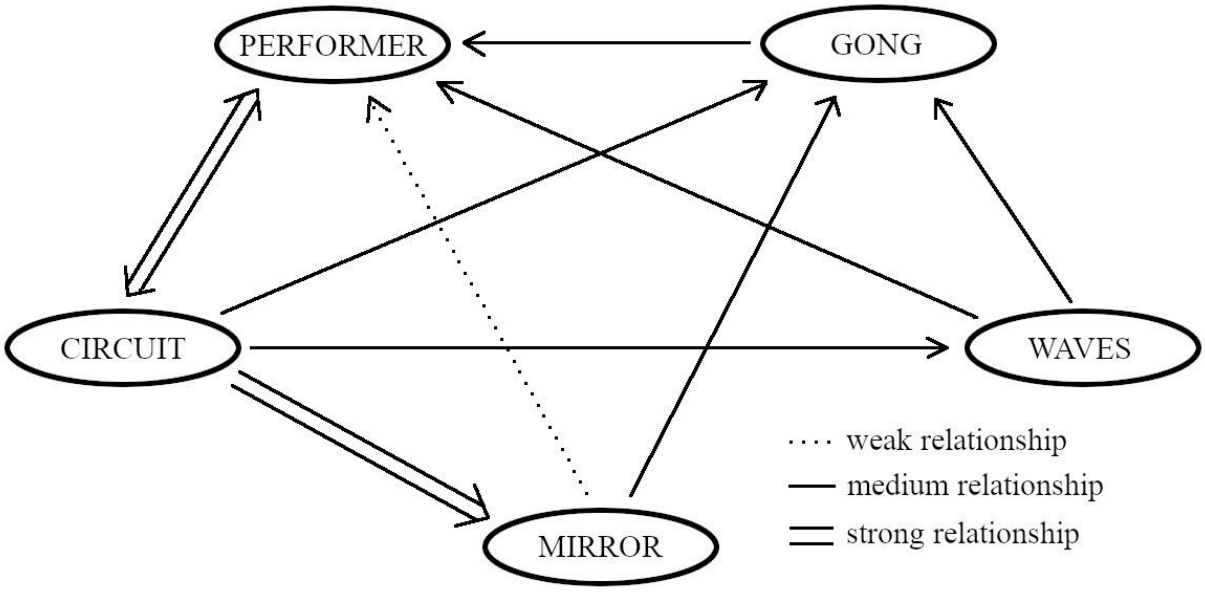


Fig. 5.2 – Diagram representing the relationships and their strength in the section of the network more closely related to the actor *gong.*

Just

[254] The aural feedback is often grouped together in a single relationship and indicated as a sort of special information channel (Bakht and Barlow, 2009). I see this as another indication of the unease to undo the exceptionalism of human actors.

Just, is part of the two relationships that occupy the entire duration of cycle 1b. The digital synthesis is done with Beelu-v3 (a lighter version of Beelu-v4). This actor responds directly to the glitches of *circuit* and rarely to the end signal of *mirror*. Although, its most characterising element is given by algorithmic decisions regarding its tonal material. The bank of resonators that confers a clear tonality to the synthetic material is tuned in a just chord chosen randomly with shuffle selection from a pool of 5 possibilities: the first 4 harmonics are always present and set the fundamental, the chord is then defined by the selection of another note repeated in the second and third octave. Expressed in ratios the possibilities for the defining tone are: 8/7, 5/4 (just major 3rd), 4/3 (perfect 4th), 7/4 (harmonic 7th), 15/8 (just major 7th). The chord is always tuned over a low global fundamental frequency that is selected randomly each time cycle 1 restarts. The chord stays the same throughout cycle 1b but its partials come and go in slow random waves of amplitude except for the first harmonic that is always present.

Kamancheh

Kamancheh is the other relationship that occupies the entire duration of cycle 1b. It works in tonal combination with *just. Kamancheh* plays very quietly, hard panned on one channel and occasionally moving in another spatial area. The sound is reminiscent of eastern bowed instruments and glides through random harmonics (9 through 15 with shuffle selection) tuned on the same global fundamental of *just.* The variety of the just tuned chords results from the combination of the chord selection of *just* and the random movement of *kamancheh.*

Its relationship with the performer's gestures is very tangential, almost unintelligible: the timing of the glitches of *circuit* and their replica from *mirror* are played back with one minute of delay and they trigger the random shifting among the harmonics allowed.

ResoX

This relationship is named after the synth producing the sound and is the best example of dynamic

mapping in this network. It comes in in the second half of cycle 1B. The FFT block of the synth module “listens” to everything is happening in the environment: the circuit and all the audio outputs of all the synthetic modules -except for *ResoX* itself- are mixed and sent to the FFT input of the synth. Initially, the filter bank is excited with white noise and loosely imitates the entire acoustic environment. From here a process that will change the relational behaviour of the module starts: gradually, the white noise used as excitement signal crossfades with the output of *circuit*, so that at the end of cycle 1B the sound coming from *circuit* is the only source that excites the bank of resonators. At the end of cycle 1B, the sound of *circuit* tangentially and slowly affects *ResoX* by contributing to the frequencies of the FFT frames used by the filter bank as at the beginning, but *circuit* also has a new and direct relationship in that it excites the filter bank every time it plays. When the actor acquires this complex behaviour, it is brought in the foreground.

Bamboo

Bamboo extends for the whole duration of cycle 2. It is an unmistakable and isochronous percussive sound whose income divides cycle 1 from cycle 2. When this actor comes in, all the other sounds are shut down; only *trains* is not really turned off but turned all the way down, and, if it was playing, it comes back with a slow crescendo. The percussive sound has resonators on the 6th, 7th, and 9^{th} harmonic, producing a just tuned minor triad, a chord not present among the tonal possibilities of cycle 1. The reverberation has a subtile probabilistic property: the reverb comes in only in the last part of the event, thus it reverberates the tonal resonance and not the initial percussive attack, and any partial has a random quantity of reverb that changes at any event, so the tail of the reverb has always a different tonal colour.

Erhu

The sound of this relationship, as for *kamancheh,* does not avoid references to eastern bowed string instruments. The relationships works in combination with *bamboo* creating an emerging idiom, as

coming from an imagined tradition. The sounds from *circuit* are sent to a pitch follower and the pitch is mapped to the pitch of *erhu*. The pitch follower is applied to white noise and glitches, so the exact result is hardly controllable, but only deciding the timing of the interventions makes the result surprisingly familiar. When the single intervention of *circuit* stops, the pitch signal is recorded into a control rate buffer and played back in loop with three possible slow directions in speed (slow down until next intervention, speed up until next intervention, stay the same), and two regarding the timbre (introduce effects, do not introduce effects). The timbre is also affected by internal decisions: every time cycle 2 starts, the resonant frequencies of the synth are slightly modified, creating all the times a sort of different resonant body for the instrument.

5.3 – Focus on nonhuman agency

In this section I focus on nonhuman actors, where human intervention in real-time is absent. Nonetheless I indicated them as *mainly* nonhuman in order to account for the intervention taking place at deferred time in the development of artificial actors. The definition differentiate between the creation of artificial actors and the mere observation of entirely natural networks.

5.3.1 – Network 6: Music for an open window

* This piece uses extremely long durations and waitings: although long durations are essential for the aesthetic experience, to understand what is going on it is not necessary to listen to the audio excerpts in their entirety. At the end I indicated the timestamps for the points of interest for each of the eight excerpts.

Music for an open window is a work that focuses on the relationships between live soundscape, several synthetic actors, and a clock that reports the time and the day of the week.

The relationship between acoustic soundscape and electronic sound is tangential and avoids direct references. The individual relationships are thought to be non-specific, thus to react tangentially to any acoustic environment. They are constructed in such a way that they tend to stay within the features of the fundamental sound of the soundscape.[255] With the exception of specific episodes during the day in response to salient events, the synthetic actors are non-intrusive and leave room for the soundscape to be appreciated for what it is.[256]

The main form of analysis used to detect salient events in the spectrum of the microphone signal is spectral anomaly detection: the FFT is divided in 8 energy bands equally distributed on the mel scale. Mean and standard deviation are calculated over the last 300 sample points every time there is an incoming value, for each band. The anomaly is detected when the input value is out of the normal interval. The normal interval is defined by the mean plus and minus the standard deviation multiplied by the tolerance factor.[257] The anomaly is also weighted, with bigger values indicating bigger changes and the sign of the delta reporting information about an incoming novelty in the spectrum or the disappearance of a frequency band. This analysis is always based on a running average, thus it is entirely adaptive: a very effective feature for an application that does not aim to be site specific, or soundscape specific. Indeed, this software is thought to be used by any user inside their houses, and adjust to the most diverse situation without any intervention. In the recordings presented, I used the mono signal coming from an electret microphone and a contact mic placed inside a bird feeder on my window, under a sort of waterproof hat, so it can stay there while it rains and the window can stay closed with punishing temperatures.

A ubiquitous element for this network is the time and date info of the computer's clock.[258]

[255] Schaffer (1994)
[256] The relationship oriented toward a non-intrusive coexistence between synthesis and soundscape owes to composer Walter Branchi.
[257] I used a tolerance factor of 4.
[258] In Max, these information are easily available as JS functions.

The higher temporal organisation of this work is a week. The relationships vary according to the day during the week and according to the minute count during the day.

In this mainly a nonhuman network, a bird may trigger the activation of a process that is informed by my decisions a priori regarding the seven chords in just intonation for the seven days of the week, the information coming from the computer regarding the hour and the day of the week, the durations delimited by the spectral anomalies of the soundscape that were recorded in the previous minutes to the process' start, and the additional major spectral anomalies in the soundscape that happen during the process and trigger immediate changes.

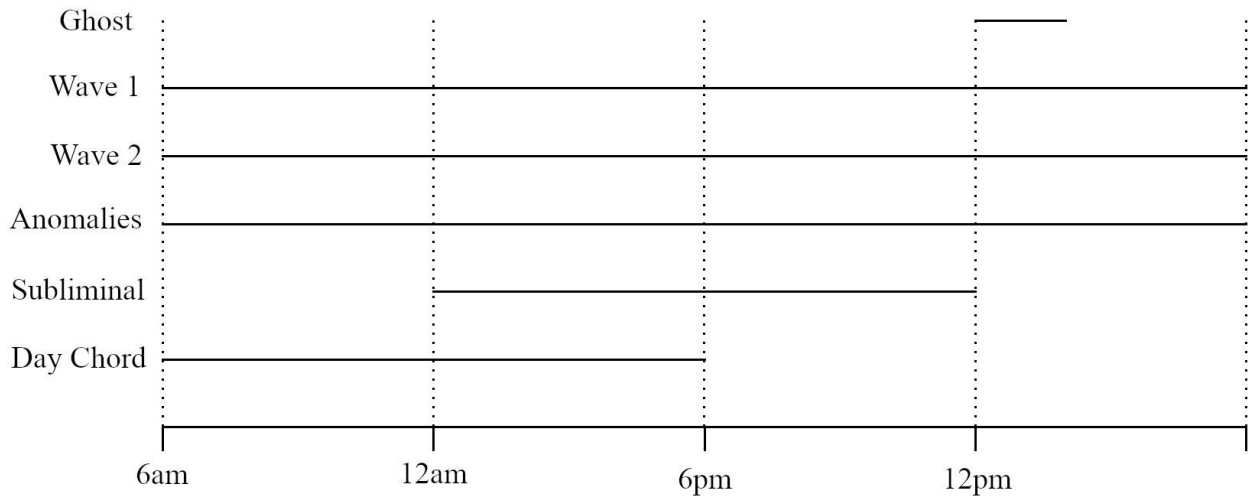


Fig 5.3 – Relational score of the timeframes of a daily cycle of Network 6

Relationships

Wave1

Three sine waves with a very long amplitude envelope, generated at long and regular time intervals, using the frequency of the first 3 most prominent partials of the FFT frame taken at the start of the envelope. The pan changes slowly and randomly. The time intervals are defined by an overlap

factor: when the sound is dense the overlap is 0.66, while when it is more sparse and wave-shaped, it is 2.4. This factor is associated with the time of day: when it is night, the sound is dense, more immobile, drone-like, and quieter, whereas during the day there are waves that leave room for other actors to play, both synthetic or coming from the more active soundscape of the daytime.

Wave2

Wave2 has a similar behaviour as wave1, but it uses 17 white noise generators with resonant filters, playing at the frequency of the 4th through 20th loudest partials of the FFT frame. Pan and q change slowly and randomly. The overlap factor, thus the starting of the spectral process, is different so that the waves have similar movements but they are rarely synchronised. The overlap factor goes from 0.5 to 2.3 and it has the same relationship with day and night as *wave1*.

Anomalies

This actor responds to any spectral change in the soundscape that surpasses the tolerance threshold (mean +- stdev*tol). When the anomaly is detected, the analysis block takes an FFT frame from the microphone signal. Synths made with filtered white noise then slowly fade in: the number of instances played is equal to the number of anomalies detected in the bands (1 through 8) in the instant the frame is taken, and the most prominent partials of the FFT are used as centre frequency of the resonant filters.

DayChord

A major spectral anomaly is the cue for this actor to start playing. After the ON message is received, the actor plays for a random duration between 3 and 7 minutes. After that, it waits for another major anomaly to stop the sound. If nothing happens within 3 minutes, the sound stops on its own. When the actor stops playing it has to wait at least 10 minutes before playing again.

Every day of the week is associated with a chord in just intonation. Each chord is divided in

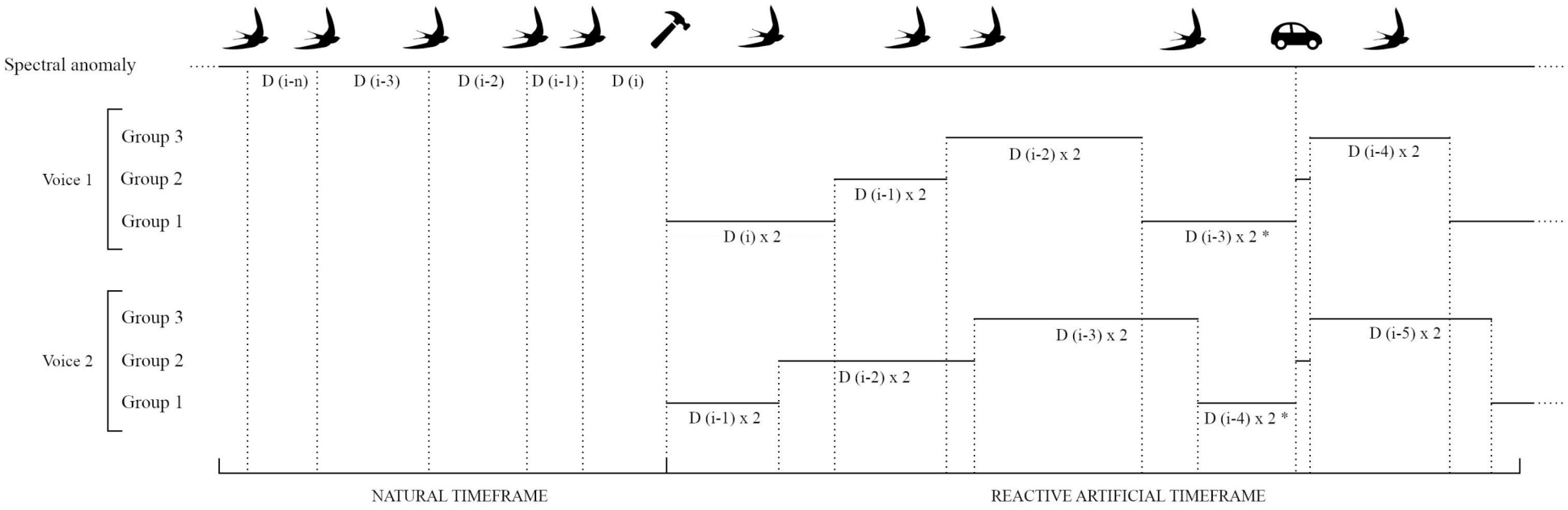
the three groups of notes that are played sequentially with a switch. The change of the day is automated with the internal clock. The group change within the day follows the timeframe defined by the occurrence of the spectral anomalies: the durations between the anomalies are stored in an array and when the actor is activated, they are played backwards, starting from the most recent, according to an emergent structure (see pic at page xx). When the two voices play the same group, minimal random deviations in the initial frequency create unpredictable beatings.

The artificial timeframe derived from the natural one, while working mostly on its own with stored data, also reacts to new incoming stimuli: the past durations coming from the natural world generate data and determine a tangential association with the new artificial timeframe, whereas the detection of new incoming stimuli (medium and major spectral anomalies) causes short chords (50ms) to interfere immediately with the artificial timeframe. New durations are added to the array also when the actor is playing, so the actor does not have to wait until the next activation to be affected by the density of the anomalies.

Ghost

6 days per week, only once a day, randomly between midnight and 2am, *Ghost* plays from 3 to 7 minutes. The resting day is also selected randomly so, even waiting two hours from midnight does not give any certainty that this actor will show up. Its main rhythmic frequency follows the mean density of the anomalies during the night, thus it is usually slow. The movement of the pitch uses buffers recorded during the morning and the afternoon, as a vague memories of the past day.

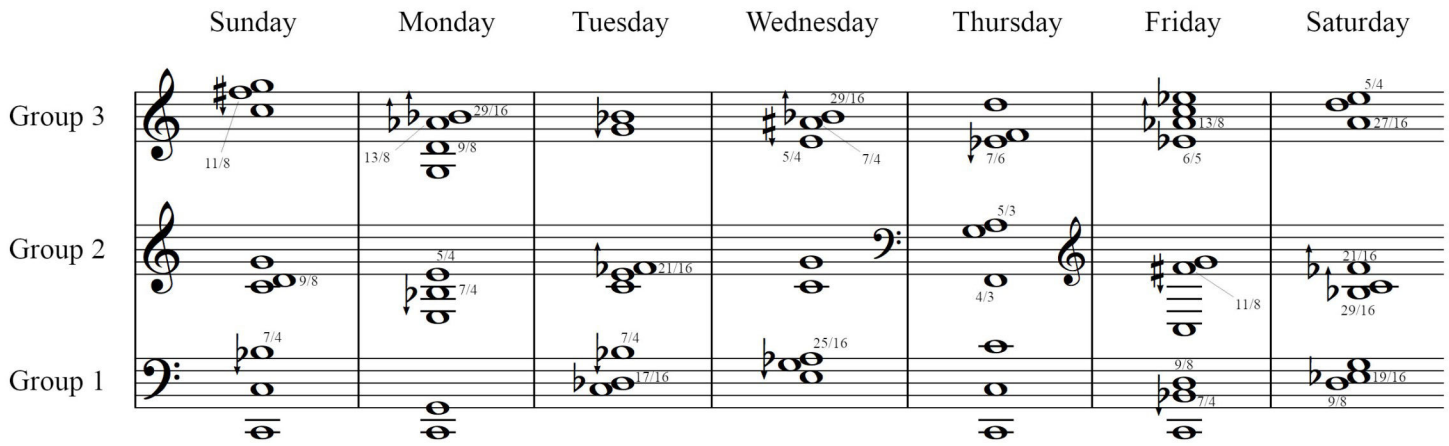
RELATIONSHIP DAYCHORD



Minor spectral anomaly

Medium spectral anomaly

Major spectral anomaly



Audio Excerpts

Thursday – Morning. The soundscape has few anomalies. The natural timeframe is mostly created by a single robin. At 1:49 a gust of wind activates *dayChord*. The slowness of the changes reflects the slowness of the soundscape. At 3:12 the alarm call of a robin is detected right away as a salient change and affects the artificial timeframe. From here the soundscape becomes more active and the density of the chordal changes follows shortly after. *DayChord* is closed by a robin flying on the bird feeder.

Friday – Early morning. The soundscape is moderately active. At 1:16 two starlings come inside the bird feeder, very close to the microphone, and activate *dayChord*, triggering a series of anomalies that determine quick changes in the synthesis. They fly away after a few seconds. At 9:51 I cannot tell if *dayChord* is closed by the sound of the robin or by the clock reaching the time limit.

Saturday – Early afternoon. Very windy, light rain, no birds. At 00:16 the relationship *anomalies* slowly responds to a gust of wind. At 2:14 another gust of wind activates *dayChord*. The wind also closes the actor at 6:47.

Sunday – Morning. At 00:21 the cracking of another bird feeder dangling nearby activates *dayChord*. The loud call of a robin closes the actor at 7:57.

Monday – Early afternoon. The soundscape is fairly active, with robins, great tits, and goldfinches in the nearby feeder defining the natural frame. A great tit coming inside the bird feeder with the microphones activates d*ayChord.* The chordal changes reflect the particular activity that resembles a beta distribution applied to the duration parameter.

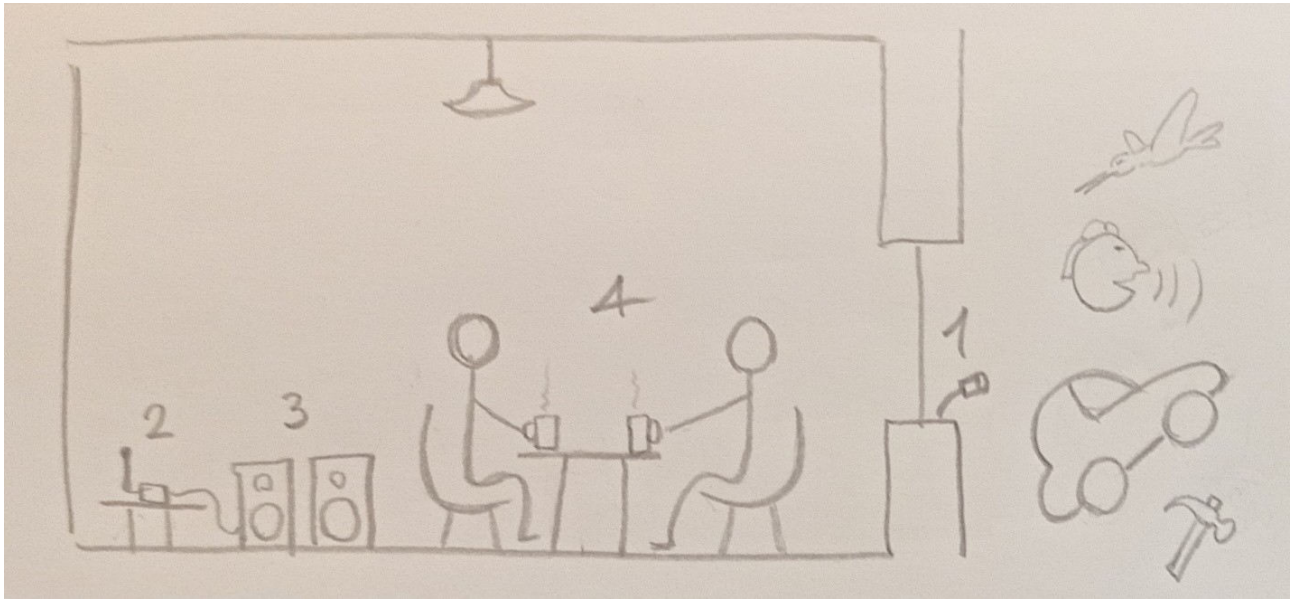
Tuesday – Early morning. At 00:37, a startling coming inside the feeder activates *dayChord.* It feeds for a prolonged time and generates many anomalies. Starting at 1:01 there is an example of the adaptiveness of the anomaly detection: at 1:01 a very loud sound is not recognised as salient anomaly because it is preceded by a lot of activity whereas, at 1:17, a far quieter sound preceded by rest is.

Wednesday – Afternoon. At 1:25, sounds of working tools activate *dayChord.* The rhythmic repetition of this action is felt clearly in the chordal changes. Starting from 10:30, a combination of sustained bird calls and working tools is mediated with especially interesting partials.

Night – There is almost nothing happening. The reactive part of the network responds mostly to the background noise of the microphone. At 2:43 there is a rare occurrence of *ghost.* Its slow pulse reflects the low density of the events in the soundscape. At 13:31 I get up to turn the mic amp off and move my chair: in the absence of anomalies, this little sound is interpreted as a huge change and *anomalies*'s response a few seconds after reflects the change.

Future work

Network 6 is thought to be used as a little screenless box inside the house. The box generates music made of non-intrusive relationships with the signal coming from outdoor, attuning to it an ever changing experience and colouring with new shades the sounds familiar to the listeners.



1 – Little waterproof wireless mic.

2 – Network 6 running on a screenless nano-computer receiving the signal from outdoor.

3 – Amp.

4 – People enjoying the music, without headphones, while carrying on their daily activities.

Conclusions

In this dissertation I looked for answers to the question: "how do the relationships between human and nonhuman actors contribute meaningfully to the aesthetic of today's electronic music performance?" In order to address this question, I proposed a revision of the concept of relational music focusing on its applications to experimental performance involving digital calculators. Even though the conclusions I arrived to bear very little resemblance to relational aesthetics as it was conceptualised in the 90s, I refrained myself from looking for new terminology: the conscious discussion about relationships among actors in experimental music precedes the term relational aesthetics and the excessive insistence on the authorship of terminology is a practice that I hope will stay associated with the 20th century in favour of a more current and intellectually rewarding semantic evolution of the terms. The concept of relational music I presented confronted two key aspects for electronic music performance in the 21st century: the inclusion of neurologically accurate notions of intuition in the narrative about improvisation and the foundational epistemological change we are witnessing in the fall of the demarcation line between objective and subjective world. After achieving some degree of clarity regarding these two complex topics, I proceeded to the development of a relational theory that drew mostly from the still very relevant Herbert Simon's bounded rationality and an imperfect application of the Actor-Network theory. In presenting a portfolio of works focusing on a broad variety of actors and shades of mediation, I provided practical examples of what possible applications of this relational approach might look like, both in the composition and analysis phase.

But maybe the most rewarding conclusion I came to with this dissertation was the possibility to see expressed in a fairly coherent, yet still open aesthetics my concerns and enthusiasm regarding the forces that are reshaping what surrounds me now. In 2019 I visited an exhibition dedicated to Nam June Paik at the TATE Gallery and I read iconic cellist Charlotte Moorman saying in 1967:

"With the assassination of Kennedy, the war, the bomb – well, in times like this you just can't expect the kind of art you had before." Even though many of the musical movements I built upon have their roots in that cultural background, such as free improvisation and the League of Automatic Music Composers, both the world they saw and the one they envisioned then is far removed from my wordly experience. The gradual statistical increment in the number of wildfires, a few centimeters of sea level rise, the messages shared by mycelium networks, the slow erosion of democratic values, or an algorithm mediating the information before we see it on the screen of our smartphone do not have the same immediate impact of the image of a child in Vietnam running from an explosion, cloths and skin burned by napalm. Nonetheless, the agency of these silent and often slow moving forces is bound to modify our future far more than those very loud and clear conflicts we were told to be so important from the generations who lived them decades ago. The attention is now all on these silent, often slow moving agencies, and because of their tangential nature, the solutions we propose cannot be again bold, clear manifestos presenting new *-isms,* or top down formalisations and social systems aiming to organise all men and sounds under a unifying principle. The idea so dear to the League of Automatic Music Composers of networks where no single node can take over is still very relevant, as it is ANT idea that we actively choose an access point to the network and our access point modifies the network itself. The work I presented tried to create wordly associations between these ideas and what I see around me today, and did so insisting on a more neurologically accurate consideration of intuition, abandoning the dualism subject/object in favour of psychological reductionism, and accepting that machines are my silent normality and they are just another actor in the network whose agency I can try to observe, like a friend who plays the clarinet, or the hormones in my blood stream that affect my decision-making.

References

Aristotele, *Metaphysics*, Book 8.

Attali, Jaques (1985) *Noise: the Political Economy of Music*. Minneapolis: University of Minnesota Press.

Axelrod, Robert, and William D. Hamilton (1981) "The Evolution of Cooperation", *Science*, 211 (4489), pp. 1390–1396.

Bakht, Salman and Clarence Barlow (2009) "PAPAGEI: An Extensible Automatic Accompaniment System for Live Instrumental Improvisation", *Proceedings of the International Computer Music Conference (ICMC)* pp.521-523, McGill University, Montreal, Canada.

Bailey, Derek (1992) *Improvisation: Its Nature and Practice in Music.* London: British Library Sound Archive.

Beins, Burkhard, Christian Kesten, Gisela Nauck, and Andrea Neumann (eds) (2011) *Echtzeitmusik Berlin: Self-defining a Scene*. Hofheim: Wolke Verlag.

Bell, Clive (2005) New London Silence. "Clive Bell remaps the city with third generation of improvisers Mark Wastell, Phil Durrant, Rhodri and Angharad Davies", *The Wire*, 260, pp. 32-39.

Bischoff, John, Rich Gold, and Jim Horton (1978) "Music for an Interactive Network of Microcomputers", *Computer Music Journal,* 2 (3), pp. 24-29. doi:10.2307/3679453.

Bischoff, John (1999) "Unforeseen Music: the Autobiographical Notes of Jim Horton", *Leonardo Music Journal,* 9, p. 121.

Blazanovic, Marta (2010) "Berlin Reductionism – An Extreme Approach to Improvisation Developed in the Berlin Echtzeitmusik-Scene", *Proceedings of the International Conference Beyond the Centres: Musical Avant-gardes since 1950.* Thessaloniki, Greece, 1-3 July 2010.

Blazanovic, Marta (2014) *Echtzeitmusik. The social and discursive contexts of a contemporary music scene.* Doctoral thesis. https://edoc.hu-berlin.de/handle/18452/17633 (accessed 10 January 2020)

Blitz, David (1992) *Emergent evolution: Qualitative novelty and the levels of reality*. Dordrecht: Kluwer Academic Publishers.

Born, Georgina (1995) *Rationalizing Culture: IRCAM, Boulez and the institutionalization of the Musical Avant-Garde.* Berkeley: University of California Press.

Born, Georgina, Eric Lewis, and Will Straw (eds) (2017) *Improvisation and Social Aesthetics*. Durham and London: Duke University Press.

Boulez, Pierre (1977) "Technology and the Composer", *The Times Literary Supplement*, 6 May 1977. Original French text in *Passage du XXe siècle*, 1ère partie, January/July 1977 (Paris,

IRCAM) under the title "Invention/Recherche". Reprinted in *Orientations, Collected Writings,* Harvard University Press, Cambridge, MA, 1986, pp. 486-495.

Bourdieu, Pierre. (1993) *The Field of Cultural Production. Essays on Art and Literature.* New York: Columbia University Press. (Transl. & Ed. Randal Johnson)

Brötzman, Peter (2014) *We thought we could change the world: conversations with Gérard Rouy*, Hofheim: Wolke Verlag.

Burial (2007) interviewed by Mark Fisher. *The Wire,* 286.
Also available unedited at
https://www.thewire.co.uk/in-writing/interviews/burial_unedited-transcript (accessed 3 May 2020)

Butterfield, Jim, Stan Ockers and Eric Rehnke (1977) *The First Book of KIM*, Rochelle Park, NJ: Hayden Book Company.

Cardew, Cornelius (1968) *The Great Learning,* http://experimentalmusic.co.uk/ (accessed 2 March 2019)

Cage, John (1961) *Silence: Lectures and Writings,* Middletown, CT: Wesleyan University Press.

Chang, Ha-Joon (2010) *23 Things They don't Tell You about Capitalism.* London: Penguin Books Ltd.

Crick, Francis, and Christof Koch (1990) "Towards a neurobiological theory of consciousness", *Seminars in Neuroscience,* 2, pp. 263-275.

Di Scipio, Agostino (2003) "Sound is the interface: from interactive to ecosystemic signal processing", *Organised Sound*, 8 (3), pp. 269-277.

Feld, Steven (2012 [1982]) *Sound and Sentiment* [3rd edition], Durham, NC: Duke University Press

Feldman, Morton (2000) *Give my Regards to 8th Street*. *Collected Writings of Morton Feldman,* Cambridge, MA: Exact Change.

Fell, Simon H. (2013) *IST - Berlin release,* [linear notes], London: Confront Recordings.

Fletcher, Richard (2019)
https://reutersinstitute.politics.ox.ac.uk/risj-review/truth-behind-filter-bubbles-bursting-some-myths (accessed 2 January 2020)

Foer, Joshua (2011) *Moonwalking With Einstein: The Art and Science of Remembering Everything,* London: Penguin Books.

Ghazala, Reed (1997) Interviewed by Jason Gross for *Perfect Sound Forever.*
http://www.anti-theory.com/texts/Perfect_Sound_Forever/index.html (accessed 10 March 2020)

Haidt, Jonathan (2012) *The Righteous Mind: Why Good People Are Divided by Politics and Religion,* London: Penguin Books Ltd.

Haworth, Chris (2014) “Ecosystem or Technical System? Technologically-Mediated Performance and the Music of The Hub”, *Proceedings of the Electroacoustic Music Studies Network Conference Electroacoustic Music Beyond Performance*, Berlin, June 2014.

Haworth, Chris (2016) “All the Musics Which Computers Make Possible: Questions of genre at the Prix Ars Electronica”, *Organised Sound,* 21 (1), pp. 15-29.
doi:10.1017/S1355771815000345

Henrich, Joseph, Steven J. Heine, and Ara Norenzaya (2010) “The weirdest people in the world?*”, Behavioral and Brain Sciences,* 33*,* pp. 61-135.

Kahneman, Danial (2011) *Thinking, fast and slow.* London: Penguin Books Ltd.

Keller, Emma (2013) *Beyoncé's performance a soaring highlight of older, greyer inauguration.* The Guardian, 21 January 2013,
https://www.theguardian.com/music/us-news-blog/2013/jan/21/beyonce-performance-highlight-older-inauguration (accessed 14 March 2019)

Khuong, Anaïs, Jacques Gautrais, Andrea Perna, Chaker Sbaï, Maud Combe, Pascale Kuntz, Christian Jost, and Guy Theraulaz (2016) “Stigmergic construction and topochemical information shape ant nest architecture”, *Proceedings of the National Academy of Sciences,* 113 (5), pp. 1303-1308.

Koelsch, Stefan (2011) “Toward a neural basis of music perception - a review and updated model”, *Frontiers in psychology*, 2, p. 110.

Latour, Bruno (1993) *We Have Never Been Modern.* Cambridge, MA: Harvard University Press.

Latour, Bruno (2005) *Reassembling the Social: An Introduction to Actor-Network-Theory.* Oxford: Oxford University Press.

Latour, Bruno, Pablo Jensen, Tommaso Venturini, Sébastian Grauwin, and Dominique Boullier (2012) **“**The Whole Is Always Smaller Than Its Parts **–** A Digital Test of Gabriel Tardes**’** Monads”, *The British Journal of Sociology*, 63 (4), pp. 590-615.

Lewes, George H. (1874–1879) *Problems of life and mind*. London: Truebner.

Lewis, George (1996) "Improvised Music After 1950: Afrological and Eurological Perspectives", *Black Music Research Journal*, 16 (1), pp. 91-122.

Lewis, George (2000) "Too Many Notes: Computers, Complexity and Culture in Voyager", *Leonardo Music Journal,* 10, pp. 33-39.

Lewis, George (2008) *A Power Stronger than Itself: The AACM and American Experimental Music.* Chicago: University of Chicago Press.

Lorenz, Edward N. (1980) "Nonlinear statistical weather prediction"*, WMO Symposium on the Probabilistic and Statistical Methods in Weather Forecasting,* Nice, Sept. 8-12, Collection of papers presented, Geneva, World Meteorological Organization, pp. 3-8.

Lucier, Alvin (1992) *Music on a Long Thin Wire* [linear notes]. New York, NY: Lovely Music Ltd.

Luria, Alexander R. (1987 [1968]) *The Mind of a Mnemonist: A Little Book about a Vast Memory*. Cambridge, MA: Harvard University Press.

Mayas, Magda (2020) *Orchestrating Timbre: Unfolding Processes of Timbre and Memory in Improvisational Piano Performance.* Unpublished doctoral thesis.

McCormack, Jonathan, Alice Eldridge, Alan Dorin, and Peter McIlwain (2012), "Generative algorithms for making music: Emergence, evolution, and ecosystems", in RT Dean (ed.), *The Oxford Handbook of Computer Music,* pp. 354-379. New York, NY: Oxford University Press.

McLuhan, Marshall and Quentin Fiore (1967) *The Medium is the Massage*. New York, NY: Bantam Books.

Mencke, Iris, Diana Omigie, Melanie Wald-Fuhrmann, and Elvira Brattico (2019) "Atonal Music: Can Uncertainty Lead to Pleasure?", *Frontiers in Neuroscience*, 12, p. 979. doi:10.3389/fnins.2018.00979

Merriam, Alan P. (1964) *The Anthropology of Music.* Evanston, IL: Northwestern University Press.

Mill, John Stuart (1872 [1843]) *A system of logic ratiocinative and inductive.* London: John W. Parker and Son.

Mudd, Todd (2019) "Between Chaotic Synthesis and Physical Modelling: Instrumentalising with Gutter Synthesis", *Proceedings of the Seventh Conference on Computation, Communication, Aesthetics & X,* pp.217-229.

O'Doherty, John, Peter Dayan, Johannes Schultz, Ralf Deichmann, Karl Friston, and Raymond J. Dolan (2014) "Dissociable roles of ventral and dorsal striatum in instrumental conditioning", *Science,* 304 (5669), pp. 452-454.

Oliveros, Pauline (1996) *Four Meditations for Orchestra.* Troy, NY: Deep Listening Publications

Paik, Nam June (1974) Report to the Rockefeller Foundation "Media planning for the Post Industrial Society - The 21st Century is only 26 years away."

Parsons, Michael (ed) (1994) *25 years from Scratch.* London: Instant Print West One.

Peltier, Elian, James Glanz, Mika Gröndahl, Weiyi Cai, Adam Nossiter, and Liz Alderman (2019) "Notre-Dame came far closer to collapsing than people knew. This is how it was saved", *The New York Times,* 18 July. https://www.nytimes.com/interactive/2019/07/16/world/europe/notre-dame.html (accessed 18 July 2019)

Perkis, Tim (2002) *Complexity and Emergence in the American Experimental Music Tradition.* https://www.perkis.com/_site/writings/abisko.pdf (accessed 3 August 2018).

Piekut, Benjamin (2011) *Experimentalism Otherwise: The New York Avant-Garde and Its Limits*. Oakland, CA: University of California Press.

Pinker, Steven (2011) *The Better Angels of Our Nature: Why Violence Has Declined*. New York: Viking Press.

Prévost, Eddie (1995) *No Sound is innocent: AMM and the practice of self-invention*. Harlow: Copula.

Rosenstein, Michael (2019) *The Seen: Not necessarily quiet music.* http://www.pointofdeparture.org/PoD66/PoD66TheSeen.html (accessed 2 March 2020)

Salimpoor, Valorie, Iris van den Bosch, Natasa Kovacevic, Anthony Randal McIntosh, Alain Dagher, and Robert J. Zatorre (2013) "Interactions Between the Nucleus Accumbens and Auditory Cortices Predict Music Reward Value", *Science, 340*, pp. 216-219.

Sanfey Alan G., James K. Rilling, Jessica A. Aronson, Leigh E. Nystrom, and Jonathan D. Cohen (2003) "The neural basis of economic decision-making in the Ultimatum Game", *Science,* 300 (5626), pp. 1755-1758.

Sapolsky, Robert (2017) *Behave.* New York: Penguin Random House.

Schafer, R. Murray (1994 [1977]) *Soundscape: Our Sonic Environment and the Tuning of the World.* Rochester, VT: Destiny Books.

Schnell, Norbert, Diemo Schwarz, Joseph Larralde, and Riccardo Borghesi (2017) ″PiPo, A Plugin Interface for Afferent Data Stream Processing Modules", *International Symposium on Music Information Retrieval (ISMIR),* October, Suzhou, China.

Shannon, Claude (1948) *"*A Mathematical Theory of Communication*"*, *The Bell System Technical Journal*, 27, pp. 379-423, 623-656.

Simon, Herbert A. (1947) *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization* (first edition). New York, NY: Macmillan.

Simon, Herbert A. (1957) *Models of Man.* New York, NY: John Wiley.

Simon, Herbert A., (1968) "The Future of Information processing Technology", *Management Science,* 14 (9), pp. 619-624.

Simon, Herbert A. (1992) "What is an Explanation of Behavior?", *Psychological Science*, 3 (3), pp. 150-161.

Simon, Herbert A., (1996) *The Sciences of the Artificial.* Cambridge, MA: MIT Press

Simon, Herbert A. (1997) *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization* (fourth edition), New York, NY: Free Press.

Simon, Herbert A. (2000) *Herb Simon: Earthware Symposium: October 2000: Carnegie Mellon University*, https://www.youtube.com/watch?v=EZhyi-8DBjc&t=925s (accessed 12 August 2018)

Smith, Wadada Leo (2015 [1973]) *Notes (8 pieces).* Chicago: Corbett vs. Dempsey and The Renaissance Society at the University of Chicago.

Smith, William D. (1970) "Maxi Computers Face Mini Conflict: Mini Trend Reaching Computers", *The New York Times,* April 5, p. 12.

Stuber Garret D., Marianne Klanker, Bram de Ridder, M. Scott Bowers, Ruud N. Joosten, Matthijs G. Feenstra, and Antonello Bonci (2008) “Reward-predictive cues enhance excitatory synaptic strength onto midbrain dopamine neurons”, *Science,* 321, pp. 1690-1692.

Smuts, Jan C. (1926) *Holism and evolution.* New York: Macmillan Inc.

Tegmark, Max (2017) *Life 3.0: Being human in the age of Artificial Intelligence.* New York: Penguin Random House.

Tarde, Gabriel (2012 [1895]) *Monadology and Sociology.* Melbourne, Australia: re.press.

The League of Automatic Music Composers (2009) *Archive 1978-1981*. Barcelona: ALKU label.

Tomasello, Michael (2019) *Becoming Human: A Theory of Ontogeny*. Cambridge, MA: Harvard University Press.

Toop, David (2002) “Frames of freedom. Improvisation, otherness and the limits of spontaneity”, *Undercurrents. The hidden wiring of modern music,* pp. 233-248. London: Bloomsbury Academic.

Toop, David (2014) *Into the maelstrom: Music, Improvisation and the Dream of Freedom.* London: Bloomsbury Academic.

Tudor, David (1995) *Neural Synthesis* [linear notes]. New York: Lovely Music.

Weiser, Mark (1991) "The Computer for the 21st Century", *Scientific American,* September, pp. 94-104.

Wastell, Mark (2006) Interviewed by Tomas Korber for *Paris Transatlantic,* May 2006, Stirling. http://www.paristransatlantic.com/magazine/interviews/wastell.html (Accessed 2 March 2020)

Zatorre, Robert, and Jane Mary Zarate (2012) "Cortical Processing of Music", in D. Poeppel *et al*. (eds), *The Human Auditory Cortex. Springer Handbook of Auditory Research*, 43, pp. 261-294. doi:10.1007/978-1-4614-2314-0_10

Appendix 1 – Jim Horton

* Almost all this biographical information is based on Jim Horton's writings that I received from John Bischoff on 10 May 2018, and the emails that we exchanged to clarify some points.

> When the programs are running autonomously, slightly beyond my comprehension, playing music I probably wouldn't have thought of left to my own devices, I like to imagine they are precursors to uplifting, slightly alien musical A.I.s of the twenty-first century. Oh, how I hope and wish that contemporary cyberculture will lead to a beautiful utopian compassionate world of Good!
>
> Jim Horton

As far as we know, Jim Horton was the first person to compose music by the use of microprocessors. Well, in 1977, one year after he first started to use the microprocessor KIM-1, the most diffused book for learning how to use the machine came out, and it had a demo for turning the KIM-1 into a squeaky music box. So we can guess that there were other people tinkering with sound at that time, but we can also reasonably guess that Horton was the first one to use microprocessors for musical ideas that left a mark.

Considering the current widespread use of portable computers for studio recording techniques, it might sound surprising that the first use of the microprocessor had nothing to do with fixed media. Horton used it for real-time electronic music performance. Having an active role in taking musical decisions, the computer was seen as a semi-autonomous part of an interactive system, involving agency either from people or machine. In this approach he was not alone. By the same year Joel Chadbade had created one of the earliest computer systems for interactive electronic music.[259] His CEMS system did not use microprocessor but a bigger and more expensive version, the so-called "minicomputer." The CEMS system was used for interactive compositions where the machine responded with pseudo-random criteria to the musician's input, creating a chain in which machine and musician were mutual influential. However, Horton's decision to dive into the new and inexpensive microprocessors that would soon inundate the world, and his ability to foster enthusiasm in the community of brilliant composers he was working with makes of him a truly seminal and understudied figure.

Jim Horton was born in 1944 in southeastern Minnesota and grew up in the small town of Rochester and Austin. His father was an accountant, manager and later vice-president for a chain of dairies. His mother was a nurse. As a child he was an enthusiast for listening to "Whoopy John" and his polka band. In high school he wrote songs for a folk music and Buddy Holly style rock band in which he sang and played guitar.

From a young age Horton showed inclinations toward technology and weird sounds. He became very involved in shortwave radio listening. He was fascinated by Fidel Castro speeches and exotic music from far away places, but usually he listened more for the electronic sounds than for content. When an astronomer published in a magazine the frequency to tune in the planet Jupiter and described the signal as sounding like ocean surf, Horton got a record from the library to find out what that was like, hardware-hacked his receivers, designed and built many antennas, and after much effort he was able to tune in the planet Jupiter. He built a radio telescope antenna with a chickenwire reflector and tried to listen to the sun. He also heard the "dawn chorus" by using a long wire fence plugged directly into a hi-fi preamp, reading only later about the dangers of this experiment.

[259] Chadabe, J. (1997) p.286.

Horton sang in the tenor section of the church choir. For several years in college he was seminarian and sang Gregorian Chant several times a day. In those years he also experimented with tape splicing and overdubbing.

He went to grad school at University of Minnesota in Minneapolis to study logic positivism. There, with a fellow student who was a Fortran programmer, he experimented with computer-generated poetry.

When the '68 arrived, Horton felt the call of the time: he dropped from the university and moved to San Francisco. In his first stint to the Bay Area he improvised modal music with handmade bamboo flutes in the parks and streets, sometimes danced and played at the Avalon Ballroom along with the Greatful Dead, and devoted himself to the "empirical and philosophical study of psychedelic states of consciousness."

After a few years, in the fall of the '68 he moved back to Minneapolis. There he met Tom Zahuranec, and they soon became close friends and collaborators. They improvised together on flute and guitar, and spent many hours listening and discussing music by Varese, Stockhausen, Ussachevsky, Partch etc.

In 1969 Horton composed his first electro-acoustic piece. A piece for amplified cymbals, flute and dual tape delay, influenced by Max Neuhaus record "Electronics and Percussion; 5 Realizations."

In Minneapolis, Horton and Zahuranec went to a Merce Cunningham dance event and talked to the musicians. Horton did not remember exactly but there were two or three of John Cage, David Tudor, Gordon Mumma or David Behrman. The two young musicians asked where they could learn that kind of music and the consensus answer was Mills College with Robert Ashley.

Horton moved back to the Bay Area with Zahuranec. In the early 70s he studied at the Center of Contemporary Music at Mills College (CCM). He was unregistered; one day he showed up and began to do work that needed done at the studios. Zahuranec had a technician's job and after a while Horton acquired a set of keys. When he signed up for synthesizer studio time there were objections, but Ashley left his name on the schedule and, according to him, he got added to the list of graduate students.[260] He remembered fondly the time spent there. He felt he learned a lot, the concert series were outstanding and shared the opinion of a fellow student, Blue Gene Tyranny: "The whole atmosphere of the center was extremely conductive to imagination. The social thing was incredible. People could constantly give information and support. Just the way the center itself was organized, if you can say it was organized, was conductive to a great deal of creativity."

At Mills Horton especially got into the Buchla 100, the first voltage controlled synthesizer ever built. The Buchla 100 was inherited by the CCM from the San Francisco Tape Music Center. Horton was fascinated by the possibility of integral serialist inspiration to control independently the parameters of music such as pitch, duration, amplitude and timbre. Also, the device was never set up to synthetize acoustic instrument, and he felt that its design seemed to proclaim the liberation of the electronic sound. Initially he started to use the Buchla to process text but then followed Zahuranec's suggestion to consider it as an instrument. Horton soon became intrigued by designing patches that would let the machine to play for itself. He saw the machine as having its distinct personality, and saw those uncontrolled sounds as result of interactions between instabilities in its oscillators and sub-audio control voltage modules. He thought that this interactive approach arose

[260] John Bischoff clarifies that this passage: "My understanding of what must have happened here is that Nic Bertoni, the CCM Tech Director during the Ashley years, let Zahuranec and Horton book time in the studios in exchange for tech work. This was the kind of thing that was possible then because during those early years the CCM studios were public access—anyone could book time in the Moog or Buchla Studio for an hourly rate ($5 for Buchla and $10 for Moog as I remember). I think Nic extended that idea to include tech work in exchange for the hourly rate—this would have been completely in keeping with Nic's approach to the CCM back then. The part about Jim somehow getting put on a grad student list which then gave him access is likely a Horton embellishment. He was a "student of Bob Ashley" in spirit but not in fact is the way I view it. CCM public access ended around 1980, so by the time you were at Mills [2008], the administration had tightened up the studio access rules a lot!"

naturally from the system and its interface of cords and knobs. In this period Horton was living on the street and his Buchla tapes were lost or stolen.

The first half of the 70s saw Horton involved in many concerts and collaborations across the Bay Area, experimenting with a wide variety of media and approaches. He played drone music with the Buchla; he was one of the first to acquire four and half panel Serge Tcherepnin synthesizer; played a 12 hour concert of mostly automatic ambient music for Serge, phaser foot pedal and tape delay; a conceptual piece based on McLuhan writings; a piece for Tibetan horns and feedback with Zahuranec (Music for Tibetan Horns); performed many times a piece for Serge, a patch inspired by traffic flow patterns (Proletarians from UFO); experimented with Jan Pusina with cross patching analog synth. He got involved in just intonation, reading Partch and managing also to play on his instruments a few times. He participated to many improv sessions, playing various instrument but mostly as a synth player. He found one of these sessions especially satisfying: an electronic music improv using the Paik-Abe Video synthesizer with video feedback as a graphic score. Later he would report in his notes en excerpt about video feedback by chaos theory mathematician James Crutchfield:

> For the world about us is replete with complexity arising from its intimate inter-connectedness. This takes two forms. The first is the recycling of information from one moment to the next. This is feedback. The second is the coupling at a given time between different physical variables. In globally stable systems, this often gives rise to non-linearities. This inter-connectedness lends structure to the chaos of microscopic physical reality that completely transcends descriptions based on our traditional appreciation of dynamical behavior.[261]

Complexity emerging from interconnected elements, resulting in non-linear, unpredictable behaviors is an essential concept to understand the ideas that surrounded the first musical application of the microprocessors. These ideas applied to music are now better known as emergent behavior.

In 1971 an important technological development would have led to one of Horton's major contribution to the history of electronic music. That year Intel developed the first microprocessor (MPU), the Intel 4004, when Federico Faggin was able to squeeze the 2300 transistors of the 4-bit MPU into a 16-pin package. Faggin also supervised Hal Feeney's design of the 8-bit 8008 device announced in 1972. In 1974 Intel and a team led by Tom Bennett at Motorola introduced the second generation of 8-bit designs, the Intel 8080 and the Motorola 6800. The MPU rapidly found widespread acceptance. A low-cost variant on the 6800 architecture by MOS Technology (6502) enabled personal computers. MOS Technology's had launched its first processor, the 6501, in 1975 at the retail price of $20. The 6501 could be plugged into existing motherboards that used the Motorola 6800 allowing potential users (i.e. engineers and hobbyists) to get a development system up and running very easily using existing hardware. Motorola quickly sued MOS Technology's, which made a lawsuit-friendly version of the 6501, the 6502, by changing the pin layout. The 6502 was still the cheapest MPU available at $25 nevertheless had the disadvantage of having no machine in which new users could quickly start playing with the CPU. Chuck Peddle, leader of the 650x group at MOS (and former member of Motorola's 6800 team), designed the KIM-1 in order to fill this need. The KIM-1 came to market in 1976. Its CPU worked in 8-bit at the speed of 1 megahertz (for reference today's smartphones have multiple 64-bit processors working together at a speed in the order of gigahertz; a gigahertz is 1000 megahertz). A complete system could be constructed for under 500 US$ with the purchase of the kit for 245 US$, and then adding a power supply, a terminal and a cassette tape drive (data were stored in cassettes). The machine was programmed in assembly language. Many books were available demonstrating small examples, including *The First Book of KIM* by Jim Butterfield, Stan Ockers, and Eric Rehnke. In this book,

[261] Horton (1996)

one demo program converted the KIM into a music box by toggling a software-controllable output bit connected to a small loudspeaker.[262] Programs were saved on cassettes and reloaded into the RAM every time the machine was turned on. The RAM was anywhere from 1 to 4 megabytes (always for reference, a good smartphone now has 64 gigabytes; 1 gigabyte is 1000 megabytes).The closest thing to a KIM-1 portable system were the mini-computers use by Joel Chadbade but the difference was unbridgeable. According to an article by the New York Times:

> The definition of a mini-computer depends on to whom you are speaking. Descriptions range from electronic, cal culators to the International Business Machines Corporation System 3 that sells for $42,000. A consensus opinion would probably include as mini-computers machines that costing less than $25,000 and that in chide some type of input-output de vice such as a teleprinter. A memory of about 4,000 words and with circuitry capable of performing calculations under the control of stored programs written in some form of higher-level computer language such as Fortran or Basic.[263]

In order to bring electronic music outside of the big academic centres and make it available to everyone, the KIM-1 was the only solution, no matter how crude the 8-bit sound could be.

In the summer of 1976 Jim Horton acquired via a blind mail order his first KIM-1 microcomputer board, thought himself machine language and worked on a first automatic music piece. In 1976, he had started to participate in a composers discussion group that included among others John Bischoff and Rich Gold, whom he had both met at Mills. Horton demo'd his first KIM-1 piece at the composer discussion group.

On October 20 1976 Horton performed "Euler Music" at the San Francisco Exploratorium as participant in a Real Electric Symphony real-time composition. This was probably the first official performance with a microprocessor. The microprocessor was played as a real-time interactive semi-autonomous musical instrument. For the piece Horton had implemented his first real-time interactive scheduler. The program played Leonhard Euler's (1707-1783) theory of just intonation, and he would adjust parameters for the minimum and maximum of Euler's "gradus suavitatus" aesthetic measurement on intervals and transitions between intervals. The rhythm was controlled by an automatically playable rhythmic system based on the idea of "the long and the short". The KIM was interfaced to a Lunetta style digital circuit of down counters and flip-flops.

1977 is another important year because it sees the first performance of networked computer music, a computer duo by Horton and Rich Gold. In the same period Horton convinced John Bischoff to buy a KIM-1,[264] and in 1978 Horton and Bischoff performed another duo of networked music. At this point the ground for the birth of the first networked computer music band was laid out. In 1978, Horton and Bischoff founded the League of Automatic Music Composers, and from that year to its demise in 1983, Horton's activity is inextricably linked to the activity of the League.

[262] Butterfield, Ockers, and Rehnke (1977) p.91.
[263] Smith (1970)
[264] Private email exchange with John Bischoff, 10 May 2018.

Appendix 2 – Experimental music trends pre and post 2008

In a book called *Everybody Lies,* Seth Davidowitz says that we are entering a new age of statistical truth because of the big data revolution. One of the most easily and freely accessible online depository of big data is Google Trends: since 2004 Google is storing anonymously all our searches and, according to the author, the interests we do not confess to each other are more easily confessed to the screen of a computer in form of Google searches.[265] Electronic music performance still belongs to the experimental,[266] and since its labelling is not straightforward, I looked at some data relative to the parent container experimental music. In fig 2.1, I plotted the results given by Google Trends regarding the search "experimental music" according to three different geographical limits.

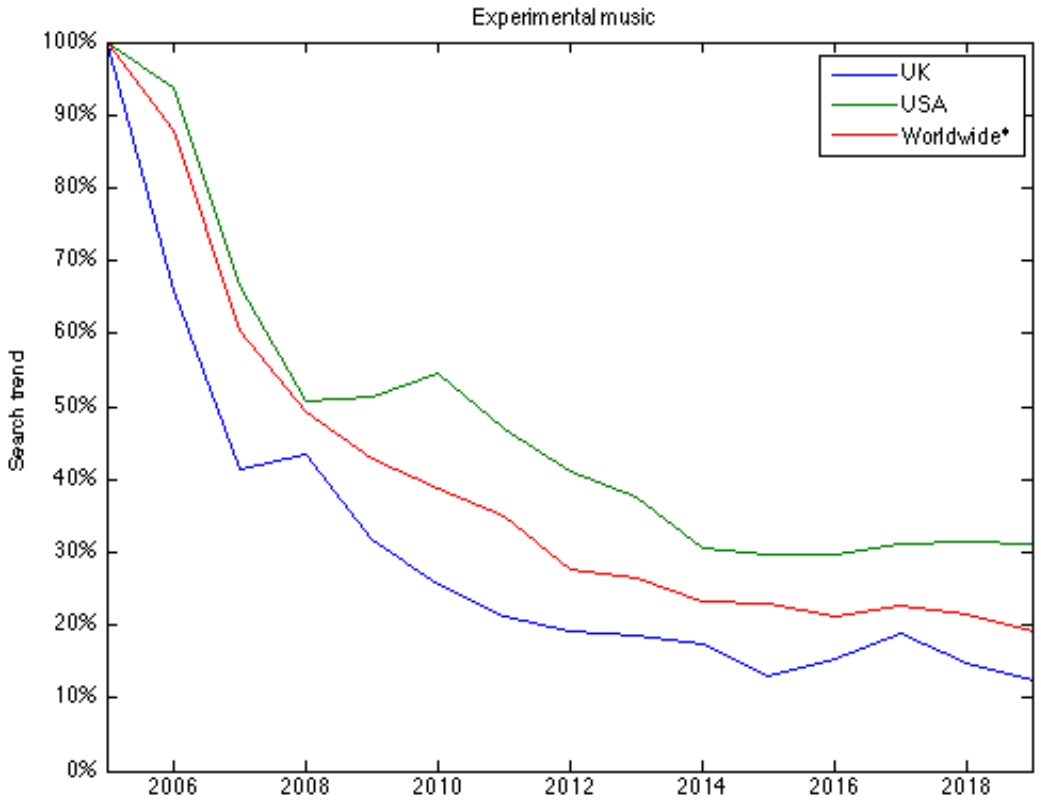


Figure 2.1 - Search trends for "experimental music" in UK, USA, and worldwide*

[265] Davidowitz (2017), pp.15-16.

[266] In 2012, EDM (Electronic Dance Music) DJ Deadmau5 depicted the situation of electronic music performance outside the experimental in very unambiguous terms in a Tumblr post that stirred the Internet community. The post titled "we all hit play" (http://deadmau5.tumblr.com/post/25690507284/we-all-hit-play, accessed on 12-Dec-2016) and made the point that, in regard to the performative aspect, mainstream electronic music "It's not about performance art, its not about talent either (really its not) ... given about 1 hour of instruction, anyone with minimal knowledge of ableton and music tech in general could DO what im doing at a deadmau5 concert. Just like i think ANY DJ in the WORLD who can match a beat can do what 'ANYONE else' (not going to mention any names) is doing on their EDM stages too." And he goes on explaining that his and other producers' skills shine where it needs to shine: in the studio and on the releases.

Source: Google Trends. Monthly data are converted to yearly averages and plotted with the next year on the x-axes; for instance, the 2008 value is the average of the monthly values of 2007.[267]The trend is clear: the overall decline in online searches in the last twenty years ranges from 90% to 70%. What is also clear is that the decline is steep until around 2008 and after that it becomes gradually smoother until reaching a relative stability around 2014. More accurate datasets presents some additional points of interest regarding this timespan.

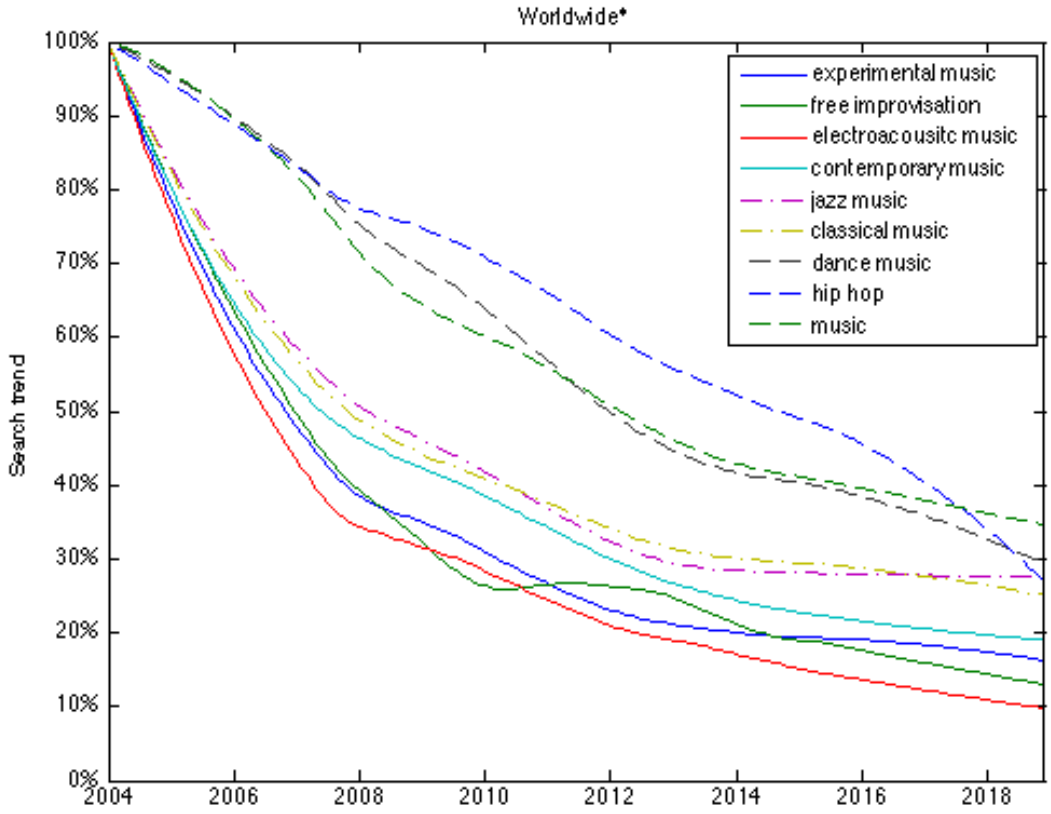


Figure 2.2 - Worldwide* search trends for many genres-related words plus the control search "music."
Source: Google Trends. Monthly data. Curves are smoothed with a polynomial function to highlight to long-term trend.

In Figure 2.2 I plotted the trends for many musical searches, some are close to the "experimental," such as free improvisation, other are completely different as long as representative of musical

[267] All the graphs use monthly data from Jan-2004 to Dec-2018. The type of Google search is the standard one, so that the value represents the searches containing all the words. Searches such as "experimental music", "experimental dance music" or "experimental practice in music", are all included in the trend for "experimental music".The curves are normalized: standard Google Trends does not provide absolute data so the curves are not comparable in absolute terms but should be seen merely as trend indicators. Also, Google Trends data are relative to the overall number of searches (eg. if "cat" is searched 50 times in a month in the UK and that month the overall number of searches for any word is 100, the trend value for the word "cat" is 50%, if the overall searches are 1000 the value is 5%; than the maximum value over the timespan considered is set to 100% and all the other values are rescaled accordingly.) The location "worldwide" always appears with an asterisk: the searches considered are in English language, so the data are far from representative in those countries where English is not diffused, not to mention where Google is censored. As a partial solution, Google Trends provided the "topic" category, but the searches presented here sometimes are representative of such a small community that no topic category is listed; in some cases they are not even listed as musical genre. Moreover at the time of writing the topic category is still a beta option.

genres that did not appear or disappear in the timespan considered as a result of quick changes of fashion.[268] I was looking for more general trends so I used the worldwide data: even though they do not represent what is happening in any country of the world (see notes of figure 1.1), they work like a sort of mean of the UK and USA data plus the rest of the WEIRD international community.[269] Remember that these are relative data and say nothing about absolute numbers, otherwise in comparing hip-hop to free improvisation we would see the free improvisation line crawling over the x-axis. The first thing to strike my attention is that the decline of interest before the economic crises shows a correlation between resistance to the decline and diffusion. In other words, before 2008 the more the musical genre is diffused in the community the lower its chances of disappearing into the obscure underground. For clarity I divided the curves in three groups: 1) Music rooted in popular culture and responding to rules of direct demand and offer; 2) Music that made it to the ranks of tradition and received large amounts of state funding; 3) Musical phenomena that do not enjoy large market diffusion and even if they have been present for long enough for us to start to use the word tradition, they belong to the tradition of an extremely small and heterogeneous group. The trends seem to define a very clear ranking and within this logic, before 2008, we can predict many of these results. If we had to rank musical genres for their diffusion we would expect a huge gap between popular genres such as hip-hop and niche phenomenon such as electroacoustic music. Indeed from 2004 to 2008 the two lines present one of the biggest divergences. We could expect to see "dance music" in the upper part of the graphic, and notice that when it comes to big numbers "dance music" and the control search "music" have similar shapes, denoting that in the timespan considered this function of music is so predominant that it almost stands for music itself. We could also expect to see in the middle classical music and standard jazz, both of which now command a big part of civic budgets for the arts and are played in the leading auditoriums. We can expect even more details such as to find contemporary music somewhere between classical and experimental, with the line going higher if we switch the country to the USA, where experimental music often came to coincide with contemporary music because of the American Experimentalism's tradition; in the UK "experimental" does not call to mind authoritative orchestral directors and well dressed instrumentalists in an auditorium.

What may be hard to predict without seeing the data is the logic itself: why does the gap in interest between less diffused musical genres and more diffused ones widen in favour of the latter before 2008, whereas after 2008 the gap either stays stable or even shrinks? Since virtually any search related to art I could think of, excluding words that were invented during the data timespan, presented sharp declines, I checked if declining searches were inherent to some change in technology I was not aware of. The simplest check that does not exclude the possibility but makes it less likely was identifying steadily rising trends.[270] Indeed there were.

[268] Considering genres that are too recent, were born and died fast, or are too subject to the waves of fashion would have been useless. For example searches for dub step before 2004 were almost inexistent and spiked from there. I included hip-hop because of its ability to become a global phenomenon steadily rooted in popular culture since the 80s, but even there the 2014 decline is probably only a result of the same demographic quickly shifting toward the new thing, Trap music: a trend comparison matches this hypothesis, especially in the US.

[269] Henrich et al. (2010)

[270] Similar trends to the ones I reported for music were also given by the searches "contemporary literature," "architecture," "Shakespeare," "Michelangelo," "Proust," "Rothko," and "Beethoven." Same story for "Stockhausen" with the exception of a huge peak when he died in December 2007: the peak of attention did not change not even remotely the direction of the general trend.

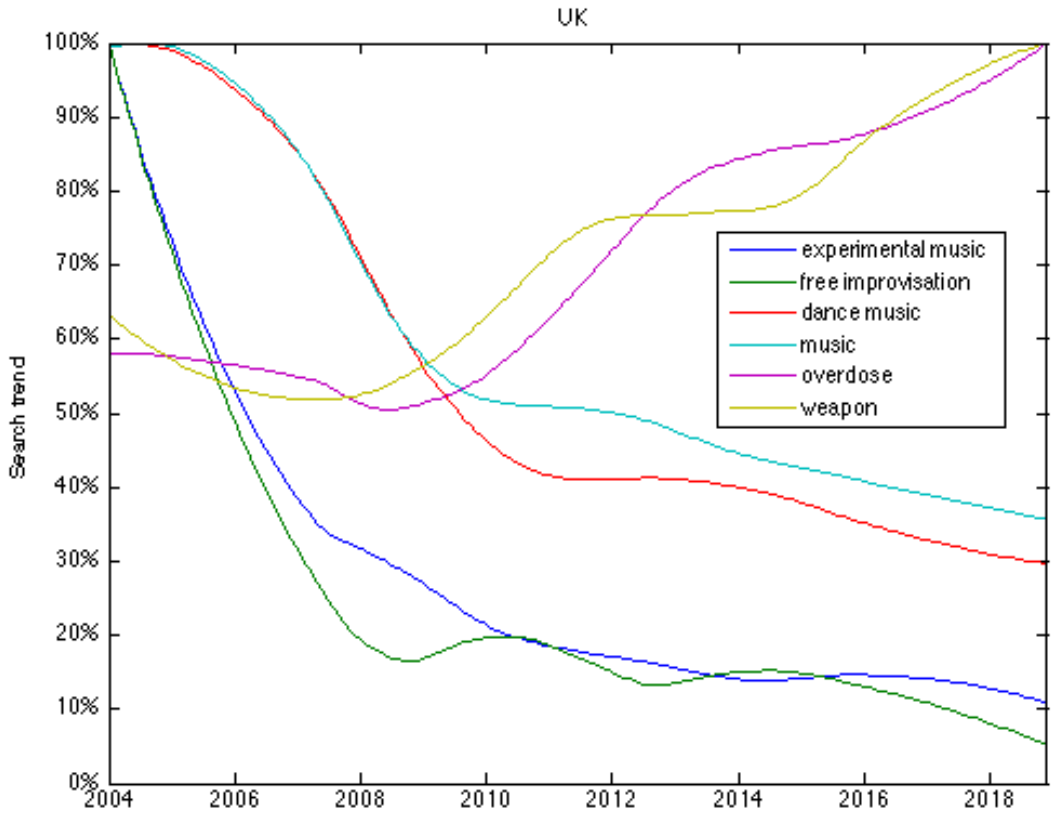


Figure 2.3 - UK search trends for words denoting interest toward experimental music, mainstream music, and some indicators of social unrest.
Source: Google Trends. Monthly data. Curves are smoothed with a polynomial function to highlight to long-term trend.

In figure 2.3 the timespan from 2008 to 2010 seems to work like a dark hole changing the trajectory of all the lines that pass through it.

Causal connections between the economic crisis and these trends are uncertain, but my hypothesis is that the slowing down of the declines, especially for music that defies market utility, could be a feeble sign of awakening from decades of misleading assumptions about people's behaviour.

Appendix 3 – The Audio Babel Project (ABP)

The conversion of code from an environment to another draws a lot of energy from the creative process, not to mention the seat-backs caused by the bugs that inevitably occur in the conversion. Every time a new musical hardware or software comes out, it is inevitable to spend some time recoding the basic techniques for the new environment or platform. But the incredible amount of effort dedicated to port white noise generators, filters, FM synthesis, LFOs and samplers which are essentially the same from the 60s, from Csound to Max, from Max to Supercollider, from the Intel architecture of a Mac to the ARM architecture of Raspberry Pi or Bela is indicative of a more endemic problem: misunderstandings about cooperative strategies. For instance, the steps to take to make the same command lines and configuration of modules valid both for Max and Supercollider do not go beyond some lines of regular expression and the establishment of some very basic standards that would be almost transparent for the creative process. This would mean that musicians could focus on the part of the code that is truly unique and rely on performance-proven code for the ubiquitous techniques that keep being ported. It would also mean that if a new technology comes out and does not support one platform, musical ideas could be ported right away on the other platform reducing the technological dependency: for instance, all the knowledge contained in decades of Max programming could have been made available right away for Raspberry Pi. Successful cooperative strategies are a very powerful tool but are also extremely hard to achieve.[271] I think that the idea that an online platform such as the communities of Bela, Max or Supercollider could produce those strategies without a thoughtful organisation of the information posted or a clear objective to initiate cooperation is unlikely.
The Audio Babel Project is an initial sketch of cooperation-aware coding that, expanded to a larger scale, could limit technological dependency.

Standard Synth (standSynth) library

The standSynth library is a series of synthesizers with associated command-line style syntax implemented in Max 8 using the regular expression for the parsing of the command line instructions and vanilla Max objects for the synthesis. The library covers some basic synthesis techniques and the examples meet the following criteria: performance level quality; open source; playable in one click from any location of the environment; the syntax allows a smooth way in for the mid-level user; developed keeping in mind the ease to build from previous knowledge; thought to be ported to all the main musical programming languages, so that the same knowledge embedded in the command lines will have the same results in Max as well as in Supercollider or Pure Data, with minimal or no need of parsing.
See the standSynth patch inside the folder “Network6.”

The hub library

The hub library is a set of abstractions that improves networking inside the max environment and outside it via OSC with a very limited set of rules.
It performs tasks such as:
1) Creates automatically a series of senders and receivers for any parameter exposed to the system: OSC receivers, modulation receivers, control parameters' offsets and ratio, thru messages, etc.

[271] Axelrod and Hamilton (1981)

2) Stores an internal state of the patch in an array (a coll object) already formatted in OSC and ready for all sort of operations.
3) Takes care of some not-so-friendly topics such as scheduler load when updating the UI, and various forms of modulation practices.
4) Does everything in a way which is relatively transparent and reliable in terms of synth design: it doesn't show in the interface, when you don't use its possibilities it doesn't affect the behaviour of the patch, and the specific modular approach lowers the mistakes in the programming phase in areas where mistakes aren't usually interesting.
See lm.hubTutorial inside the folder “Network6.”

Net.activ and net.param

The activation of the relationships is a delicate phase. The form of relational music depends so much on when these relationships start to act and when they stop, that the topic deserves meticulous care. Unfortunately it also adds a layer of complexity: in timeline composition the composer has a palette of sounds and decides where to place them on the timeline, whereas in relational composition their placement is a result of potential happenings of the performance. When relationships grow in number, it is easy to get lost if the program does not respects some basic standards.
Here is a proposal for a model to help manage the excessive complexity.[272]

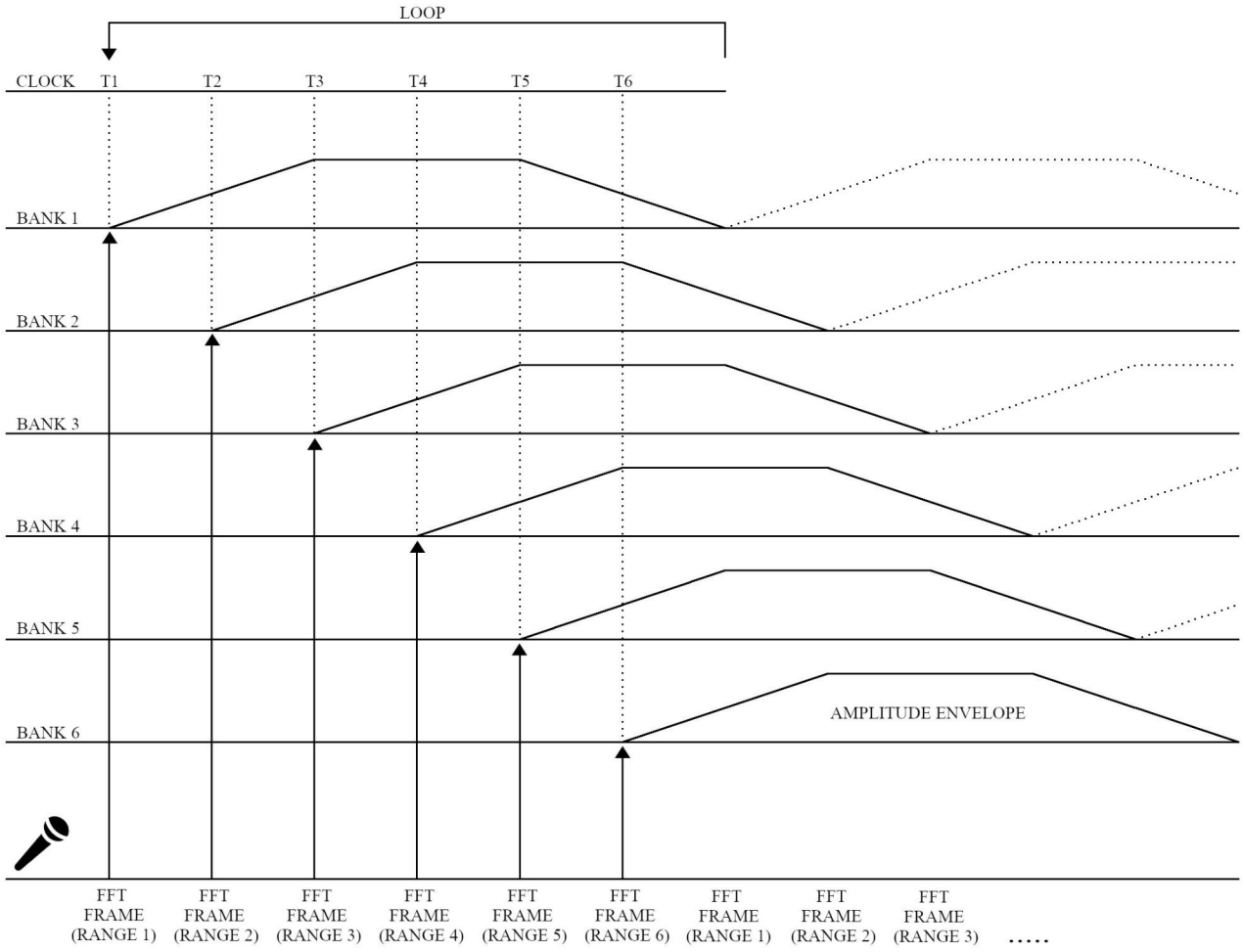
Net.activ
There are four states for each relationship of the network:
1) On state - When the opening condition is met, the on message initializes all the parameters of the module, opens all the communication channels between the analysis and the response, and set the relationship to listening state.
2) Listening state – Unless this step is bypassed, by default, when the relationship is turned on, it does not start playing but it is in listening state. This means that the relationship starts receiving analysis data and is "listening" to what is going on, waiting for the activating condition to tell the module to start playing.
3) Active state - When the activating condition is met, the relationship is fully operative and is now listening for the ending condition that will tell the module when it is time to stop. The module is playing now, but it does not mean that there is necessary sound in output: the activating condition is like a cue for two members of a group to start playing together, they have their pauses and they exchange their cues inside the duet but the duration of the duo is dependant on what happens in the overall group.
4) Off state - The off message closes the communication channels, stops all the ongoing messages circulating in the relationship such as delays, random generators, or ramps controlling a parameter, and turns off the audio immediately or with a custom exit routine (a fade out for instance).

Net.param
All the parameters that affect a module and all the output parameters of a module pass through a special gate, net.param. This gate is linked to the state of net.activ. If everything is done correctly, this gates guarantee that the behaviour of a single relationship can be isolated for debug, an enormously useful possibility when things get overwhelmingly complex.

[272] This is the standard I used in all the works of the series *Netwroks* discussed in this research. The specific patches that implement the task are net.activ and net.param

Appendix 4 – *ResoX*

ResoX is a synth based on a spectral filter that creates slowly evolving textures related to the spectrum of the input signal. The module takes FFT frames at regular intervals from the input and assigns a user-defined number of partials to six banks of resonant filters (CNMAT *resonators~*), which are then driven by a selectable excitement signal (either an internal source such as white noise, or an external one such as a dedicated input).
When the FFT frame is taken, the partials are reordered by loudness, and cropped to a total of 64. Of the 64 partials available at any given moment T, the user defines the range of which partials will be assigned to the corresponding bank. After six FFT frames are assigned to the corresponding six banks according to six user-defined ranges, the loop restarts. When the selected partials are assigned to the bank, the amplitude envelope of the corresponding band is triggered, so that the six banks crossfade into each other with an overlap factor of 1/6. The loudness of the partials is rescaled both according to the q of the filter and the number of partials played to approximate a uniform perception.
Since the FFT frames are continuously recalculated at large intervals and the banks always need a new frame, there should be always an input signal. To solve this problem, there is an automatic amplitude threshold detection[273]: when there is sound in input, the module uses the input, when there is silence, the module records a buffer of the last part of the input and plays it back in loop with 1/2 overlap factor; the buffer is played silently in the background so that the FFT always finds something related to the input to calculate the frame from.



273

The q of the filters are also responsive to the input. The CNMAT object *anayzer~* is used to calculate the noisiness of the signal (the more the signal resembles white noise the closer the noisiness value is to 1, the more the signal resembles a sine wave the closer the value is to 0).[274] There are two additional functions that present some interesting and sophisticated solutions:
1) It is possible to ask *resoX* the current partials played, which are not the simple FFT frame but a mixture of all the frames being crossfaded at the moment of the request, rescaled by the amplitude envelopes.
2) It is possible to use as excitement signal for the filter the same signal used for the calculation of the FFT frames. Since *resoX* fishes for a new FFT frame at large intervals, the filter banks do not adjust right away to the input signal: the moving frequencies of the filter banks are a slow and tangential response to the input signal which can excite them with its far more reactive and fast shape, generating a great variety of material from the same source.

[274] Unfortunately, the IRCAM pipo~ object, which is the closer solution to a standard spectral noisiness analysis in Max 8, seems to be not enough sensitive when the signal becomes noisy giving always 1 as value. The previous version the IRCAM descriptors had a noisiness analysis that behaved similarly to CNAMAT analyzer~. Since both are old externals, I left in place the old analyzer~.

Appendix 5 – Network 1 and Network 2

Network 1

Network 1 is a passage piece. The relational theory was in an early stage, nonetheless it contributed to provide cyclical elements of organisation in an otherwise Fluxus-like aesthetic, which I always enjoyed but for which I was exploring alternative solution. I preferred to include this piece because, even if the relational technique was less developed than Network 2 and 3 (see appendix), it produced a variety of behaviours in the digital synthesis that I found more valuable than the more polished formal achievements of the successive works before Network 5. Moreover, I started here to introduce elements of just intonation in the form of a generative melodic pattern. Even if this pattern has stringent limits and it is realised entirely with classic stochastic methods, from here I started to think about *emergent idioms*, a concept that I would not use for this case but became always more present in my mind, with more successful applications in the first improvisation project presented and in Network 5.

In this work, I play a digital synth, designed to be quickly reactive to my spontaneous gestures; an analysis block analyses my gestures and the sound produced by the synth and send the result to other synthesis modules that provide a slower response. The two outputs -the synth and the interactive system- can be recognized by a trained ear, but this is definitely not the goal of the work, nor is it the visual association between gesture and sound produced. The goal stays within the acoustic traces left by the performance, traces that mirror a continuous exchange between the improvisatory practice and generative computer structures. Quiet drones, harsh noises, predetermined elements like melodic fragments in just intonation are all subjected to an intuitive sense of duration that shapes the performance and make the gesture indispensable.

Unfortunately, not only the relational theory was in its early stages but also the code: since then I updated almost all the abstractions, synths, analysis modules, and passed to 64-bit externals. Updating this network would have been excessively time consuming for a work I decided not to perform anymore, thus the only part that can still be used is the one I think to be the most valuable: the synth controlled directly that is responsible of most of the digital noise (see recFM in the folder, which is an early version of Beelu).

Network 2

For Crackle Box and 10-relationship-network

Outlook of the network.
12 actors: a human actor improvising with limited means; a crackle box working as an instrument with semi-predictable behaviour, thus mostly an intermediary; 10 classes of digital synthesisers each displaying a different shade of mediation.

Network 2 is a work that uses the analog output of a crackle box[275] to drive a network of digital synthesizers and surround the performative gestures with an immersive synthetic landscape. This landscape requires no intervention other than the input sounds for its whole development. These sounds are converted into a wide variety of data, which are then recombined to generate all the aspects of the computer's response, which is always a result of a combination between incoming data and automatic behaviors; there is no use of sampling or timeline sequencing. The sounds do not avoid referenciality: there is glitch, synth patterns, percussive gong-like sounds, a part evokes an eastern bowed string instrument. It's not an intellectual operation of de-contextualization, those sounds belong to my experience. It is more a chance for me to explore a particular view about emergent behavior. We are starting to get used to the "alien" sounds of the machines, it is almost if we expect them to sound that way. What happens if the machines use sounds that we are starting to consider socially codified? If the machine behavior proposes with an unpredictable logic sounds that evoke a vague sense of familiarity and then betray our expectations? In this work there are two distinct phases of agency, which also determine two clear musical sections. The first section is responsive to the input sounds. Sometimes the association is direct, but most of the times is tangential: the spectrum analyzed is spread over a larger timespan, and often the computer recombines data coming from sounds produced at different time, blurring the association between sound and gesture. In the second section there is no input analysis. The network uses all the data accumulated during the first section to generate an independent landscape with formal ties to the sounds played in the first section; although, the relationships are mostly unintelligible. Here, the result of the mapping process concerns mostly the spectral components of one single sound that is then repeated, lengthly, with a rhythm that is the symmetric reflection of the timing of the performative gestures.

Relationships

Relationship 1 - Initial additive synth.
This actor is the most independent of the first section. It starts on its own when the network is turned on. The occurrence is choosen by a beta distribution applied to the duration and it is mostly unrelated to the input. If the input sound is longer than 5 seconds the generation stops and wait for the next onset to start again. The fundamental pitches are a replica of the input signal with a 8-second-delay, enough to cancel an excessively direct perceptual association, and they are then transposed in a lower register. All the glitchy variations are independently generated by the computer but they have a simple relationship with the input: when the amp detection module sends the on message, it flips the state of a switch that controls many generative processes turning on and off most of the variations. Timber-wise, some bands of a bark list of the input are directly mapped to the amplitude of some partial of the synth.
Activating condition - Network is on
Ending condition - Detection of special evnent 1.

[275] The crackle box is a circuit designed by Michel Waisvisz in 1974. The original circuit consists of an operational amplifier whose connections are brought on the control surface, and left open. The user, touching them, closes the circuit using the body as conductor. The sounds produced are related to the resistance of the body, and the amount of pressure applied on the connectors. The classic crackle box used the integrated circuit LM709. Unfortunately the LM709 is not that easy to find, so instead I used the schematics of John Richards bed of nails, which uses a far more common IC, the LM358. The op amp inside the LM358 is more stable and less prone to surprises, but in the bad of nails this is compensated using both the op amps on the IC, basically creating two crackle boxes feeding back into each other. Furthermore, there is a white noise generator made amplifying the background noise of a small 10 Ohm resistance connecting pin 2 and 3. The connection is done manually, pushing with the finger the resistor on the pad, so it's possible to control the white noise in a fairly performative way.

Occurrence - Mostly continuous. A sound longer than 5 seconds stops the generation, the next onset re-activates it.

Relationship 2 - First train pulse.
The actor reacts when the amp detection module sends the on message. When this happens there is a high probability that the event occurs. Some initial parameters are choosen algorithmically. The pulse is also controlled with a variable mapping of the input spectral centroid, and the sound is very reactive to my gestures.
Activating condition - Detection of 1st event.
Ending condition - Detection of special event 1.
Occurrence - Probabilistic, when the amp detection module sends the on message.

Relationship 3 - Second train pulse.
The actor reacts when the amp detection module sends the off message. When this happens there is a high probability that the event occurs. Some initial parameters are choosen algorithmically. The input continous pitch is recorded in a buffer when there is sound. When the synth plays, this buffer is played back at variable speeds and mapped to the delay of the comb filter. If the buffer is controlling the delay and I play again, the buffer stops and restarts when I'm done.
Activating condition - Detection of 1st event.
Ending condition - Detection of special event 1.
Occurrence - Probabilistic, when the amp detection module sends the off message.

Relationship 4 - Slowly moving background.
This relationship is very tangential and uses spectral techniques to relate the spectrum of the input to the spectrum of the synth. Every 6 seconds an FFT frame of the input signal is taken, and some of the frequency/amp pair of the most prominent partials are assigned to banks of resonant filters. The banks are six and fade into each other providing a slow and dense morphing. The selection of the frequency/amplitude pairs follows a user-defined pattern based on one important parameter: how much the spectral content of the filter banks have to resemble the input (a variable tangentiality). When a spectrum more resembling the input is desired the program uses the most prominent partials; when a spectrum more tangential is desired, the program discards the loudest and selects the quietest ones. The overall amp is always normalized but it preserves the amp ratio of the FFT partials, setting the amp of the loudest used partial to 1. The resonating filter banks are excited with white noise. Slow random automations are used to control the amp and the transition from a flat sound to an impulse-like one. The decay of the resonant filter (here you can think of it as a normal Q) is directly related to the noisiness of the input signal, so when the input is more similar to white noise the decay is high and viceversa. This relation requires a continuous input, so when there is no sound to be analyzed it uses a silent loop created with the last part of the input sound.
Activating condition - Detection of 15th event.
Ending condition - Detection of special event 1.
Occurrence - Continuous.

Relationship 5 - 2 static high-frequency synths.
The actors react when the amp detection module sends the on message. The probability of occurrence is not too frequent. The synths use very high frequency content. The relationship is very simple. Here it is all about the minimal generative behavior of the synths.
Activating condition - Detection of 20th event.
Ending condition - Detection of special event 1.
Occurrence - Probabilistic, related to the amp threshold.

Relationship 6 - Gliding bass.
This actor uses the pitches recorded on the onset of the input events, transposed in a low register. It starts playing probabilistically, when the amp detection module sends the on message. Rarely it is activated automatically. The pitch are stored in an array and selected with a shuffle among the last 5. The selection happens with an interrupt that uses the beta distribution applyed to the duration; the limits are very broad. The synth glides to the new value.
Activating condition - Detection of 20th event.
Ending condition - Detection of special event 1.
Occurrence - Probabilistic, related to the amp threshold. Rarely automatic

Relationship 7 - 2 synths that respond to glissandi.
This relationship links the pitch, especially the glissandi of the input signal, to the gliding synths. It uses two kinds of buffer recording to store some user-defined parameters: the spectral centroid and an on/off signal when there is input sound. One kind of recording opens the buffer and closes it in correspondence with the amp threshold, so a buffer with a defined length is recorded every time there is an event in input and can be used right after. A second kind of buffer recording is continuous and these data can be used even if the buffer isn't closed, respecting the condition that its reading speed isn't faster than the real sound (reading index <= 1). This allow to sync some buffer based operations with the attack of the input sound. The use of these buffers and the related onset of the synth is triggered using probability: the reading can start in correspondence with the attack of the input sound, a few ms after, in correspondence with the end of the sound, or after the end it can wait for a random delay. The spectral centroid recorded on the buffer is applied to the pitch of two additive synths both displaying independent behavior in many other parameters. The probability works independently for the two instances of the synths. The reading speed of the buffer is random and often is extremely slowed down. On top of that there is the possibility that the reading freezes so that the timbral independent movement of the synths can emerge from the sustained sound.
Activating condition - Detection of 25th event.
Ending condition - Detection of special event 1.
Occurrence - Probabilistic, related to the amp threshold.

Relationship 8 - Electro patterns.
This relationship is the one responsible for those patterns that provide some melodic and rhythmic material. The pitches of the patterns are the most prominent partials of an FFT frame. When the actor is called, a FFT frame is taken from the input sound, and a random pattern is chosen probabilistically. If for example the pattern has a rhythm of 11 beats, the most prominent 11 partials of the FFT frame are used as pitch material for the pattern. The pattern also can have one or two notes that are two beats long. The pattern is looped and the loop can change during the occurrence of the relationship, but with a very low probability. Each occurrence has an overall duration that ranges from 30 to 60 sec.
Activating condition - Detection of 25th event. (actually, a safer equivalent: relationships 5 and 7 are active)
Ending condition - Three occurrences.
Occurrence - When the input sound is longer than 6 seconds. Probability 50% OR after 2 detections. After each occurrence the module wait 40 sec before it can be used again.

Relationship 9 - Bowed string-like instrument.
This actor responds directly to the spectral centroid of the input. The centroid is mapped directly to the pitch of a recursive FM synth, and at the same time it is recorded into a buffer. When the input sound stops, the buffer is looped and continues to control the pitch of the synth. The loop goes

through a series of generative processes: it can remain constant, slow down, or speed up. Some parameters of the synth can be changed during the looping time. When they change, they follow a direction and cannot go back until a new loop is used.
Activating condition - 3 occurrences of relationship 8.
Ending condition - Activation of relationship 10.
Occurrence - Continuous.

Relationship 10 - Percussive sound.
This actor alone occupies the entire second section of the work. It is different from all the others in that it uses the data stored in the long term memory of the system, and operates when the performative gestures are over. This is one of the most tangetial relationship possible. The time intervals of the percussive synthetic sounds are the reverse of the intervals of the onsets of the sounds analyzed in the first section. Their spectral content is a result of data recombination of the spectra of the analyzed sounds: the most prominent partial of the last 18 events are used to create the spectrum. They are transposed in range to make sure that the spectrum is balanced but they are left unaltered, so that any possible harmonic or inharmonic relationship is the result of an emergent behavior. The overall duration of this section is the smaller part of the golden ratio of the overall duration of the first section.
Activating condition - After the special event 1 has been detected, wait for the detection of an event that is longer than 6 seconds, when that happens, wait until there is no sound, than wait for a duration that is equal to the detected event and activate the module.
Ending condition - The condition is met when the internal clock of this relationship that starts with its activation is major equal to the duration of the first section multiplied by 0.382 (golden ratio).
Occurrence - Continuous.

Special event 1.
If relationship 9 is active, detect a sound longer than 40 seconds.