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|---|---|---|
| Name | : | Tijs Ham |
| Pathway | : | Music and Sound Design |
| Grade | : | MA |
| Institute of education | : | HKU / Art, Media & Technology |
| Supervision | : | Jorrit Tamminga |
| Date | : | August 12th, 2013 |


# The Institute of Constrained Chaos

How chaos can be used to enhance musical expression in live electronics

# Contents

# Preface

*Opening remarks*

Working on this project has been a wonderful but hectic experience. Each day there were new developments, insights, changes of plans and new opportunities to pursue. Some highlights include the weekend I spend in Birmingham, performing at the Network Music Festival, playing in a hot, dusty and packed cellar in Utrecht and many, many more. For this supportive narrative I have tried my best to categorize all of the events and developments into chapters and subchapters but I will apologize in advance if some of the chaos is still in there.

In the past half year, while working on this project, I have been able to take important new steps as a sound artist and as a performer. I have learned that sometimes it helps to let go of control in order to find exciting new sonic worlds. Besides having worked on a powerful new performance to add to my resume, I have extended my toolkit with fresh concepts and techniques for the creation of new sounds.

*Acknowledgments*

Thank you, Jorrit Tamminga, for all of the lectures, supervision and inspiration you provided for this project and so many projects before. I would like to thank Yaniv Schonfeld, Mario van Etten and STEIM for sharing their knowledge, workspace, thoughts and ideas. Also thanks to Marko Ciciliani, Laurens van der Wee, Ernst Bonis, Ángel Faraldo, Frank Baldé, Jonathan Reus and Marije Baalman for the conversations that have shaped this project into its final form. Thank you, Dianne Verdonk, Stan Verberkt, Dave Mollen, Wim Schönermarck, Roald van Dillewijn, Olivier Schreuder, Eric Magnée and Gagi Petrovic for teaming up as 'Custom Made Music' and showing such a level of professionalism and dedication. Thank you, Jannie Pranger, Hans Leeuw, Mark IJzerman, Pinar Temiz, Roland Spekle, Thanasis Deligiannis, Ewoud Scheifes for additional supervision and inspiration. Thank you Jan & Ad for all the advice and help in building the controller.
Thank you, Bart van Gemert, for the music, the improvisations, the rehearsals and the performances. Also thanks to all of the many other musicians that I performed with in the past few months, it has been a great honor.

# Abstract

This supportive narrative is connected to the graduation project 'The Institute of Constrained Chaos' (TIOCC) which investigates the use of chaotic processes in order to enhance musical expression of a live electronics performance. Inspired by the chaotic, expressive, musical power of overblown brass instruments, the project aims to develop a live electronics performance that utilizes a combination of new and existing hardware and software such as no-input mixing, circuit bending, digital signal processing and sensor based controlling to create an instrument that navigates the musical edges between order and chaos. The project has resulted in a ten minute improvised performance in collaboration with Bart van Gemert, a drummer, as part of a concert series organized and executed by a group of HKU graduate students operating under the name 'Custom Made Music' (CMM). Through many tryout concerts and several iterations of the instrument it can be concluded that the use of chaotic processes can enrich the expressive musicality of a live electronics performance.

# Chapter 0 : Chaos

## *A short introduction to chaos*

Before diving into the topic at hand it might be good to make a couple of statements that are important in establishing the correct type of context. I do not have a background in science. I also do not have a background in mathematics. I am not a chaos theorist, nor a specialist in dynamic systems. Science, maths and biology do form a magnificent source of inspiration for my work. I do enjoy science documentaries and occasionally follow lectures and talks on scientific subjects that spark my interest. The following description on chaos should be viewed in that light. I acknowledge the limitations of my understanding on the subject from a scientific perspective, yet the parts of chaos and chaos theory that I do grasp form an important starting point for 'TIOCC'.

### *Chaotic processes*

Chaos, chaos theory and chaotic processes play a vital role in this project and subsequently this supportive narrative. Theories around chaotic processes have been around since the late 1800's[1] but a lot of advances in the understanding of these processes have been made in the past century due to the iterative mathematical power of computers. While trying to develop accurate and predictive models of weather systems or thermo-dynamics, researchers stumbled upon the typical complex behaviors that arise out of chaotic processes. Although it is difficult to come up with an all compassing definition of what a chaotic process is, there are a number of features that clearly indicate if a system or process is of a chaotic nature.

### *Great sensitivity to initial conditions*

The sensitivity to initial conditions of chaotic systems was famously discovered by E. Lorenz[2] while working on computer simulations of weather models. While trying to restart one of his iterative equations, he wanted to save some time by inserting a dataset that he had printed out earlier instead of running the program from the start. As he ran his program again he quickly found the results to be very different from the original dataset. Lorenz realized there was something interesting going on. It turned out that the data he had printed was rounded off to a limited number of decimals. The very tiny difference between the rounded off data and the actual dataset caused the entire system to behave in a radically different way.

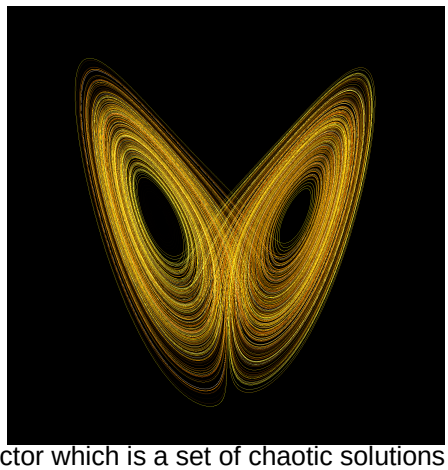

Figure 1 – A plot of the Lorenz attractor which is a set of chaotic solutions of the Lorenz system. When plotted, it looks somewhat like a butterfly or figure eight. It actually is a representation of outcomes that seem to spiral around two 'attractors'.

1 Chaos, Making a New Science, James Gleick, 1987

2 Edward Norton Lorenz (May 23, 1917 – April 16, 2008) was an American mathematician and meteorologist, and a pioneer of chaos theory. He discovered the strange attractor notion and coined the term butterfly effect.

This sensitivity to initial conditions is also referred to as the 'Butterfly Effect'. Tiny changes in initial conditions, such as the flapping of butterfly wings, can set a string of complex consequences in motion that may eventually end up causing a hurricane.

Next to this great sensitivity to initial conditions there are two more features that are necessary in order to classify a process as being chaotic, namely topological mixing and having a high density in periodic orbits. As these concepts are a lot more complex in nature, for the purposes of this supportive narrative it is suffice to say that they deal with imposing certain boundaries to the dynamic systems. For example, an equation, multiplying its outcome by two at each iteration is very sensitive to its initial conditions, but does not behave in a chaotic way.

*The difference between chaos and randomness*

It is very important to distinguish between systems that behave in a chaotic way compared to systems based on randomness. In everyday speech the two concepts are often confused, and the complexity of some the outcomes of chaotic processes may seem quite random at first glance. The differences become more apparent as one looks at the underlying systems that drive the complexity within chaos. These systems are best explained through an example, such as the 'Mandelbrot[3] set[4]'.

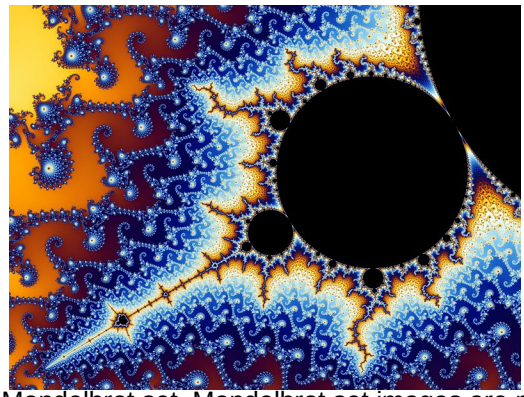

Figure 2 – Zoom of a plot of the Mandelbrot set. Mandelbrot set images are made by sampling complex numbers and determining for each whether the result tends towards infinity when a particular mathematical operation is iterated on it. Treating the real and imaginary parts of each number as image coordinates, pixels are colored according to how rapidly the sequence diverges, if at all.

Without going into the math behind these fractals[5] displaying an infinite complexity, it also clearly demonstrates that the process that creates this complexity has nothing to do with randomness.

*Tipping points*

A lot of chaotic systems behave differently depending on the state it is in. These states are depending on differences in values of certain parameters affecting the balance of the system. The output of such a system can either be static, show predictable behavior or show unpredictable behavior. Tipping points are the specific areas where a change in the

3 Benoit B. Mandelbrot (20 November 1924 – 14 October 2010) was a Polish-born, French and American mathematician, noted for developing a "theory of roughness" in nature and the field of fractal geometry to help prove it, which included coining the word "fractal". He later discovered the Mandelbrot set of intricate, never-ending fractal shapes, named in his honor.

4 The Mandelbrot set is a mathematical set of points whose boundary is a distinctive and easily recognizable two-dimensional fractal shape.

5 Fractals are typically self-similar patterns, where self-similar means they are 'the same from near as from far'

value of a parameter causes the system to switch from one state to another. One musical example of a system that behaves in various states would be the saxophone. If a player softly blows into the tube the resulting sound is soft and breathy. Once the player increases the airflow steady tones can be heard. Now if the player continues to increase the airflow it will reach a tipping point where the sound becomes much richer and noisier in timbre. This technique of blowing so heavily into an instrument that the output becomes noisy and harsh, is called overblowing.

*The tension between predictability and unpredictability*

The sound of an overblown saxophone has become a characteristic element of genres such as free jazz but is also sometimes used in noise music or experimental pop songs. A well trained musician is able control this overblowing to a great extend. In this way, the concept of tipping points are being used as an expressive musical feature in both improvisations or compositions. The act of crossing over the point of predictable sound and unpredictable sound is quite remarkable. The moment at which the solid tonality begins to crumble down has an almost poetic fragility to it.

*Recursion and feedback*

One way to initiate a chaotic process is by allowing two or more recursive events to be influenced by each other in such a way that patterns of balance and imbalance starts to occur. In sound, this process could be achieved by creating multiple feedback loops whose audio signals interfere with each other. The sonic result of such setups exhibit exactly the kind of complexities that would be expected from a chaotic process. No-input mixing (explained in more detail in chapter 4) is a method analog sound generation that solely relies on these kinds of interfering feedback loops. This is also the type of chaotic process that forms the main focus for this project.

*The Institute of Constrained Chaos*

The title of this project refers to the fragile tension between predictability and unpredictability in chaotic processes. Complete, uninterrupted chaos is only interesting for short periods of time. It is when the chaos is constrained, sometimes on the edge of collapse, when interesting things are happening. The title also makes a reference to my debut album, 'The Institute of Random Events'[6], released one year prior to the start of my education in sound design.

6 Since 2004, I have been writing and producing electronic music as 'Tapage'. This music has been released on either vinyl, cd or digital formats as part of e.p's, compilations and full length albums. In the past I have worked with many different record labels including Chicago based 'Tympanik Audio' who released my debut full length album 'The Institute of Random Events' in 2008.

# Chapter 1 : The Goal

*What is the goal?*

*- The goal of this artistic research is to investigate the usage of chaotic processes in order to increase musical expression within the context of a live electronics performance.*

In order to say anything meaningful about this goal it is important to be as clear as possible in defining and describing each element of this research.

*Artistic Research*

This thesis describes the conceptual and artistic choices and actions that I have made in relation to the graduation project 'TIOCC'. These choices and actions are subject to the sonic and performative preferences of myself and should be reviewed in that context. The overall context and aims of the project will be described in more detail below.

*Usage*

For this project, the chaotic processes that have been examined could be implemented on various levels. Both in software and hardware, at control level and as part of the audio synthesis. Also both on a performative scale and as part of the bigger musical structure. Some of these combinations turned out to be linked together automatically. The use of complex feedback loops as the main form of synthesis turned out to also have a profound influence on the way in which this feedback was controlled, which in turn had its implications for the eventual performance.

*Chaotic processes*

There are some specific elements of chaos theory that I have incorporated into the project. Since chaotic processes come into play in a great number of disciplines within science, biology, economic and so on, its important to keep in mind that I'm only referring to the specific recursive chaotic processes as described in chapter 0.

*Musical expression*

Musical expression can be described as the manner in which a musical phrase is executed regardless of its actual tonal content. Dynamics play a very important role here but timbre, articulation, intensity and phrasing are crucial as well. If the same melody is played twice, once softly and once loudly, each performance would be interpreted differently by the audience. The meaning of a musical phrase can change entirely according to the way its performed. Slight changes in timing can add to a dramatic impact. In short, musical expression can be seen as the art of communicating musical passages to an audience.

*Live electronics performance*

The use of electronics in live music has been around for almost a century now which has resulted in an incredible amount of different approaches and viewpoints. A broad definition would include all ways in which electronic technologies are used to establish a musical performance. But that would encompass a lot of live electronics practices that are not relevant to this particular project.

This project focusses on electronic instrument design and performance. While designing the instrument there were a number of decisions that further narrowed down the scope of the project within the field of live electronics. First of all, the instrument should be standalone in nature. This means that there is no live sampling of external musicians. Secondly, the design of the instrument should take all of the performative aspects into consideration. It was clear from the start that the software part of the instrument should not require any GUI elements which can form a distraction during a performance. This instrumental approach to live electronics fits very well within the direction that the 'Studio for Electro Instrumental Music'[7] (STEIM) has taken over the past few decades.

7 STEIM (the STudio for Electro-Instrumental Music) is an independent electronic music center unique in its dedication to live performance. The foundation's artistic and technical departments support an

## *1.1 What will be the result / artifact?*

The Aim of the project is to be able to perform a 10 minute structured improvisation within the context of a series of concerts organized by a graduate collective operating under the name of 'Custom Made Music' (CMM). My own part of the piece will be performed on an electronic instrument which I have designed and built myself, incorporating chaotic processes into its design. The performance is a duet with the musician Bart van Gemert, a drummer with a background in jazz and experimental improvisation.

*Structured Improvisation*

Due to the chaotic nature of the instrument it is impossible to fully recreate performances. As such, it is useless to write a detailed score for the performer. It is however possible to have control over several musical aspects of the sound. These might include texture, rhythm, frequency, loudness, noisiness, dynamics etc... Furthermore, due to the context in which the performance takes place, its necessary to keep track of the time. After many rehearsals the choice was made not to write down an actual score but rather to select a variety of playing styles or modules which are then strung together to form the piece. Each time the piece is performed, certain rhythms and sounds reappear although never quite in the same way.

*Custom Made Music*

Custom Made Music consists of the following group of nine graduate students of the KMT who have chosen to collaborate on organizing a concert series.

Dianne Verdonk
Stan Verberkt
Dave Mollen
Wim Schonermarck
Roald van Dillewijn
Olivier Schreuder
Eric Magnée
Gagi Petrovic
Tijs Ham

Each of the collaborating students have made the choice to focus their graduation projects on creating a performance within this context. The evening consists of 8 diverse music performances, some divided over several movements, ranging from electro-acoustic ensembles with pop influences to highly experimental solo pieces. There are however a few elements that hold the wide variety together. The use of self built electronics can be seen as a clear theme throughout each of the performances. For the concert evenings themselves a choice was made to focus on fluid ways to string all of the performances together. The time needed to switch from one performance to the next is kept to a bare minimum which gave gives the evening a great flow. The pieces are really varied, providing the audiences with a number of surprising and engaging transitions.

*Electronic Instrument*

The electronic instrument consists of three connected parts.

The first part is a circuit bend mixer which is fed back to itself in various ways. Two auxiliary channels are routed to inputs. Also, the control output channels are send back as inputs. The mixer is also circuit-bend, creating four additional feedback loops. Lastly, the four channel output of the mixer is send to a sound card. The mixer can be seen as the

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international community of performers, musicians, and visual artists, to develop unique instruments for their work.

main sound source of the instrument.

The second part is a laptop running a program coded in the audio programming language SuperCollider[8]. This program takes care of three distinct tasks.

The incoming sound from the mixer is slightly altered and again send back to the mixer creating yet four more feedback loops. The manipulations that I ended up using include ring modulation, comb filtering, tremolo and a resonant filter. The settings of each of the manipulations are very subtle but the results get enhanced through the feedback loops within the mixer.

The incoming sound from the mixer is also cleaned up, converted to a double mono signal and send to the output of the sound card. This cleanup includes a DC offset filter (LeakDC.ar), soft knee compression (SoftKneeCompressor.ar) and a hyperbolic tangent (.tanh) used to prevent the signal from clipping. The output is send to both a guitar amplifier and a bass guitar amplifier. There are some reasons why I prefer using these amplifiers instead of a PA. The raw energy of the sounds coming out of the mixer is preserved very well through such amplifiers. Also, by separating the low and high end I still have more than enough control over the sound. Lastly, the amplifiers allow for the sounds to be projected locally. This avoids the disconnect that can happen when electronic instruments are played in one location while the sounds that are produced are played over speakers in positioned at different locations.

The last part of the patch is connected to the third element of the instrument, namely the controller. The patch reads out sensor data from an Arduino connected to four linear potentiometers. The potentiometers are installed in between two wooden boards. The boards are suspended by springs forming a plateau on top of which the mixer itself is positioned. The plateau itself becomes an extra controller which turns the instrument into something much more expressive.

*Bart van Gemert*

It must have been about two years ago when a HKU project focussed on rhythms and beats got me in contact with Bart van Gemert, a drummer and percussionist studying at the Conservatory of Utrecht. In the two or three months in which we were developing the performance there was a clear musical connection. Both of us have an open mind combined with a curiosity towards sounds and timbres. After finishing the project we agreed that it would be a shame to stop collaborating, yet it took about one and a half years before we ended up playing again. This time around, I was performing with one of the very first prototypes of the chaotic instrument I had just started to develop. Bart, in the meantime, had been playing in many ensembles, big bands and jazz outfits, looking forward to once again dive into a more experimental musical context. During one of the rehearsals of this new project, which involved improvised music via network, connecting several musicians across different cities, we ended up playing a really great improvised duet. I decided to continue playing with Bart as part of my graduation project.

8 SuperCollider is an environment and programming language for real time audio synthesis and algorithmic composition. It provides an interpreted object-oriented language which functions as a network client to a state of the art, realtime sound synthesis server.

## 1.2 What is the motivation behind the project?

In the past 10 to 12 years of creating electronic music I have always been struggling with the translation of studio productions to live performances. At first my focus was fully shifted towards the production side and consequently, performing this music onstage caused huge problems. The approach was to sample my own tracks, slicing the samples into loops and sequence them through a sampler. This setup allowed me to somewhat reproduce the studio material and gave me limited freedom to interact with the material but it always felt too restrained. The intricacies that I would spend hours on while writing and producing the music in the studio seemed to get lost in translation.

During my studies at the KMT I got introduced to audio programming languages such as Pure Data[9], Max/MSP[10] and eventually SuperCollider. The flexibility of these programs opened up a whole new world of possibilities. Suddenly I was able to generate, manipulate and sequence sounds in realtime while retaining all of the complexity and intricacy which I used to spend all my time on in the studio. This affected my view on live electronic music greatly and in collaboration with Roald van Dillewijn and Eric Magnée I started the band The Void* to further investigate the artistic possibilities of code and live electronics. The two main focus points from the start were timbre and performance. Creating flexible systems for sound synthesis and manipulation within specific concepts and at the same time creating equally flexible control environments. In our projects we always took an existing instrument group as a source of inspiration and proceeded to make adjustments to the sounds and performative possibilities in order to increase the sonic and expressive qualities of the instruments. Designing and performing these instruments, visiting many concerts of other artists working in the field of sound art and also my experiences as an intern at STEIM, eventually led up to some observations live electronics.

*A disconnect between performative actions and sonic output*

Within the realm of acoustic instruments, the sounds you hear require energy from a musician in order to be audible. This energy can be in the form of blown wind, strumming, hammering or bowing a string, or similar. The gestures a musician makes while performing such an instrument are usually connected to this input of energy. In live electronics however the source of the energy used to produce sound is separate from the performer. Electricity takes over. The most common interfaces for electronic instruments, such as knobs and faders, require almost no energy from a performer. There is no physical effort required to reach musical climaxes in sound. One way to deal with this issue is by coming up with theatrical gestures to replace the musical gestures. An example of this can be observed when DJ's make elaborate gestures when changing equalizer settings during a performance. By placing the mixer that I use for my own performance on a plateau equipped with springs and sensors, the sounds can be manipulated by applying pressure on the mixer and in that way physical energy is reintroduced as a performative gesture.

*Different controls for each sonic aspect within the parameter space*

In a lot of live electronics setups only make limited use of multi mapping. Most keyboard based instruments do link pitch and velocity to the same keys, but all of the other aspects of the sound is controlled by separate knobs and faders. Consequently, it hard to make drastic changes in timbre during a performance since this requires many parameters to be changed all at once. By making use of several feedback loops all of whom influence each others sound, each control parameter has the ability to change the overall sound in pitch,

9 Pure Data (aka Pd) is an open source visual programming language. Pd enables musicians, visual artists, performers, researchers, and developers to create software graphically, without writing lines of code.

10 Max is a visual programming language for music and multimedia developed and maintained by San Francisco-based software company Cycling '74. During its 20-year history, it has been widely used by composers, performers, software designers, researchers, and artists for creating innovative recordings, performances, and installations.

dynamics, timbre, and texture.

*Dynamics focussed on loudness instead of timbral complexity*

Again, this observation focusses on mapping. But in essence it is asking the following question. What happens in sound when an instrument is pushed to its limits? Most electronic instruments have a well defined scale between the softest possible sound and the loudest. Usually this mapping only involves the amplitude of the sound although sometimes there is also a filter cutoff connected to the velocity... the louder the instrument is being played the brighter the sound gets. For this project however, I'm much more interested in increasing the complexity of a sound as it becomes louder. This can result in vast sonic differences between soft sounds and loud sounds. While it becomes much harder to control such an instrument, it does open up a much larger sound pallet with which musical ideas can be communicated.

# Chapter 2 : The Context

*Critical Review, Literature & Repertoire*

Chaotic processes and live electronics have already been combined by artists and researchers in the past. Chaotic behaviors have been discovered in many fields including, for instance, the expressive behaviors of blown instruments. Music technologists have used chaos in their physical models of these instruments, resulting in precise reproductions of both their sound and sonic behavior. The technique of no-input mixing is also being used in noise music and live electronics for quite some time now. The term is said to be coined by the Japanese electronic musician Toshimaru Nakamura in the late nineties. By combining the techniques of no-input mixing, circuit bending, digital sound processing and sensor based controlling, I have attempted to add a performative edge to these existing fields.

## *2.1 Interviews and advisors*

*Marko Ciciliani*

*Background*

*Marko Ciciliani* is a composer, audiovisual artist and researcher based in Vienna/Austria. He received his musical training as a composer and electronic musician in New York, Hamburg and The Hague. Already during his studies he has collected extensive experience not only in the fields of composition, but also in free improvisation and cross-disciplinary projects. His music has been performed in more than 30 countries in Europe, Asia, Australia and the Americas. He received numerous project-residencies at STEIM, ICST and ZKM. Ciciliani is a guest professor for electro-acoustic composition at the Institute for Acoustics and Media (IEM) of the Arts University in Graz/Austria and lecturer for electro-acoustic composition and acoustics at the University of Music and Performing Arts Vienna.

*Discussion topics*

The conflict between chaos and control. Ciciliani ended up abandoning no-input mixing because of a need to be able to reproduce compositions.

Wether the no-input mixer could be viewed as an additional player as well as an instrument. This notion is related to the unpredictability in sonic behavior of a no-input mixer when it is approaching a tipping point. As a player it is necessary to listen and respond to these behaviors in a similar way as you would listen and respond to another musician during a performance.

*Laurens van der Wee*

*Background*

Laurens van der Wee is a sonic designer, 'electronic musician' and composer of electronic music from The Netherlands. He gained his Master of Music and Bachelor of Art and Technology degree at the Music Technology department of the Utrecht School of the Arts in 2011 and 2009 respectively. After playing piano and cello, among other instruments, Laurens has now found a way to work with music and sound, art and technology at the same time.

*Discussion topics*

The attraction of the performative aspects of no-input mixing. Using no-input mixing in a

band context.

Talked about the difference in sound between different kinds of mixers and the possibilities of making adjustments to the mixers. One example was the addition of a spring reverb in between a feedback loop adding both sonic and performative options.

*Ernst Bonis*

*Background*

Ernst Bonis is an expert in sound synthesis, electronic-musician, author, former lecturer in sound synthesis at the Utrecht school of the Arts, Rotterdam conservatory and the Netherlands Carillon school. He has written a book on FM Synthesis and has written many articles for 'Interface' magazine. Nowadays he works as an Independent electronic-musician, workshop leader in the field of electronic music, sound synthesis, DIY electronic music circuits and music for automatic carillons.

*Discussion topics*

The use of chaotic processes in Nord Modular[11] to achieve natural relationships in sounds and timbres. Ernst opened several of his own patches which made use of feedback and recursion.

Experiments by Jaap Vink creating chaotic feedback loops in the analog studio at Sonology in The Hague.

*Ángel Faraldo*

*Background*

Ángel Faraldo is an experimental musician interested in the systematic exploration of processes that maximize minimal resources, as materialized in his cycle The Feedback Study Series (comprising pieces for instruments and electronics, works with dance and installations), his digital synthesizer MISS or his approach to no-input mixing.
Besides his artistic practice, he is very active teaching workshops on improvisation and electronic music, and collaborating as digital instrument designer and electronic music performer with composers and ensembles such as Modelo62 (NL) and Vertixe Sonora Ensemble (ES). He has studied guitar at the Royal Conservatoire of Madrid and holds a Master’s Degree in Sonology from the Royal Conservatoire in The Hague.

*Discussion topics*

The high level of control over his no-input mixer performances through strict rehearsals and memorizing and executing longer sequences of actions.

Working with two identical mixers and investigating wether the sounds of one mixer can or cannot be replicated on the other one.

*Yaniv Schonfeld*

*Background*

Yaniv Schonfeld is an interdisciplinary artist working with sound and stage. In his work he uses the discipline of theater, it's philosophies and theories, as a basis for creating unique musical performances that are neither concerts nor music theater in the traditional sense. Yaniv's practice focuses heavily on the building of and use of self-constructed instruments

11 The Nord Modular combines a powerful digital synthesis engine based on the well known type of modular synthesis building blocks, with a hardware keyboard capable of controlling these sounds.

which are treated as objects that can be actuated on a stage. The instruments themselves become actors that are part of a unraveling theatrical dynamic between performer, musical object and audience

*Discussion topics*

The concept of repurposing the mixer from a devise that combines audio signals into a chaotic oscillator. The repurposing of objects is a recurring theme in his work.

The performative qualities of no-input mixing with and without the addition of a control structure.

*Frank Baldé*

*Background*

Born 1956 in Delft, the Netherlands. After his technical studies and playing in numerous pop groups he joined Steim Foundation in Amsterdam in 1985 and started his work as software designer. A big influence has been and still is, the close collaboration with Michel Waisvisz, the artistic director of Steim which resulted in a number of music programs for live performance such as LiSa and JunXion.

*Discussion topic*

We spoke about the different options in the use of pressure sensors, resulting in a shift in perspective from purely measuring pressure to measuring the distance of an object moved by that pressure.

## *2.2 Performances*

*Colin Stetson*

Seen in concert at 'Le Guess Who' festival in 2012. Colin Stetson, born in Ann Arbor, Michigan and currently based in Montreal, Quebec, is a bass saxophone player and touring member of Arcade Fire, Bell Orchestre and Bon Iver. I only have had the chance to talk to Colin briefly after a show. We spoke about the saxophone as an instrument that behaves chaotically when overblown. This concert has made a huge influence on me and inspired the investigation into chaos and musical expression.

*Tom Verbruggen (Toktek) & Simon Berz*

Seen in performance at the STEIM 'Patterns & Pleasure' festival back in 2011 where I was working as a volunteer. Relevant due to the combination of live electronics by Tom Verbruggen and drums by Simon Berz. Although the live sampling techniques Toktek uses in his work have nearly nothing to do with the type of live electronics this project pursues, The energetic and expressive performance can be cited as an influence.

*Gert-Jan Prins*

Seen in concert at 'Oorsprong curators sessions' in may 2013 where I performed myself as well. I was impressed by the both the richness of the sounds, which also utilized forms of chaotic feedback, and the confident musicality of performance. The directness with which the sounds were introduced worked really well in structuring the improvisation he was engaged in.

# Chapter 3 : The Method

*How?*

This project has provided me with a broad set of challenges to meet, in hardware, software, performance and of course in the management of acquiring performances. Yet, by methodically facing each of these challenges, iterating over numerous versions and prototypes, I have been able to tackle each, one by one. The only way such an approach to a project can work is by starting rather too soon than too late and being able to keep up a very productive work ethic.

*Trial and error*

Throughout my development as a student and artist I have always preferred to view the projects that I was working on as prototypes or sketches. This allowed me to create quick working models of what I wanted to achieve and then assess if I was still going in the right direction. Depending on the project and time I could easily go through several iterations of prototypes before ending up with a product that behaved according to the necessities of the project. There are several advantages to this method of approaching projects that benefit my productivity. It allows me to turn concepts into practice in a very early stage of a project. Unforeseen practical difficulties are thus also identified and dealt with early on. By viewing each iteration as a sketch I inherently build in the possibility of failure, without endangering the overall process of the project. It should also be noticed that these moments where a prototype behaves differently than expected can be very helpful and inspiring in moving concepts forward.

*Reflection*

The only way in which trail and error can truly work is by combining the practical advances with periods of honest reflection. It should be noted that this reflection should look at the process of a project from a multitude of angles. One aspect is determining if something works as it is expected to do. Another aspect is to be aware of the unintended results that might turn up and to decide wether or not these results are allowed to affect the project. The reflection should also shift its perspective between design choices, performative aspects, audience viewpoints, technical possibilities, etc. At times, there might arise a conflict of interests among these perspectives which should be resolved, baring in mind the original goal of the project.

*Peer review*

Besides the reflecting on the advances of the project from a personal standpoint its also very important to listen to the judgements of others. It can be very helpful to determine how an audience of peers respond to the outcomes of a project without being aware of its goals and history. Since everybody who experiences a performance will relate to it from a different reference point, the feedback you will get from them could reveal some interesting insights. Of course it is always a good idea to ask for help when your own knowledge or abilities are not sufficient to get something done.

*Tryout concerts*

There is an enormous difference between a private studio performance and a live audience performance. Both have important roles to play in the process of developing a live electronics performance. Working in the studio is great for exploration and fine tuning. There is a lot of room for experimentation without bothering an audience.

The pressure of performing in front of an audience however can not be recreated in a studio environment. Many of the more practical issues that arise become much more important when playing concerts. A software malfunction during a studio rehearsal is unfortunate, but during a concert it is unacceptable. Playing a series of shows also tests the durability of the setup. Since musical expression is such an important factor for the project, its important to ask audiences for their opinions on the performance.

*Artist in Residence*

Working in a well equipped studio, surrounded by professionals in the field of performative sound art for a predetermined period of time can be greatly motivating. My residency at STEIM was planned at the very start of the project and allowed me to take the important first steps in a focussed environment. Unimpeded by the everyday distractions of normal life, it was possible to work for long stretches of uninterrupted time.

*Interviews*

Every great project stands on the shoulders of giants. It builds upon the advancements of what came before it. It is important to be or become aware of the context in which you are operating. One inspiring way to do so is by talking to the people working in a similar field as you are. To find out what steps they took to get to where they are now. To find out who or what inspired them.

# Chapter 4 : The Execution

*Describing the process*

The first rough ideas and concepts of what would eventually become 'The Institute of Constrained Chaos' were already brooding as early as september 2012. The choice to focus on live electronics resulted naturally from the path I had taken both in my study and in the many projects that were not connected to my education. In earlier projects I had already worked with intriguing dynamic systems including genetic algorithms and neural networks. To me these kinds of concepts or methods are incredibly inspiring and for my graduation project I really wanted to incorporate something similar. Eventually, working with chaotic processes sparked so much enthusiasm that it ended up becoming the main theme for the project.

## *4.1 The development of the 'No-Input Mixer'*

*Introduction to no-input mixing*

At the very start of the project I was investigating in what shapes or forms chaos was already being used in live electronics. A quick search pointed me towards several totally separate and virtually unrelated approaches. Some chaotic processes are being using in the physical models of certain instruments. Secondly, chaotic functions are translated to DSP signals forming chaotic oscillators. Although both of these approaches have really interesting qualities, it was the practice of no-input mixing that immediately grabbed my attention. The intuitive interactions, the almost unparalleled sonic width and the fluid transitions between tonal, textural and rhythmical elements were completely in line with the direction I wanted to take in my performance. What also attracted me to no input mixing was the rawness of the sonic output. For years I have been 'cleaning up' my sounds, polishing everything until the sound was just right. The screaming and growling sounds of the mixer felt like a breath of fresh yet smelly air.

*Feeding the output back into the input*

But how does all of it actually work one might ask? I was wondering about the same thing several months ago when I went to visit Yaniv Schonfeld, an expert in performative feedback setups, in Amsterdam. I owned a small Behringer[12] mixer and had heard about the possibility of turning it into a chaotic oscillator by feeding it back on itself. The process was really as simple as taking a mono jack cable, plugging it into the auxiliary output and connecting it to an input on the mixer. The main output of the mixer was routed to a pair of active speakers. By turning up the volume of the input channel and the main output, sounds were already playing from the speakers. Yaniv showed me how it was done and within about a minute I was listening to the bleeps and ticks that were bursting out of this tiny mixer that I had discarded as useless a couple of months ago.

The audio signal can in some cases be damaging to such speakers as the signal could very well contain unfiltered clicks and DC offsets. To deal with this issue for my own instrument, I made sure that I eliminated the DC offset and limited the output of the sound in the SuperCollider software before sending it out to any speaker.

With the auxiliary knob one is able control the amount of feedback. Similar behavior can be achieved by routing either the tape-, control- or headphone output back to an input. This will impose an interesting problem though. The main volume faders of the mixer will affect the sound of the feedback. Volume control becomes quite difficult in such cases, although not impossible. As a musician you just have to bear in mind that dynamics and tonality are now manipulated through the same controller.

12 German company well known for their low budget audio equipment

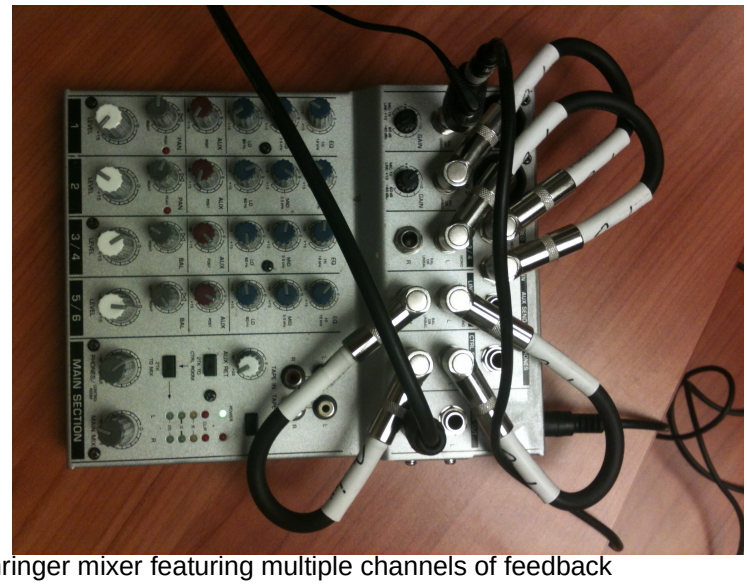

Figure 3 – A small Behringer mixer featuring multiple channels of feedback

*From signal combiner to chaotic oscillator*

As I was exploring these new sounds I quickly came to the realization that just about every function of the mixer had a profound influence on the overall sound. Especially the equalizer knobs turned out have a great effect the frequency and consequently timbre. By increasing the bass frequencies, the overall sound would morph from through different timbral phases including the familiar ringing tones, rich textural sounds and ending up in deep rhythmical pulse like clicks. The transitions between these sounds are clearly not smooth in nature. It is as if modifying the equalization changes the overall energy in the dynamic feedback system, forcing it to collapse into new states. These sudden changes in timbre can be interpreted as tipping points in the recursive, chaotic oscillator that the mixer has now become.

*Multichannel feedback*

Feeding only one channel back onto itself already changes the function of the mixer into an oscillator but in order to achieve a wider complexity in sound, it is necessary to repeat the principle to allow for multiple channels to feed back unto each other. The amount of sonic complexity seems to increase exponentially when there are more layers of recursion interfering with each other and changing the overall sound. Altering the panning of the channels will determine the level of the interaction of these layers. By hard panning the channels its possible to create independent streams of feedback, but as soon as the panning knobs are changed these streams start to dramatically affect each other.

The mixer that I mainly worked with for the project was a Behringer Eurorack MX 1604A, which, being a four channel mixer, also allows for four independent channels of feedback. As I spend time exploring the sonic possibilities of this mixer I soon came to the conclusion that the real challenge would be to keep the sound within certain limits. To constrain the chaos. Anything from harsh noise to harmonic arpeggios, screaming saxophone free-jazz solo's, complex rhythms and many other types of sounds were all being produced through the same simple process.

*Applying different effects between the feedback chains*

Every tiny change in sound within a feedback loop will have a profound influence on the eventual output. Besides playing around with the built in effects of the mixer itself, I also investigated using different effects between the feedback chains. There were some

encouraging results. Especially low frequency ring modulation ended up sounding surprisingly musical as the slow modulation created an arpeggio like sound. These sonic experiments formed the basis of the type of manipulations I ended up implementing in the code, later in the proces.

*Circuit bending the mixer for additional feedback loops*

In my conversation with Marko Ciciliani he mentioned making a lot of use of the direct outputs of his mixer which allowed him to create feedback chains that went through several channel strips of his mixer. The sounds he got by using this method, he described as being both sonically complex but still very much controllable. Because the sound travels through multiple equalizers before being send to the output, there could be so much more precision and control.

The mixer I worked with unfortunately did not have any direct outputs. At least, not yet. With the kind help from Mario van Etten, a classmate of mine and an expert in anything related to hardware, we opened up the mixer and examined the inner workings of the circuit board. We could follow the signal path and quickly discovered the pins which we could use to reroute it. One long afternoon of soldering later I had build in four extra knobs on the mixer that allowed me to control the internal feedback loops. These internal feedback loops worked in exactly the same way as the direct outputs would have done.

Figure 4 – Visible wires and additional knobs after circuit bending.

These added loops allowed me to play around the sonic tipping points much more accurately compared to the level of control I had before. What I also noticed when rehearsing with the circuit bend mixer was the possibility of retaining a sound aesthetic when increasing the value of one knob while simultaneously decreasing the value of another knob or fader. This allowed me to 'store' certain sounds in fader positions. So I could tweak the faders in such a way that I would know that I'd get a certain sound when a certain fader would be all the way up or down. This proved to be a powerful and very musical feature when performing together with other musicians.

## *4.2 Development of the controller*

*Turning the mixer into a performable instrument*

Although I was very content with the sonic width and depth of the no-input mixer, I had a lot of doubts on a performative level. The interface of the mixer that I was using was clearly designed to be used in a studio environment. Although I could reach a certain level of virtuosity in playing with the fader and knobs, I felt like I was running into the very

problem of the disconnect between performative gestures and sonic output that I had set out to tackle at the start of the project.

*Pressure as a performative gesture*

Looking at several performance video's of Colin Stetson I realized that in order to design an instrument that both looks and sounds expressive when played, it should require physical energy from the performer. In an earlier HKU school project, which resulted in a contemporary solo dance performance entitled 'CLOAK', I had already worked with textile pressure sensors and I figured that introducing pressure as controller might be the solution I was looking for. The sensors utilize a property of a material called velostat which resistance changes when it is being put under pressure. This change in resistance can be measured and digitized using an Arduino[13]. The data can then be send to SuperCollider and mapped to any parameter in the program.

*First Iteration*

The first version of the controller consisted of a small rectangular plate resting on four velostat based pressure sensors which I built during my residency at STEIM. The plate was about six by eight inches in size. During a performance the plate would be next to the mixer, allowing me to explore sounds using the mixer and then switching to the controller to further manipulate the sounds. The results I got were encouraging but I also concluded that I would need to take a few more steps in order to reach the full potential of the idea.

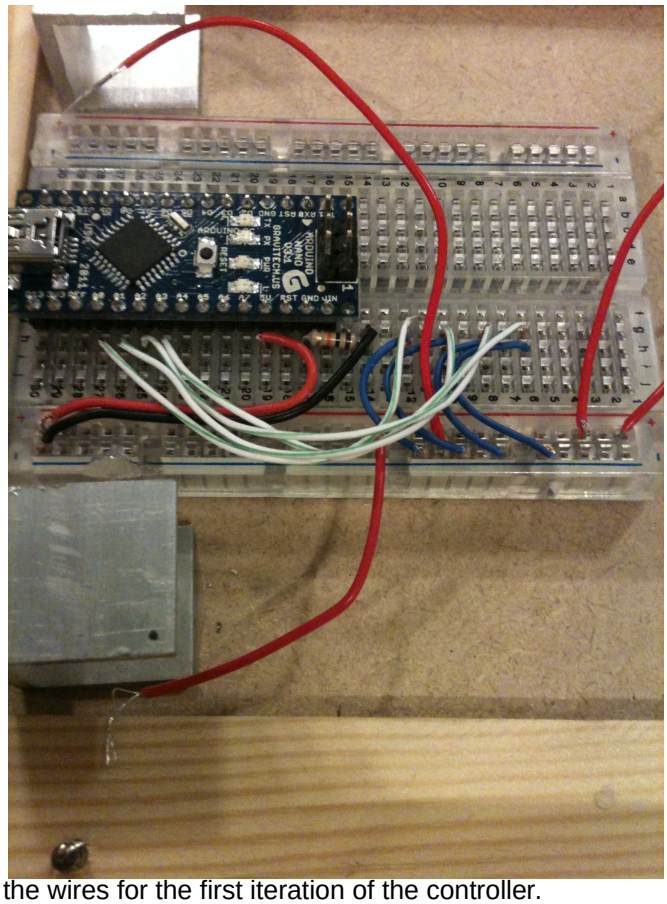

Figure 5 – Breadboarding the wires for the first iteration of the controller.

13 Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists and anyone interested in creating interactive objects or environments.

The most positive outcome was that using physical pressure as a control mechanism opened up a lot of performative possibilities. Also, by connecting the controlled parameters to an additional set of feedback loops, it became possible to play with and around the unstable sounds that were audible when the mixer was nearing a tipping point.

There were also several things that needed to be changed. The distance between the mixer and the controller meant that I needed to switch my attention back and forth during a performance which could be distracting. I also disliked the fact that I could only use one of my hands on the mixer while I was using the controller. The data from the pressure sensors was also quite unpredictable at times. The highest and lowest values would be different each time I played. This could be solved by calibrating but I noticed that the range of the data kept getting smaller and smaller. I realized that I would need to think of alternative approaches of measuring the pressure.

*Second Iteration*

I started to imagine ways of fusing the mixer and the pressure based controller into one object. One idea that crossed my mind was to make each knob and fader on the mixer pressure sensitive but that would be both incredibly difficult to build, and I would still need to come up with a better method of measuring the pressure. I then got the idea of placing the mixer on top of the controller I had, which immediately sparked the followup idea of using springs underneath the mixer and measuring distance between the spring in it normal position and pushed down as far as possible. The measurement of the distance could be done in a much more precise, repeatable and durable way using linear potentiometers. Frank Baldé, who is the heads the software lab at STEIM, was so generous to give me advise on this matter and also donate four sensors to the project.

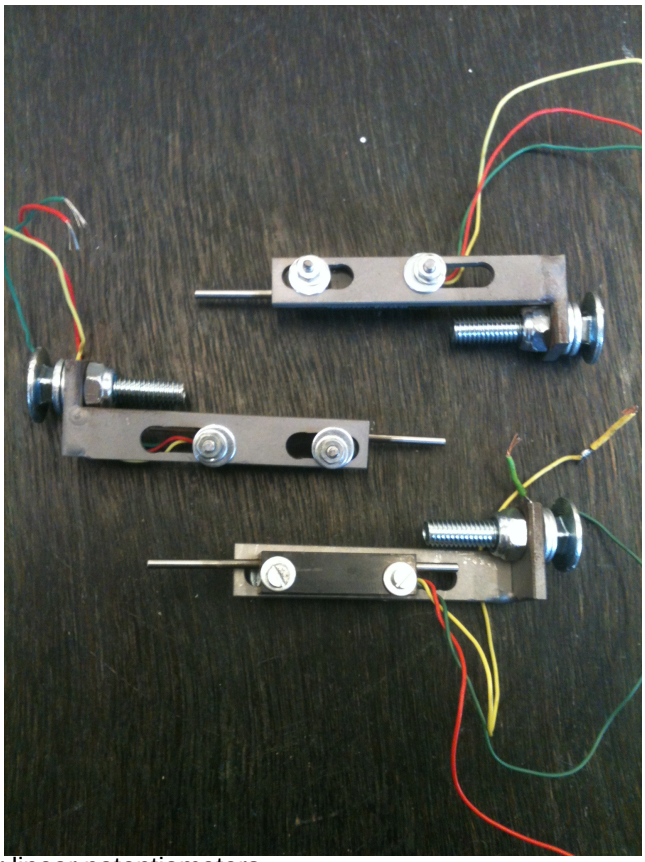

Figure 6 – Three of the four linear potentiometers.

After obtaining wood and the springs, which turned out to be really tricky, the building phase could finally start. All went well and pretty soon I got to the point of installing the sensors. This is where I ran into a difficult design problem. The sensors have a limited range and could be damaged if they were forced beyond that range. The springs however could potentially be pressed down about half a centimeter further than the range. I decided to built in a limit for the springs, ensuring the safety of the sensors. As I finished this version however, I noticed that the amount of pressure needed to get to the built in limit was reached almost effortlessly. Other than that though, this new controller felt like a big step forward. I decided to perform a few concerts with it while redesigning the way the sensors were implemented.

*Third Iteration*

After about two weeks of redesigning I came to a simple yet elegant solution to the sensor problem. By installing the sensors diagonally instead of the straight up way they were in now, the limitations on the springs could be removed. Some pythagorean math combined rubber suckers resolved all of the issues. Already in the first test run I noticed that my playing was much more free and dynamic.

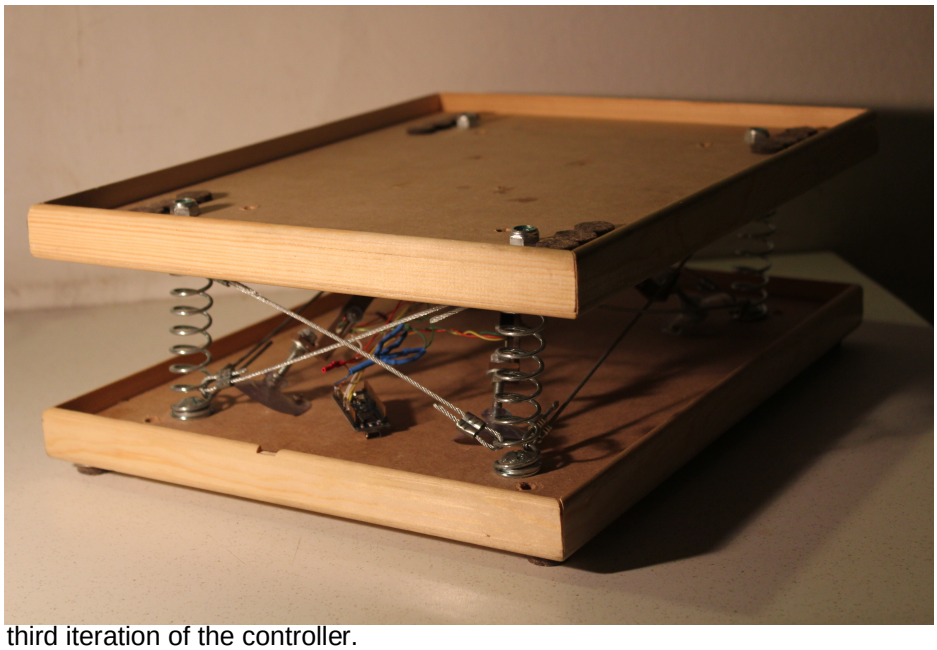

Figure 7 – The third iteration of the controller.

## *4.3 Development of the software*

Compared to many other projects in which I have coded systems for performance or sound art installations, the software side of this project has been kept really simple. I have coded all of the software in the open source languages Arduino and SuperCollider. As described in chapter 1, the software component was designed to perform three tasks. Slightly altering the incoming sound signals from the mixer and sending it back again. Mapping the sensor data to parameters of these sound manipulations. And finally preparing the signals before they are send out to the amplifiers.

### *Arduino*

Arduino is a flexible prototyping board with several analog and digital Inputs and Outputs connected to a micro controller which you can program using the Arduino programming language. The sensor setup I have used for this project is really basic and using the ArduinoSMS (Simple Message System) protocol it proved to be easy to send the extracted data from the sensors to SuperCollider where the it would be mapped to different sound parameters.

### *Code*

```
//Reads analog data and sends it through via Simple Message System
#include <SimpleMessageSystem.h>
const int amountOfSensors = 4; //number of sensors
// interval between sending out readings,too low of a value may cause data loss
const int delayBetweenReadings = 5;
void setup(){
Serial.begin(115200); //baud rate
}
void loop(){
for(int i = 0; i < amountOfSensors; i++){
int val = analogRead(i);
int c = char(97 + i);
sms(c, val);
delay(delayBetweenReadings);
}
}
void sms(char c, int val){
messageSendChar(c);
messageSendInt(val);
messageEnd();
}
```

### *Multi Mapping*

As the data is being send to and received by SuperCollider it was time to start thinking about mapping. It was decided early on that the mapping of the data should reflect the dynamic and chaotic behaviors of the sounds. The best way to achieve this goal was by combining several concepts on mapping and controlling.

One of these concepts came as a result of the way the sensors were attached. Each of the four sensors were connected to the same wooden plateaus. This automatically meant that it is almost impossible to change the measurement of one of the sensors without also affecting all the other ones. Without having to write a single line of code, the sensors were already connected to each other in a dynamic way. The intricate behavior of the springs themselves were an added bonus to this. If you would push down one of the corners of the controller and suddenly let it go, the springs would take a while to settle back into its normal position, all the while providing interesting data.

The sound signals that resulted from the audio manipulations that the controller was connected to, were send back to the mixer, forming additional layers of feedback. These layers would then in turn affect all of the other feedback loops running through the mixer. In practical terms, this meant that every slight change in the signal going into the mixer could have a lot of influence on the overall sound. The feedback loops amplify the change,

comparable to a dynamic system trying to find a new balance after it has been disturbed.

Each audio manipulation would have several parameters who's values could be altered by the controller. By mapping the sensor data of each potentiometer to several of these parameters (one to many), the interaction of the controller becomes much more complex compared to simple one to one mapping strategies. For each parameter that was related to frequency, I have chosen to crossfade between a limited set of predefined frequencies instead of mapping the values directly, resulting in a much more musical outcome.

There is a clear downside to implementing these kinds of complexities within an instrument. It becomes increasingly hard to predict what the behavior of the sound will be during a performance. This forces me as a performer to stay sharp and keep on listening throughout the entire piece. The continuous concentration feels akin to playing an improvisation with another player. As if the instrument itself has a mind of its own. On a positive note though, this also means that every performance is a unique opportunity to further explore the sonic width and depth of the instrument itself.

*SuperCollider*

The core of the software has been coded in the audio programming language SuperCollider. During my studies at the HKU, this tool has grown to become one of the cornerstones of my skill set. Initially I had assumed a much bigger role for the software, but as I was discovering the sonic possibilities of the no-input mixer I eventually decided to keep the software aspect of the project to a minimum. As described earlier in this chapter, the program takes as input four channels of audio and four streams of sensor data. Each of the audio channels are manipulated and send back to the mixer. The sensor data is mapped to parameters of these manipulations. The four audio channels are also filtered, converted to mono send out to the main outputs of the sound card.

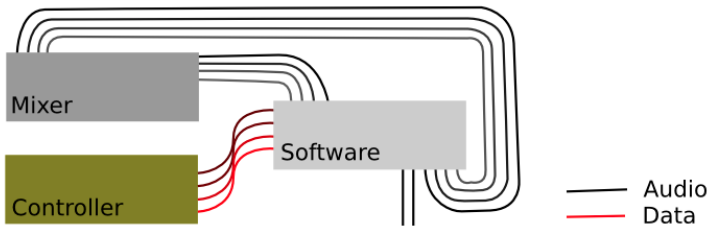


Figure 8 – Overview of the in- and outputs of the instrument.

## Code

```
//setting up
Server.default.options.memSize = 512000;
Server.default.options.numOutputBusChannels = 10;

//boot
s.waitForBoot{{

//global variables
~outBusses = [2,3,4,5];
~numBands = 8;
~warps = ~numBands.collect({|i| SegWarp(~numBands.collect({|j| if(i==j,{0.5},{0})}););});
~aMax = 0;
~aMin = 2000;
~bMax = 0;
~bMin = 2000;
~cMax = 0;
~cMin = 2000;
~dMax = 0;
~dMin = 2000;

/*
SYNTHDEFS
*/

SynthDef(\inmod0, {|inBus=2, outBackBus=0, outBus=0, amp=1, dt, fb|
var in, out;
in = Limiter.ar(LeakDC.ar(SoundIn.ar(inBus).tanh));
out = in + CombL.ar(in, 1, dt, fb);
out = SoftKneeCompressor.ar(out, out);

Out.ar(outBackBus, out*amp.lag(0.01));
Out.ar(outBus, in);
}).add;

/////

SynthDef(\inmod1, {|inBus=2, outBackBus=0, outBus=0, am1, am2, am3, am4, am5, am6, am7, am8, ra, dt, fb, amp=1|
var in, out;
in = Limiter.ar(LeakDC.ar(SoundIn.ar(inBus).tanh));
out = Ringz.ar(in, [10, 15, 20, 30, 40, 60, 80, 120]*ra.lag(0.1), fb, mul: [am1, am2, am3, am4, am5, am6, am7,
am8].lag(0.1)).tanh.sum;
out = SoftKneeCompressor.ar(out, out);

Out.ar(outBackBus, out*amp.lag(0.01));
Out.ar(outBus, in);
}).add;

/////

SynthDef(\inmod2, {|inBus=2, outBackBus=0, outBus=0, am1, am2, am3, am4, am5, am6, am7, am8, ra, dt, amp=1|
var in, out;
in = Limiter.ar(LeakDC.ar(SoundIn.ar(inBus).tanh));
out = in * LFSaw.ar([5, 7.5, 10, 15, 20, 30, 40, 60]*ra.lag(0.1), 0, mul: [am1, am2, am3, am4, am5, am6, am7, am8].lag(0.1), add:
[am1, am2, am3, am4, am5, am6, am7, am8].lag(0.1)).tanh.sum;
out = SoftKneeCompressor.ar(out, out);

Out.ar(outBackBus, out*amp.lag(0.01));
Out.ar(outBus, in);
}).add;

/////

SynthDef(\inmod3, {|inBus=2, outBackBus=0, outBus=0, am1, am2, am3, am4, am5, am6, am7, am8, ra, dt, amp=1|
var in, out;
in = Limiter.ar(LeakDC.ar(SoundIn.ar(inBus).tanh));
out = in * SinOsc.ar([5, 7.5, 10, 15, 20, 30, 40, 60]*ra.lag(0.1), 0, mul: [am1, am2, am3, am4, am5, am6, am7,
am8].lag(0.1)).tanh.sum;
out = SoftKneeCompressor.ar(out, out);

Out.ar(outBackBus, out*amp.lag(0.01));
Out.ar(outBus, in);
}).add;

/////

SynthDef(\out, {|      outBus=0, inBus=100|
var in, out;
in = InFeedback.ar(inBus, 4);
out = SoftKneeCompressor.ar(in, in, -10, 0.7, 9, 0.1);

Out.ar(outBus, LeakDC.ar(Splay.ar(out, 0.1)).tanh);
}).add;

s.sync;
```

```
/*
SYNTHS
*/

~out = Synth(\out);
~inmod = 4.collect({|i| Synth(\inmod ++ i, [   \inBus, i+2, \dt, (i*0.1)+0.1, \ra, (i*0.2)+0.2, \outBackBus, ~outBusses[i], \outBus,
i+100]);});

s.sync;

/*
ARDUINO
*/
// devise >> arduino IDE >> "tools >> serial port
p = ArduinoSMS("/dev/tty.usbserial-12FP0809", 115200);

p.action = { | ...args |

switch( args[0],
                        "a",{   if(args[1] > ~aMax, {~aMax = args[1]-1});
                                if(args[1] < ~aMin, {~aMin = args[1]});
                                ~inmod[0].set(\am1, ~warps[0].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am2, ~warps[1].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am3, ~warps[2].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am4, ~warps[3].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am5, ~warps[4].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am6, ~warps[5].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am7, ~warps[6].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\am8, ~warps[7].map(args[1].linlin(~aMin, ~aMax, 0, 1).clip(0,1)));
                                ~inmod[0].set(\amp, args[1].linlin(~aMin, ~aMax, 1, 0).clip(0,1));
                                ~inmod[0].set(\fb, args[1].linlin(~aMin, ~aMax, 2, 0).clip(0,2));
                                ~inmod[0].set(\rq, args[1].linlin(~aMin, ~aMax, 4, 0.0001).clip(0.0001,4));
                                ~inmod[3].set(\peak, args[1].linlin(~aMin, ~aMax, 120, 10).clip(10,120));},
                        "b",{   if(args[1] > ~bMax, {~bMax = args[1]-1});
                                if(args[1] < ~bMin, {~bMin = args[1]});
                                ~inmod[1].set(\am1, ~warps[0].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am2, ~warps[1].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am3, ~warps[2].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am4, ~warps[3].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am5, ~warps[4].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am6, ~warps[5].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am7, ~warps[6].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\am8, ~warps[7].map(args[1].linlin(~bMin, ~bMax, 0, 1).clip(0,1)));
                                ~inmod[1].set(\amp, args[1].linlin(~bMin, ~bMax, 1, 0).clip(0,1));
                                ~inmod[1].set(\fb, args[1].linlin(~bMin, ~bMax, 6, 0).clip(0,6));
                                ~inmod[1].set(\rq, args[1].linlin(~bMin, ~bMax, 4, 0.0001).clip(0.0001,4));
                                ~inmod[0].set(\peak, args[1].linlin(~bMin, ~bMax, 120, 10).clip(10,120));},
                        "c",{   if(args[1] > ~cMax, {~cMax = args[1]-1});
                                if(args[1] < ~cMin, {~cMin = args[1]});
                                ~inmod[2].set(\am1, ~warps[0].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am2, ~warps[1].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am3, ~warps[2].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am4, ~warps[3].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am5, ~warps[4].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am6, ~warps[5].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am7, ~warps[6].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\am8, ~warps[7].map(args[1].linlin(~cMin, ~cMax, 0, 1).clip(0,1)));
                                ~inmod[2].set(\amp, args[1].linlin(~cMin, ~cMax, 1, 0).clip(0,1));
                                ~inmod[2].set(\rq, args[1].linlin(~cMin, ~cMax, 4, 0.0001).clip(0.0001,4));
                                ~inmod[1].set(\peak, args[1].linlin(~cMin, ~cMax, 120,10).clip(10,120));},
                        "d",{   if(args[1] > ~dMax, {~dMax = args[1]-1});
                                if(args[1] < ~dMin, {~dMin = args[1]});
                                ~inmod[3].set(\am1, ~warps[0].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am2, ~warps[1].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am3, ~warps[2].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am4, ~warps[3].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am5, ~warps[4].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am6, ~warps[5].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am7, ~warps[6].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\am8, ~warps[7].map(args[1].linlin(~dMin, ~dMax, 0, 1).clip(0,1)));
                                ~inmod[3].set(\amp, args[1].linlin(~dMin, ~dMax, 1, 0).clip(0,1));
                                ~inmod[3].set(\rq, args[1].linlin(~dMin, ~dMax, 4, 0.0001).clip(0.0001,4));
                                ~inmod[2].set(\peak, args[1].linlin(~dMin, ~dMax, 120, 10).clip(10,120));}
                        );
};

s.sync;

~cleanup = {SerialPort.closeAll; };
CmdPeriod.add(~cleanup);

}.fork;
};
```

## *4.4 Development of the performance*

While designing, coding and building the instrument, the performative aspect of the project was always lurking in the back of my head. All throughout the test phases I came across beautifully rich sonic landscapes. I had to be careful though. It can be very tempting to get lost in these sounds. Ending up with a self centered ego trip neglecting the communicative aspects of performance in front of audiences. Luckily there were a number of helpful guiding aspects to the project.
Already from the start it was clear that the eventual performance would be part 'Custom Made Music', the concert series mentioned in chapter 1. The meetings we had with the group gave the project a lot of context, both musically and from a performative standpoint.

- The performance could not last much longer than roughly ten minutes.
- The performance had to become the musical climax within the evening.
- The performance had to fit among a wide variety experimental pieces.
- The performance should be mobile and easy to execute in different environments.

One of my personal goals from the start has been to explore possibilities for musical expression. Musical communication with the audience had to be a center point. The performance should not be impeded by unnecessary distractions such as graphical user interfaces of the software, which only distracts from the act of playing. Each element of the instrument had to be able to withstand the forces generated by an energetic performance.

*Solo*

When I started out with the project I had imagined the outcome to be a solo performance. This partly explains my interest in creating an instrument with a very wide set of sonic possibilities. Being able to take different roles while performing was a priority. The instrument could be used to create rhythms, melody, noise, textures and soundscapes. It would be even better to be able to combine several of these roles at once. Separating multiple feedback loops, each performing its own function within the piece, proved to be possible but very tricky and at times unstable. While practicing in a rehearsal studio there were definitely beautifully layered moments balancing expressive outbursts with a solid rhythmical undercurrent. These moments however were usually surrounded by extended episodes of abstract harsh noise, interesting from a textural perspective perhaps, but also very hard to digest from an audience perspective. I have had several conversations regarding this topic with Roald van Dillewijn and others from the 'CMM' group. Eventually my supervisor Jorrit Tamminga gave me the suggestion to try and find other musicians to play with. To see how the instrument would behave in these different contexts. In the course of the project I ended up performing with a wide variety of instrumentalists including flutists Kim Josephine Bode and Nina Bjelajac, pianists Pascal Meyer and Kiriakos Spirou, trumpeter Berit Janssen, drummer Bart van Gemert and also many electronic artists such as Roald van Dillewijn, Eric Magnée and Dianne Verdonk. Playing with all of these people in different contexts taught me a lot about the mixer and its possibilities and limitations.

*HKU Improvisation Platform*

Halfway through the project my attention was pointed towards an amazing initiative set up by the contemporary singer and lecturer Jannie Pranger. The HKU Improvisation Platform would become a weekly meeting of excellent musicians focusing on group improvisation in all its various forms. After the first session it was clear that this would be a perfect space to be able to experiment with setups while also working on virtuosity and musicality. Each week would I could work on different design challenges and try out new or improved features during these sessions. The platform proved itself to be highly inspirational for all musicians involved and eventually resulted in a performance at Zaal100 as you can read below in the 'Tryout concerts' section. During the sessions we would also talk about our ideas on improvisation, musical structure, listening and responding. The improvisations

and discussions were very helpful in determining the both the potential and the limitations of my instrument.

*Drums*

So after collaborating with diverse groups of instrumentalists I ended up deciding to abandon the idea of a solo performance, instead aiming to play a duet with drummer Bart van Gemert. The reasons for this decision are plentiful. The timbres coming of the drum kit create a sharp contrast to the timbres of the electronics, which gives each instrument a lot of room even when both are playing at the same time. This also gives each instrument the option of taking on a distinct role during improvisations, either by taking the lead and moving the improvisation into new territory, or by following or mimicking the other player. Both instruments are extremely dynamic in nature, allowing for subtle, quiet interplay to take place as well as harsh, energetic sonic outbursts. Another important aspect that both instrument have alike is their focus on timbre as opposed to tonality. Although it is possible to produce pitched sounds from the mixer, and it is even possible to tune these pitches to some extend, it is clearly not the designed as a pitched instrument. Timbre, texture and dynamics have been given priority over pitch. Playing together with drums eliminates many problems that most likely would occur when the music would be subject to tonal scales and such.

The most important reason to collaborate though is through the musical chemistry between Bart and myself. Already in the first rehearsals we would set up our gear and, without any talking or explaining, would play long improvisations that kept on evolving and allowed for many spontaneous musical discoveries to arise. During these rehearsals we came across playing techniques that we could later use as building blocks during performances. The only agreements made prior to the performances were related to the length of the performance, how the performance would start and end and when climaxes would take place. All of the music in between would rely solely on improvisation. Listening to each other and responding. Taking the lead or following. We both naturally play very physically, making it easier to respond to cues while also adding an theatrical quality to the performance.

## *4.5 STEIM Artist in Residence*

In January, the first month of the individual graduation project, I started out spending three weeks in a studio at STEIM as an artist in residence. I had applied for the residency several months earlier, after deciding to focus my graduation project on live electronics. A week before the start of the residency, I had purchased the second hand Behringer Eurorack MX 1604A mixer that would eventually become the core of my live electronics setup. The first aim as an artist in residence was to investigate the possibilities of sounds from the mixer by itself. Having twelve input channels, two auxiliary channels and four output channels, there were a lot of different ways to create feedback loops, each possessing a different character in sound. Each day I would re-patch the mixer several times while exploring the sounds. After a few days I decided to write a SuperCollider program that would be able to record the output. Looking at the recorded waveforms, I opted to remove DC offset and limit the signal to avoid damaging any of the STEIM equipment.

As the days progressed I expanded the experimentation by adding effects between the feedback loops opening up a whole new realm of sound. I made an appointment with Yaniv Schonfeld and he came over along with his gear for some extended jam sessions providing me with new ideas, approaches and inspiration. Near the end of the second week I decided to investigate manipulating the sounds in software and sending the outcome back to the mixer. In the meantime I had recorded over an hour of sketches, sound experiments and the like. It was time to listen back to these recordings to see what direction seemed most promising.

In the final week I thought out designed the first prototype of the controller which took me about one and a half days to build. Being able to control the software sound manipulations was an important step, moving from the studio sound experiments I had focussed on the first two weeks towards designing an instrument usable in a live context.

At the end of the residency I took some time to reflect on the progress that was made. Listening back to the recordings gave me the confidence necessary to proceed in the direction that I had explored. While reflecting on the work done so far it was also time to make some choices. Already a mere few days after the residency I had planned my very first tryout performance.

## *4.6 Tryout concerts*

*HKU Proeflokaal at Muziekhuis Utrecht*

*Short description of the event*

The HKU Proeflokaal is a miniature festival organized by Gaudeamus Muziekweek in collaboration with the HKU to display various student projects. These projects vary between short theater plays, jazz outfits, singer songwriter performances and the occasional sonic experiment. The festival was held at all available spaces at the Muziekhuis Utrecht venue where Gaudamus Muziekweek is based.

*What setup did I use?*

Behringer Eurorack MX 1604A
Self built, Arduino based, four point pressure controller
SuperCollider

*What were my intentions?*

This performance was scheduled almost straight after my residency at STEIM ended. So for me it was a perfect opportunity to display the most successful outcomes of my sonic experiments. Although it was my first time onstage with an extended no-input mixer, I made sure that my laptop screen was down so I could completely focus on putting on a performance. My aims were to showcase a rich variety of textures and sounds. Trying to find an improvised musical form and to connect performative gestures to the sonic manipulations.

*Personal reflection*

I felt a strange combination of confidence and fear surrounding this performance. Confidence fueled by the endless days I spend at STEIM developing the material and the specific kind of fear attached to the feeling of taking the first steps into a new world that might not appreciate what I had in store for them. I had the good fortune of being the sound technician as well as the performer, which meant plenty of time to soundcheck. The performance went quite well although I noticed difficulties in containing the dynamics of the performance in both loudness and timbre. There were certain peaks in the sound that were very extreme in volume. Even though I could move away from these peaks very fast, it still alienated at least a part of the audience, disrupting the flow of the set. Still I managed to play a powerful and diverse set of about 10 minutes.

*Audience reflection*

Since this was a HKU event, there were a quite lot of colleagues and teachers in the crowd which was great for getting some feedback. The weeks spend at STEIM certainly payed off considering the remarks I got on the level virtuosity in the performance. But as expected I also got remarks on the dynamics. I noticed that the audience could clearly distinguish between the moments during the set where I was really playing with the sounds comparing to the moments in which I was in search of new material, even though both would essentially sound equally abstract.

*Influence on the project*

The performance revealed the performative limitations of the small controller and shifted my focus towards designing the second iteration of the controller.

*Network Music Festival at The Edge, Birmingham*

*Short description of the event*

Through Soundlings[14], an international sound collective that I am a part of, we responded to a call for works of this festival, devoted to networked sound and music. A few months before at the Discovery Festival[15] we had performed an improvisation via network allowing us to connect several different cities through music. The Network Music Festival in Birmingham seemed like the perfect opportunity to take this concept. As we got the conformation that we could join the festival it seemed like a great context in which to experiment with musical interplay among several musicians.

*What setup did I use?*

Behringer UB 802 Mixer
SuperCollider

*What were my intentions?*

Learning to play alongside other musicians. In this case I was especially curious to be playing alongside several acoustic instruments. The performing group consisted of:

Bart van Gemert – Drums & Percussion
Nina Bjelajac – Flute
Berit Janssen – Trumpet
Eric Magnée – Electronics
Tijs Ham – No Input mixing

*Personal reflection*

This project taught me a lot about playing together with others, about the troubles surrounding traveling with gear on flights. It was really hard to put together a rehearsal schedule in which each musician could be present at the same time. We ended up deciding that we would plan a lot of rehearsals and each time a different set of players would be able to play together. This meant that during each of the rehearsals I could focus on the interplay between the different instruments. During one of the sessions I ended up playing a duet with Bart van Gemert, forming the basis of our future collaboration.

*Audience reflection*

Reactions were very positive. Especially at the beginning of the improvisation I had some really strong interplay with the flute. There were a number of people asking me if that part of the piece was composed or improvised. Other than that there were a lot of discussions about the method we used to improvise over network. I will not go into this as it will only distract from the main objective of the thesis.

*Influence on the project*

The experience of traveling with a live electronics setup by plane got me thinking about the necessity of building an instrument that could sustain the wear and tear of transport and performances.

14 Soundlings is an international sound collective founded by Pinar Temiz in 2012. Its mission is to unite young sound professionals in a global network and to stimulate a sonic perspective in a visually oriented cultural landscape.

15 The Discovery Festival is an annual celebration of arts, music and science. The first editions were held in Amsterdam, but the festival has expanded to multiple locations in the Netherlands.

*The Wrong Wave at Goleb and VillaK*

*Short description of the event*

The Wrong Wave is a concert series based around the concept of drone music. The idea came from Yaniv Schonfeld who asked me if I was interested in helping him to organize it and also play along. The event would start at 16:00 and last until midnight, resulting in eight hours of continuous improvised music. Other musicians could show up, plug in and join, while others could fade out, take a rest and rejoin later on.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (first version)
Behringer UB 802 Mixer
SuperCollider
Electric Calimba

*What were my intentions?*

The focus for this performance was subtlety. Taking time to extremely slowly zone in on the tipping points of the mixer while at the same time never allowing it to fully explode into chaos. Exploring the edges between predictability and unpredictability.

*Personal reflection*

Being active as both an organizer and a performer proved to be difficult in the first edition at Goleb. Especially in keeping up the concentration while playing. Fortunately there was a lot of time to play resulting in a number of great moments, exploring the boundaries of sonic tipping points. Later in the evening a group of people came in, including the drummer and percussionist N.U. Unruh of Einstürzende Neubauten[16] who eventually joined the improvisation on percussion, which was a unexpected but great experience.

During the second edition a large part of organizing was taken over by the people at VillaK, allowing for me to focus on playing. This second edition was scattered over multiple rooms in the villa which resulted in me playing solo for extended periods of time. After building up the drone layers for several hours I noticed a level of control over the instrument that I had not experienced before.

*Audience reflection*

Unfortunately I was only able to talk to a small selection of the attendees that were still around near the end of the evening. Reactions were positive, especially regarding the intensely rhythmical sections.

*Influence on the project*

Performing for such extended periods of time confirmed my assumptions that the idiom of the instrument contained enough versatility in sound. It shifted my focus away from further development and towards learning how to play the instrument.

16 Einstürzende Neubauten is a legendary industrial music group from the early eighties hailing from Germany. They are know for their unconventional use of all kinds of materials as percussion.

*Chambernoise at De Groene Gemeenschap, Amsterdam*

*Short description of the event*

De Groene Gemeenschap is a living community in IJburg that organizes various workshops and other events including a monthly giveaway afternoon usually combined with other activities. The Chambernoise event is an example of such an extra activity, organized by Marije Baalman, member of the community. The most interesting aspect of combining a giveaway afternoon with a noise concert is the possibility to play unconventional music to an audience that would otherwise not come in contact with these kinds of sounds.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (first version)
Behringer UB 802 Mixer
SuperCollider

*What were my intentions?*

Performing a solo noise set using the spring based controller.

*Personal reflection*

Having played now for a longer period of time with different iterations of the instrument, I noticed that I could perform with a lot more confidence. The venue was quite small and informal which resulted in a performance that could best be characterized as being both noisy and humorous.

*Audience reflection*

Somewhat to my surprise, most of the crowd, clearly not used to listening to any form of noise, continued to watch the performance. Yaniv Schonfeld, who was also performing at the same event, mentioned that he was excited to see the performative possibilities of the spring based controller.

*Oorsprong at Tolhuis, Amsterdam North*

*Short description of the event*

Oorsprong is a monthly concert organized by Raoul van der Weide focussing on improvisation. The core principle of the evening is to bring together improvisers that have never played together before. For each edition 3 curators are appointed who in turn ask improvisers from their network to play a unique set. I was asked to perform alongside flutist Kim Josephine Bode and pianist Pascal Meyer.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

To focus on listening and matching my sounds to the other players.

*Personal reflection*

The improvisation turned out to be very musical. The flute is quite limited in its dynamic range compared to piano and my own instrument, but each of us held back sufficiently to allow for interplay.

*Audience reflection*

I heard two opposing opinions on my role in the improvisation, one being very positive about my modest and withdrawn approach, while others were waiting for, or expecting a more explosive performance.

*Influence on the project*

Due to a lack of guitar or bass guitar amplifiers I was asked to plug into a PA setup. I did a soundcheck but decided to take the PA speakers off the stands and positioned them right next to the instrument. The performance reminded me of the importance of local amplification in the context of an otherwise mostly acoustic improvisation.

*HKU Improvisation Platform at Zaal100, Amsterdam*

*Short description of the event*

Organized by Jannie Pranger as the conclusion of the HKU Improvisation Platform. For several months a group of six or seven graduate students of the HKU with an interest in improvisation came together to play sessions. During these sessions there was a lot of experimentation in structuring the improvisations leading to several rule based systems. These systems formed the basic structure of the concert

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

During this period I had decided to stop developing the software and hardware of my instrument but instead focus on building up virtuosity, exploring as many sounds that the fixed system could possibly produce. My intentions were to expose this wide sonic range while still connecting to the sounds of the other players.

*Personal reflection*

The concert was divided in three separate parts, connected to three different rules of playing. I noticed that my playing got increasingly better throughout the evening. During the first set it took me too long to find interesting sounds and wasn't able to find the patience needed to hold on to these sounds long enough. During the second set my laying got more focussed and I was able to play much more comfortably. In the last set I chose to be more expressive which led to some impressive musical climaxes.

*Audience reflection*

Each part of the concert was accompanied with its own stage setup. In the short breaks between sets all of us moved our instruments into different locations and moved the seats of the audience to different locations. These relatively simple adjustments to the space worked really well and gave the audience the sense that could experience the performative space from a new perspective each time. There were also remarks on how well the electronics blended in with the acoustic instruments forming a really good balance.

*Influence on the project*

The concert, as well as the weekly improvisation sessions made me realize that rhythm becomes a key musical element when you cannot be sure what an instrument will do as far as pitch and timbre are concerned.

*Custom Made Music at Zaal100, Amsterdam*

*Short description of the event*

The first tryout concert featuring the graduation projects of the 'Custom Made Music' collective. In this full evening program seven performances, some divided in multiple parts were presented in a fluid program. The performances were scattered around the space forcing the audience to shift their focus between acts.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

After several weeks of rehearsing in studio environments, this would be the very first performance as a duet between electronics and drums.

*Personal reflection*

Mixed feelings. There were some brilliant moments that exceeded my expectations, but in the very last couple of seconds of my performance my sound card lost connection to the laptop resulting in silence where I wanted to built up to a grand finale. Fortunately Bart noticed and managed to wrap up the performance in such a way that most of the audience didn't notice the technical failure. I did notice that the drum kit was a bit too far removed from my setup, resulting in a loss of visual communication during the set.

*Audience reflection*

In the feedback I got from Hans Leeuw (lecturer at the HKU) he mentioned that I should try not to move from one segment to the next as fast as I did but rather to stay in certain moments. Another remark he gave was focussed on the dynamics within the performance which in his opinion were leaning too much towards the louder segments.
Roland Spekle, organizer of 'The Night of the Unexpected'[17] and guest lecturer for the 'Custom Made Music' group, was highly enthusiastic, praising our professionalism and our ability to organize a technically challenging evening with so little means.

*Influence on the project*

This performance can be seen as the most important milestone of the project. Its influence was mostly apparent in that light. It served as a clear deadline for the project.

17 'The Night of the Unexpected' is a concert series that combined an unconventional, broad style of programming with an equally unorthodox method of presentation. Each performing artist plays a short set located either on a stage or any other space in the venue that has been converted into an alternative performance spot.

*Custom Made Music, Elevator Sessions at Tuindorp West Complex, Utrecht*

*Short description of the event*

The Elevator Sessions is a student festival organized in three student flats. The performance locations, besides the elevators, consist of kitchens, living rooms and hallways in the flat. The contributing artists are mostly students playing anything from singer songwriter, jazz, rock to more experimental performances.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

This concert was really about exploring the edges of the 'Custom Made Music' concept. Performing inside of a tiny kitchen, using any equipment we could find to amplify ourselves.

*Personal reflection*

We ended up playing two sets back to back and considering the conditions it went really well. I was most content with the first set I played which was probably the most musical solo performance I had played up until that point

*Audience reflection*

Jan Nieuwenhuis who had invited us to play was impressed by our sets. Enough so to book us to play again at an event in Roodkapje, Rotterdam.

*Custom Made Music, CultFest at Oudegracht 266, Utrecht*

*Short description of the event*

CultFest is a three day multidisciplinary underground festival organized on multiple cellar locations along the Oudegracht in Utrecht. This years theme was 'madness' and the 'Custom Made Music' group was asked to provide the program for one of the locations. On the saturday evening we programmed our own concert, which was sold out.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

Taking the feedback of the first 'Custom Made Music' concert and applying it to this performance.

*Personal reflection*

The heat, the large number of audience in the small space the dust and the cables everywhere turned this concert into a very intense experience. Probably the best execution of our concept, and great individual performances. The improvisation together with Bart went really well. There was a clear story to the performance resulting in a noisy climax.

*Audience reflection*

Very positive. There were again several lecturers from the HKU among the audience including my supervisor Jorrit Tamminga, expressing his enthusiasm towards the whole evening.

Figure 9 – Performing at CultFest.

*Custom Made Music, Gaudeamus Sessions at Muziekhuis Utrecht*

*Short description of the event*

In december 2012 the last edition of 'Proeflokaal' was organized by Gaudeamus Muziekweek, ending a long series of tryout concerts. Soon afterwards it was announced that a new series would start under the name 'Gaudeamus Sessions' which would partly replace what 'Proeflokaal' used to be. 'Custom Made Music' was asked to perform at the second edition of this new series of concerts.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

The first two 'Custom Made Music' concerts had been performed in small and under equipped venues. This was the first time to test the setup in an acoustically treated space with proper equipment.

*Personal reflection*

Although the sound was really good I did not think that this was the best performance thus far. During the previous Custom Made Music concerts we had complete control over the entire evening. For this concert however, the stage was shared among two other acts, limiting our options of redesigning the concert experience. Although the sound was really good and the flow of the evening went smooth, it lacked a certain edge that made the previous concerts more appealing.

*Festival de Beschaving at Botanische Tuinen, Utrecht*

*Short description of the event*

Festival de Beschaving is a huge outdoor festival aiming to combine big festival rock concerts with a varied playful side programming that hints at the arts and sciences. I was asked to present and perform at the MusicLAB, in which short talks connected the themes of music and science followed by a performance and jamsession.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

I was really excited to be able to talk about my ideas surrounding chaos and music, combined with performing together with the visitors.

*Personal reflection*

The entire day had a sunny and layback atmosphere fitting for an outdoors festival. The organization was quite open which gave me the opportunity to play multiple sets, displaying the full width and depth of the instrument to a curious audience.

*Audience reflection*

Among this audience, one kid showed real interest into the instrument and asked if he could play it himself. He played for nearly ten minutes enjoying every second of it. It also taught me new ways of approaching the instrument, resulting in new playing techniques.

*Custom Made Music, _V2 Testlab, Graduate Edition at New Institute, Rotterdam*

*Short description of the event*

_V2 Testlab, Graduate edition is a platform giving recent graduate the possibility to present and show their work to an audience of art professionals.

*What setup did I use?*

Behringer Eurorack MX 1604A
Spring based controller (second version)
SuperCollider

*What were my intentions?*

This was the last performance with the instrument that was planned. The only intention was to showcase the possibilities for musical expression.

*Personal reflection*

This was a really tough performance to execute. The location was in a giant hallway with troublesome acoustics, no real options in lighting or other methods of creating a performative atmosphere. The concert was also programmed as a side attraction instead of an actual performance which made it considerably more difficult to engage the audience.

# Chapter 5 : The Reflection

*Reflecting upon the process (Chapter 3 & 4)*

*Reflecting upon the method*

Most of the methods that were used to get this project on track were already embedded in my usual way of working prior to the project. In my design process I always regard each step as being a sketch that may or may not take me one step closer to a finished result. Eventually one of these iterations of sketches turns out to be the final conclusion of that process and consequently gets the promotion from sketch to final product.

At the start of this project I was somewhat hesitant to apply this process to such an important graduation project. Soon enough though, the realization followed that the trial and error method has a lot of advantages. I was very pleased with the pace at which the project could be developed. Only one month in the project I was already onstage in front of an audience performing on an instrument that, despite being hard to control and far from sounding perfect, could be heard and discussed.

The relatively high frequency of tryout concerts turned out to be both a blessing and a curse. They require a lot of planning, communication, traveling, production, rehearsing and promotion next to the already demanding jobs of designing and building an instrument. At times the workload turned out to be on the verge of becoming unmanageable. Solid and precise planning was crucial in order to stay on top of everything. On a positive note though, playing all these concerts helped me a lot in building up my network among likeminded people working in sound art and improvised music.

Although I was already a regular at STEIM due to my internship and involvement in their creative coding evenings, working there as an artist in residence was a really positive experience on a number of levels. Taking this step helped me a lot in building up a greater confidence as an artist. Working in a different city, being surrounded by different people, turned out to be very inspiring.

Conducting the interviews went very well. It felt much more like having a friendly conversation with future colleagues instead of consulting specialists operating in a field far beyond my grasp.

*Reflecting upon the execution*

Looking back at the entire process of designing and building the instrument, the act of playing, testing and fine tuning the sounds turned out to be the most time consuming activity. Yet, I have enjoyed every second of it. For someone as timbre minded as I am, the no-input mixer can almost become a sonic addiction, but it was also necessary to put in all these hours. Working with so many variables that shape the sonic possibilities can be a daunting thing to fine tune. Each adjustment needed to be thoroughly tested and examined in order to understand its behavior when it passes its tipping points. There have been many occasions when certain settings produces really wonderful sounds but ended up being too unpredictable to be useful in a live situation.

Working within the context of 'Custom Made Music' has been a positive experience. Having this clear goal to work towards made it easier to take decisions during the design process. Also having a group of colleagues around to ask advise or bounce of ideas has been very beneficial for the progress of the project. Being involved in such a meta project did however increase my workload substantially. I was heavily involved in the organizational part, and next to that also collaborated with Dianne Verdonk, providing an extra layer of noise for her project 'La Diantenne'.

The most important lesson that I'm still trying to learn is managing the workload. The only way I could finish all the work for this project was by putting in many many hours, working from early in the morning until late at night. I have tried to analyze wether I could streamline my process in some way in order to work more effectively, but in the end I came to the conclusion that I need to learn how to decline additional work. In my enthusiasm it is not uncommon for me to take on new projects even though my time can be limited.

The collaboration with Bart van Gemert went really smoothly. Bart is very laid back socially, but at the same time very punctual when it comes down to planning. Even though the both of us had very full schedules we always managed to find moments to rehearse. These rehearsals themselves were always intensely focussed sessions. Having played together before on several occasions was also beneficial regarding the communication on the musical directions.

Considering the amount of time available to develop this project, I planned to take the first few months to design, develop and build the instrument. After that period the plan was to put all further development on hold and only focus on learning to play and perform with the instrument. In most projects there is simply not enough time to both develop an instrument and mastering it, resulting in performances that boil with potential even though it is only partly audible in the final outcome. Due to the very productive first month of the project I managed to execute this idea to a great extend. I ended up spending about two or three weeks longer on the development of the instrument than planned. This was mostly due to some of the design issues regarding the controller that required more time to fix than initially anticipated.

*Future developments*

To really take this instrument to a new level I would like to embed all of the elements into one devise. The software portion of this project is reasonably small and cpu efficient and it would be possible to run the entire program on a 'Beagleboard', 'Raspberry Pi'[18] or a similarly tiny computer. Secondly, I would transfer the circuit board of the mixer into a new casing while also hardwiring all of the connections inside of the casing. This would completely eliminate the use of jack cables to create the feedback loops, resulting in a much cleaner and more refined look. It would be great if the spring controller could be easily attached underneath the new casing.

For the concerts I have played so far I had to rely on available equipment of the venue for the actual amplification of the instrument and I also needed a small table. It would be a big improvement if I could build a stand for the instrument, preferably with built in amplification, so I would be able to keep things under control.

I would also like to continue working on the performance itself. During rehearsals Bart and I played extended improvisations lasting much longer than ten minutes. It would be great to expand the performance to a 20 to 30 minute piece, in which we could take much more time to introduce and develop themes. Investing more time into virtuosity and interplay can only benefit the performance even further. It feels like I am only scratching the surface of the instrument as though I have just completed a beginners course. Each rehearsal I am once again amazed at the dynamic way in which the instrument responds to my actions.

18 Both the Beagleboard and Raspberry Pi are very small, stripped down Linux computers. Although their capabilities are somewhat limited, it is possible to run simple SuperCollider patches, connect them to sound cards and Arduino boards. Both devises are often embedded in instruments or art installations

# Chapter 6 : The Conclusion

## *Reflecting upon the goal (Chapter 1)*

*Accomplishments*

I have investigated the use of chaotic processes in live electronics through practical experimentation.

I have interviewed experts in the fields of sound art and live electronics to investigate the use of chaotic processes in their work.

I have designed, build and performed with an expressive musical instrument based on the chaotic process of no-input mixing.

The artifact, a ten minute performance within the context of the 'Custom Made Music' concert series has been executed multiple times on different locations.

I have greatly expanded my knowledge of no-input mixing during the course of the project.

I have met up and collaborated with many musicians, sound artists, venues and concert organizers which has expanded my network in the field of live electronics and sound art.

I have realized the importance of realistic planning which includes prioritizing and sometimes declining assignments when necessary.

*Conclusion*

Regarding the main goal, to investigate the usage of chaotic processes in order to increase musical expression within the context of a live electronics performance, I can safely conclude that the project has been successful in achieving its aims.

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