Tampereen ammattikorkeakoulu

Electronic Music Production Methods

Musical Electronic Hardware Instruments in Album Production Process

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Bachelor's thesis
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Media and Arts
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ABSTRACT

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The thesis was done to explore the possibilities of musical electronic hardware instruments in album making process. The development of electronic sound shaping techniques and voltage controlled synthesizers revolutionized the way of making music and sound. It has greatly affected the soundscape and working methods of the modern music. Author's goal was to research the efficiency of the working methods and instruments during process and observe how the different devices, composing and sound design methods affected the end product and creativity. The conclusion is based on understanding the instruments their possibilities used in a project, through observations, experiences and the end result.

The album making process revealed strengths and weaknesses of the instruments and their effect on the end result and creativity. Author explored working methods of the electronic music making and sound design with hardware instruments. The instruments and working methods they enabled, turned out to be really inspiring and helped the author to create unique sound design and compositions on the album. The possibilities of content creation and randomization with hardware instruments offered an alternative way of making music. The interaction with the different musical devices and interfaces affected the end result and decisions made during the project.

The electronic musical hardware instruments offer a different way of making music and sound design. They can affect the creativity and working methods drastically and even shape the users´ identity as an artist. The development of computing has enabled the instruments and working methods to evolve and huge amount of functions can be packed in small space. The evolution of the instruments has continued since the first devices were introduced and the innovations around them have a lot to offer for the future of music making and sound design.

Keywords: music production, sound design, synthesizers, electronic music

CONTENTS

ABBREVIATIONS AND TERMS (choose one or other)

Audio Interface	Audio Interface is a device that expands the audio capabilities of a computer. Through audio interface it is possible to connect many audio devices like synthesizers and microphones on your computer for recording and completing other audio production related tasks. (S. Mallery 2012.)
CV	Control Voltage
Delay	Delay is an audio effect that is based on recording the input signal and repeating the audio, creating a phenomenon that is known as echo. (SoundBridge 2017)
LFO	Low Frequency Oscillator
MIDI	Musical Instruments Digital Interface
Reverb	Audio effect that recreates natural reflections, creating a sense of space. (Joe 2019)
VCA	Voltage Controlled Amplifier
VCF	Voltage Controlled Filter

1 INTRODUCTION

This thesis will go through the evolution of musical electronic hardware instruments and production process of an album “Research of Humanity “. The sound design and composing of the album will be done by using modern hardware instruments. The invention of electronic musical instruments has greatly affected the soundscape of modern music. The hardware instrument designers opened up a totally new way of making music and sound with electronic devices. Modern instruments are designed to support artists creative process. The thesis will observe and discuss the working methods that are used during the process and how the interaction with different interfaces and devices affected creativity and the end result.

In the beginning of the thesis, the history and basic functions of synthesizers will be discussed. To understand the working methods and the possibilities of the instruments used in the project, it is important to be familiar with the basic functions and principles of the base components that are used for electronic sound production. Important concepts and standards that have affected the modern instruments and the way of making music will be presented.

Author will introduce the instruments and their functions that were used in the production. Since there is a significant number of different instruments in the market, it is good to remember that the Author will be observing the project through the use and workflow of specific devices. The possibilities they offer will be explored and the functions and principles will be discussed. Thesis will observe the sound design, composing and recording process of the album focusing on the benefits and challenges the hardware instruments brought in to the project.

The author will go through the experiences he had during the process and determine the effects that the different working methods and instruments had on the project and the end product. The goal of the thesis is to observe the efficiency of the musical hardware instruments in album production. Author will consider these factors through the observations, discoveries and choices made during the process and by evaluating the end result.

2 The Evolution of Electronic Musical Hardware Instruments

In early sixties, two most influential synthesizer designers, Robert Moog and Don Buchla started to explore the possibilities of electronic sound shaping. Moog and Buchla both started to develop the first voltage-controlled synthesizers (Editors of Keyboard Magazine 1984. 7). They were individuals living in very different cultural environments, and that might be the reason for the differences in their approaches they had, when comparing their instruments. Moog designed instrument for traditional music composing, controlled by keyboard. Buchla and his fellow engineers focused on developing totally new instrument with new interfaces, like sequencer and touch sensitive pads, to control the sound with. They both developed instruments that revolutionized electronic music production and sound design and later on led into the many innovations in that field. (Pinch & Trocco 2002. 32, 39, 43; M. Prendergast 2000. 69.)

Synthesizer is an electronic instrument. It lets the user to shape the sound and introduce tonal changes in real time. Basic signal path includes three fundamental sections; sound generator, filter and amplifier (figure 1). Sound generator, usually an Oscillator, generates raw audio tone. In analog oscillators the tone is created by constant electrical signal. User can adjust the oscillators pitch and choose between different signal shapes (Waveforms) to have a different tones and harmonics on the audio signal. Oscillators output is usually connected to a filter. The Filter is used for manipulating harmonic content, by cutting or intensifying the chosen frequencies. The volume of the sound can be adjusted with Amplifier. (Editors of Keyboard Magazine 1984. 12.)

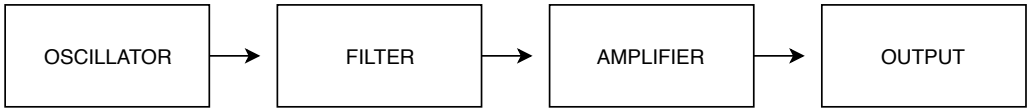


FIGURE 1. Basic synthesizer signal path (Kouvonen 2019).

Both, Moogs and Buchlas first systems were modular synthesizers. They were mostly sold for the schools and professional recording studios, because of their size, high price and the complexity. In modular synthesizer, sections are called

modules and they are separate units mounted in the rack (Editors of Keyboard Magazine 1984. 12). Modules communicate by using control voltage. In modular synthesizer audio and voltage routing is done with patch cables. This is called patching. Patching makes the workflow more complicated, but also opens up huge amount of new possibilities for sound design and composing. Modular synthesizer lets the user to create his very own signal path and decide all the details of it (J. Mishra 2009). Discovery of control voltage (CV) brought lots of control over the qualities of the sound itself. CV can be used for controlling functions of the modules such as pitch, volume, timbre and filter frequency. With the same method gate and clock pulses can be sent and used for triggering sounds and envelopes and synchronizing sequencers to the tempo. (Fundamental Concept: Control Voltage. Youtube 2019.) All the modules on Buchlas and Moogs systems became voltage controlled. Controlling the sound was not limited by how fast the knobs could be controlled by hand anymore (Pinch & Trocco 2002. 39).

Simple example of usage of control voltage is an envelope. The Envelope is a module or section that generates control voltage and operates usually in four stages: Attack, Decay, sustain, Release (figure 2). When a key from a keyboard is pressed, it sends gate signal for the envelope. Gate triggers the attack of the envelope. Attack defines how long it takes from the output voltage to reach the highest level. Decay defines how long it takes to decrease the voltage to the sustain level. Sustain defines how high the voltage is when key is kept pressed (gate signal is up). Release defines the time it takes that control voltage falls down to zero when key is released. (Editors of Keyboard Magazine 1984. 26.) By patching the envelope on the voltage controlled amplifiers volume CV input, voltage sent by envelope turns up the volume as the voltage increases. Volume goes down when key is released as the voltage decreases. The same press of the key that triggers the envelope with gate signal, will create another control voltage, which could be used for adjusting the pitch of aa voltage controlled oscillator. (figure 3.)

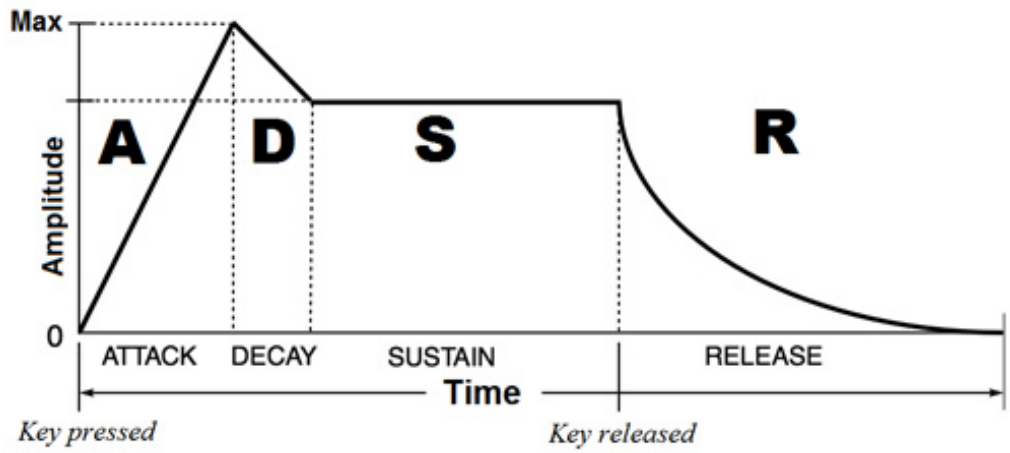


FIGURE 2. Four stages of an Envelope. (T. Newman, ADSR. n.d.)

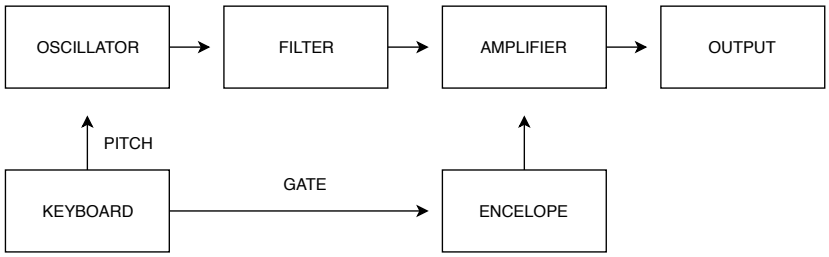


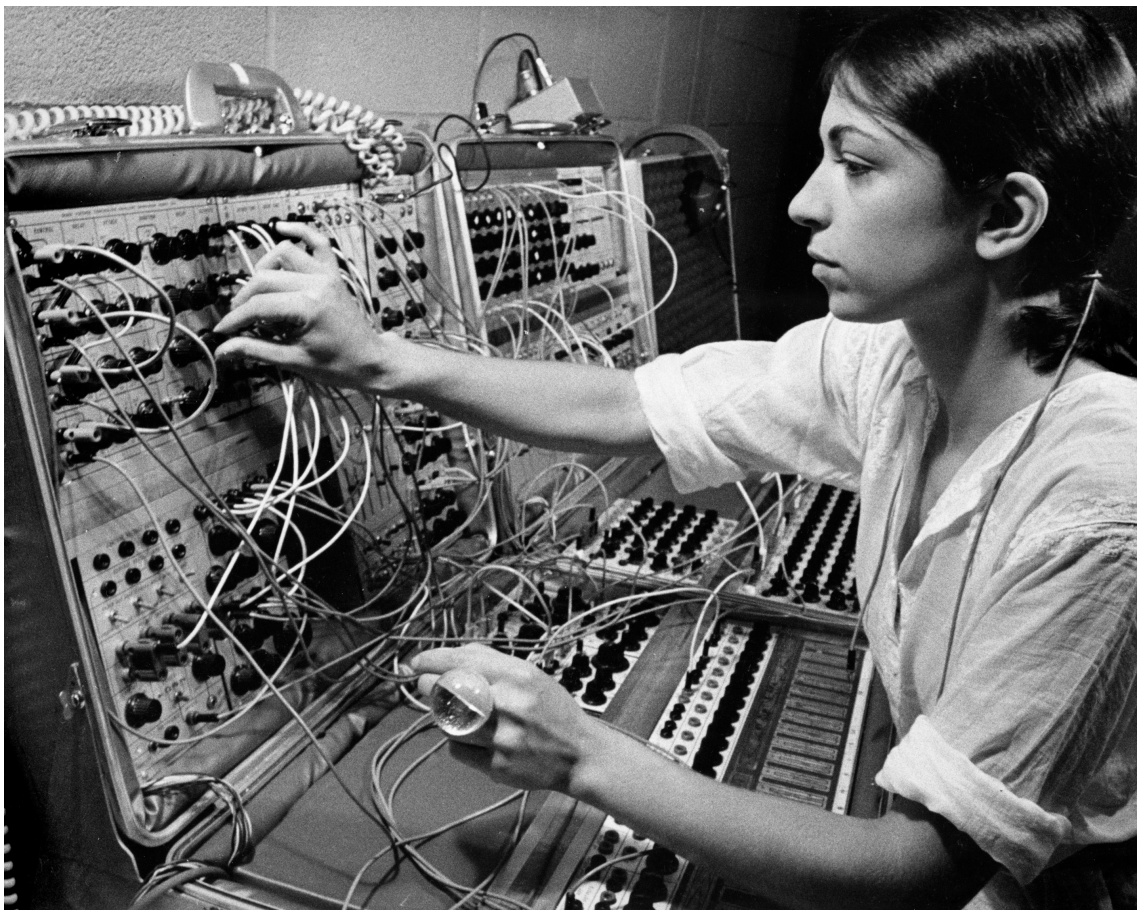
FIGURE 3. Basic synthesizer signal patch with voltage control (Kouvonen 2019).

The event, where the change in envelopes control voltage output affects the volume of an amplifier or pitch of an oscillator is called modulation. The source of control voltage is often called modulation source. (P. Schwartz 2016.) Both, Moogs and Buchlas systems offered the user a possibility to modulate the sound automatically by using control voltage sources. The modulation was explored in very early stage of synthesizers, and one of the first modulation sources was an Oscillator. Moog assembled together two voltage controlled oscillators to achieve movement on pitch. The first oscillator was patched to the other oscillators pitch CV input. The first oscillator operated in really low frequency, so that the output was out of the human hearing range and acted as a modulation source. This made the pitch of another oscillator go up and down following the voltage output of the first oscillator. (Pinch & Trocco 2002. 25.) Today this type of modulation source is called Low Frequency Oscillator (LFO) and it is essential part of the synthesizers. In addition, there are multiple other types of modulation sources for example random voltage generators. Instead of sending constant static signal

like oscillators, the random control voltage generator produces variating control voltage values.

Control voltage enabled a whole new way of playing music and Buchla took advantage of that. Instead of the keyboard, his system was played with alternative interfaces, like sequencer. The Sequencer is a device, that sends control signals for the synthesizer. The old sequencers could have only few steps, but the modern ones can have much more and the minimum number of steps is usually 8 or 16. Each step has controls for control voltage, usually used for adjusting the pitch of an oscillator and sending gate signal to trigger an envelope (Sweetwater, Step Sequencer. 2015). When sequencer is fed with a clock signal, it moves to the next step in tempo creating a cycling series of control voltages. That way user can program melodies and rhythmic patterns and sequencer will command synthesizer to play them (Sweetwater, Analog Sequencer. 2002). The invention of sequencer had a huge impact on modern way of making electronic music and it can be found almost from every modern music making computer software and from many hardware instruments.

This new exciting, versatile instrument was adapted by many pioneers of electronic sound in music and sound design industry. First real commercial success of synthesizer music was Wendy Carlos's album "Switched-On Bach", which was, like the title tells, Bachs compositions performed with Moog synthesizer. This album changed the publics opinion about the new form of art, called electronic music, which earlier was not even considered as music at all. After album was released number of big companies wanted to have a Moog synthesizer in their productions and they tried hard to replicate the album and benefit from Wendys success. (Pinch & Trocco 2002. 144, 147, 149, 150.) On field of sound design Suzenne Ciani is the artist to point out (picture 1). With her Buchla system, she worked on commercial sound design for big trademarks like Coca-Cola, Colombia Pictures and Pepsi to name few. (Pinch & Trocco 164–165.)



PICTURE 1. Suzanne Ciani and Buchla modular system (Tom Tom Magazine n.d.)

During late sixties and early seventies business changed, Moog started to manufacture Minimoog, which was a commercial success (picture 2). It was easy to use, lot smaller than heavy modular systems and cheaper. In this synthesizer signal path was hardwired and user did not have to patch anything. It was the first synthesizer that was sold in music stores in United States (Pinch & Trocco 2002. 8). One of the problems with live performances with electronic equipment at that time was, that people would come to see the live act and wonder where is the sound coming from. Minimoog had keyboard on it and when people saw the keyboard, they identified the piece of equipment as a musical instrument. (Youtube 2017. SUBTONICK: Suzanne Ciani on Morton Subtonick.) Buchlas system stayed in modular format and did not reach wide commercial success, even though it found its place in sound design and soundtrack industry. Lots of more experimentally orientated musicians, composers and sound designers are still using the system today and the ideas behind it have had an impact on the modern synthesizers.

PICTURE 2. Minimoog Model D Synthesizer (Sweetwater, Moog Minimoog Model D Analog Synthesizer. n.d.)

After commercial success of the Minimoog electronic music and development of electronic instruments experienced a golden age. Electronic sound took its place in the popular culture and music. Lots of companies released different synthesizers and after exploration of the digital possibilities and computing one of the biggest products in the history of the synthesizers was born. In early 1980s, Yamaha released DX7 synthesizer. Even though the programming on this DX7 was challenging, it was easy to use because of the pre-set sounds. Users did not have to program sounds themselves if they did not want to. DX7 sold around 200.000 units in three years. (Pinch & Trocco 2002. 316, 317.)

One milestone that was achieved around the same time with the rise of digital synthesizers was development of MIDI (Musical Instrument Digital Interface). It could be considered as a digital brother of control voltage. By connecting two devices together with MIDI cable, it is possible to control and play the sound of the instrument or instruments with external device individually or simultaneously. It enabled the artist to have an external control over the parameters of other devices. Also, MIDI made it possible to synchronize two devices, which is really important function when working with multiple instruments. The invention of MIDI is the base of computer sequencing and even today, software- and hardware

instruments communicate with music making programs through the MIDI messages. Before this standard connecting two devices from different manufacturers was really hard because of the incompatibilities. (J. Gibson 2013.) The development of computing in combination with MIDI enabled the whole new way of electronic music production.

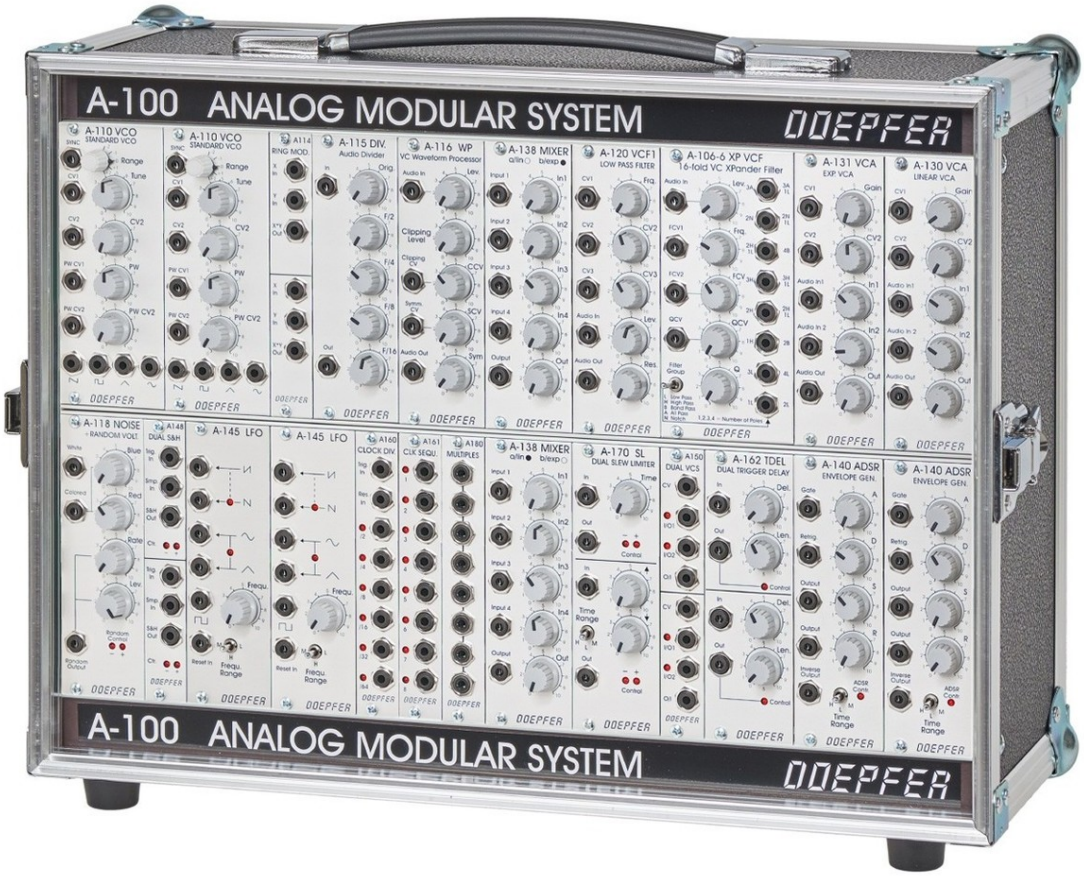
The revolution of digital instrument design did not only take the synthesizers to the next level. It delivered Samplers to the mainstream of hardware instruments. Sampler is an electronic device, which record and playback audio. (picture 3.) With sampler user can create music out of recorded audio clips. The audio clips are called samples. User can manipulate the sample with parameters that effects playback of the audio. In simplest form, the parameter is Pitch, and playing sampler with keyboard re-pitches the audio. This makes it possible to play the sample on different keys. (D. Mcnamee 2008.)

Earlier sampling was based on playing back tape recordings. This Technique was first introduced by experimental artists and gave born for musique concrete, which was based on pre-recorded sounds of real world. Sounds were played together to create sound collages. (J. Mcgrath, How Music Sampling Works. n.d.) The First playable sampling machine, the Chamberlin, was born in late 1940s. It inspired many other tape-based instruments and in end of 1970s digital synthesizer Fairlight CMI was released. Even though Fairlight was synthesizer, it had sampling capacity in addition to other functions. Like the first synthesizer systems, it was not available for average customers because its big price tag. The first sampler which was available for average artist was E-Mu SP-12. (L. Fintoni 2016.) Development of computing enabled the born of present form of samplers. Usually samplers have functions from synthesizers and samples can be mangled so drastically that they become totally new sounds.

Before the computer, recordings were done on tape. The editing of tape recordings required lots of effort and skill. In early 1990s this all was changed. The first audio interfaces and computer-based recording programs revolutionized the audio production. (Computer Music Specials 2008.) Today it is possible to record high-quality audio on computer through the audio interface and edit and polish the recordings almost without any limitations.

PICTURE 3. E-mu SP-12 sampling drum machine. (Vintage Synth Explorer n.d.)

But what happened for the modular synthesizers? Moogs and Buchlas modular synthesizers were followed by many other manufacturers, but the revolution of digital synthesizers was driving modular synthesizers to the grave. (P. Mantione 2017.) Modular synthesizer evolved to its most widely known present form in 1996, when Eurorack standard was established by Doepfer through the release of the A-100 Analog modular System (picture 4). Before the establishment of Eurorack standards, modules did not have any standard size, power requirements or control voltage expectations. Since the new module size and power standards were born, hundreds other manufacturers have adapted the Eurorack format. (W. Groves 2016.) Nowadays small and big manufacturers around the world are designing new modules that are offering the strangest and the most exciting forms of synthesis. (A. James 2013.) Some of the new modules are based on the Open source code, which enables the community to create new functions and applications for the modules.



PICTURE 4. Doepfer A-100 Analog Modular System. (Gear4music, Doepfer A-100. n.d.)

Today there is magnificent number of digital and analog hardware instruments available in market. In top of that the computer technology have made it possible to emulate almost any kind of electronic instrument and have it on laptop. Even though the software instruments are easily accessible, the hardware instrument market is more alive than it has ever been in the past (MusicRadar 2019). The instruments used in this thesis are only a fraction of the available instruments and the number is getting bigger every year.

3 TOOLS

In this part, the tools used for making the album “Research of Humanity” (APPENDIX 1) are introduced. Used equipment was chosen by identifying the needs for composing and sound design. Working methods and artistic aspects of composing and sound design will be discussed later in this thesis.

3.1 Elektron Analog Rytm & Octatrack

Elektron is electronic instrument manufacturer from Gothenburg, Sweden. Their aim is to make the interaction between the user and the machine as fluent as possible and shorten the distance between the artist and technology. They design instruments that communicate through the interface and come up with an input to help the users creative process. (Youtube 2012. Tech Talk: Elektron (EB.TV Tech Talk).)

Elektron Analog Rytm is Drum synthesizer (picture 5). It has 12 playable touchpads (Tracks) with switchable synth engines. The engines are called “Machines”. In addition to the machines, each track has a sample playback engine. Each Machine has multiple parameters for creating and tweaking the sound with, depending on the chosen track and machine. Every track has different set of Machines to choose from (table 1). On each track, the user has possibility to blend the analog sound sources and samples. Sample playback offers functions for adjusting the sample. User can load own samples to the internal memory via USB or MIDI. (Analog Rytm MKI User Manual 2014. 6, 7, 8.)

PICTURE 5. Elektron Analog Rytm Drum Machine. (Reverb.com. Elektron Analog Rytm Drum Machine. n.d.)

SOUND TYPE	MACHINES
Bass Drum	Hard, Classic, FM, Plastic, Silky, Sharp
Snare Drum	Hard, Classic, FM, Natural
Rim Shot	Hard, Classic
Hand Clap	Classic
Bass Tom	Classic
Low Tom	Classic
Mid Tom	Classic
Hi Tom	Classic
Closed Hihat	Basic, Classic, Metallic
Open Hihat	Classic, Metallic
Cymbal	Classic, Metallic, Ride
Cow Bell	Classic, Metallic
Synth Voice	Dual Oscillator
General	Noise, Impulse

TABLE 1. Available Machines, Analog Rytm (Analog Rytm MKII User Manual 2018).

Analog Rytm has rather basic synthesizer signal path. From the sound source, signal goes to the multimode filter, which offers the possibility to choose from low, high-, band-pass, notch and comb filters. (Analog Rytm MKI User Manual 2014. 6, A3.) Low-pass filter cuts high frequencies and high-pass filter does the same for the low frequencies. Band-pass filter cuts the high and low frequencies around the chosen centre frequency. Notch filter does the same, but instead of cutting frequencies around it attenuates the centre frequency. Comb filter does the same as notch filter, but instead of attenuating it intensifies the centre frequency. (S. Riesterer 2017.) Filter frequency can be controlled by hand or with an envelope. After filter, signal goes to the amplifier. Amplifier has an envelope for adjusting the sound length, volume control and effect sends. (Analog Rytm MKI User Manual 2014. 4, 6.)

Analog Rytm has assignable LFO for each track, which can be routed to the wanted destination to add variation and movement to the sound and effects. LFO speed can be raised all the way up to the audio range and it offers wide range of possibilities for the sound design. By creative use of LFO it is possible to achieve evolving and interesting details on a sound. (Analog Rytm MKI User Manual 2014. 6, 8, A5.)

Analog Rytm offers 5 different modes for Touchpads. Play mode lets user to play track sounds and samples in real-time. Performance mode lets user to assign multiple parameters on each touchpad. Pressing a touchpad will adjust the assigned parameters in real-time. More pressure on Touchpad means more radical change in sound. This is a great tool for live performances and recording, since it lets user to adjust many parameters at the same time with one hand. In Scene mode user can hard lock parameter changes in touchpads and for example create different sounds for different parts of the song. When scene is activated, all the chosen parameter values change to the programmed value. Chromatic mode lets the user to play sounds and samples chromatically. With Mute mode user can mute tracks by pressing the touchpads. (Analog Rytm MKI User Manual 2014. 14–16.)

Elektron Octatrack is eight-track sampler, but it is capable of much more than that (picture 6). User can mangle samples or real-time audio with its sample playback parameters and effect units. On top of that it has eight track MIDI-sequencer for controlling external hardware instruments. User can load and record own samples on the Compact Flash card or internal memory. It also offers good sample editor with lots of functions and with sample recording capacity it is possible to do all sample related work without computer. Octatrack has really extensive setup menus with lots of options, which lets the user to modify the behaviour of the instrument. (P. Nagle 2011.)

PICTURE 6. Elektron Octatrack DPS-1 Sampler. (reverb.com. Elektron Octatrack DPS-1 Sampler. n.d.)

On each track user has option to choose “Machine”, which in Octatrack defines the principle of the chosen track (table 2). Machines have different adjustable parameters depending on the task it is used for. Sample playback machines offer widest scale of parameters like Pitch, Sample start point and length, Rate (Playback speed) and extensive setup menu, where user can decide the way the parameters actually behave. Other machines have less parameters and they are mostly focused on gaining the external signal, audio routing and sample recording. (Octatrack User Manual 2018. 116–120.)

Each track of the Octatrack has two effect slots where user can assign the chosen effect to. By using Neighbor Machine user can chain tracks and that way expand the effect chain. (Octatrack User Manual 2018. 17.) This greatly extends the possibilities of mangling the samples and external audio signals. Octatrack offers 14 different effects and tools to choose from. Each of these effects and tools have adjustable parameters and setup page. (Octatrack User Manual 2018. 121–135.)

For controlling all the parameters, Octatrack helps the user to perform with 3 assignable LFOs and LFO designer. User can adjust the speed, depth and waveform of the LFO. LFOs can be routed to the wanted destination. LFO designer offers a step-sequencer-type user interface and tempo synced LFO, that can act like an additional sequencer for parameters. (Octatrack User Manual 2018. 59–61.)

As the Analog Rytms touchpad modes, Octatrack also have powerful tool for performing. Crossfader lets the user to fade between scenes. Scenes can contain any amount of parameter values. User can program parameter values to the scenes and that way introduce complex and radical changes on the overall sound or individual tracks by moving the crossfader. (Octatrack User Manual 2018. 53, 67.) Scenes and parameter values can be assigned in real-time. This is also great tool for designing evolving detailed textures and soundscapes and perform them by moving the crossfader.

Thru Machine	Passes an incoming signal from inputs through the tracks effect chain. Used for real-time audio manipulation.
Flex Machine	Offers the widest playground for sample manipulation. Samples used in Flex Machines are loaded to the internal memory.
Static Machine	Has the same possibilities, than Flex Machine. Static Machine reads the audio file straight from the Compact Flash card. Good for longer samples that take too much space from internal RAM memory. Sample playback may not perform as good in extreme sample manipulation as in Flex machine, since the playback is affected by reading speed of information from the card.
Neighbor Machine	Passes the audio from the previous track through the current track. Really powerful tool for creating complex effect chains.
Pickup Machine	Used for recording loops.

TABLE 2. Machines explained (Octatrack User Manual 2018. 117.)

After all, the most influential and important technical feature which affected the end result is the Elektron sequencer design. The sequencers are pretty much the same in both of these previous instruments. Analog Rytm and Octatrack both have a step-sequencer. length of the sequence can be configured individually for each track. It lets the user to experiment with polyrhythms and the sequence length can be set in anywhere between one and 64 steps. (Analog Rytm MKI User Manual 2014. 37–39.)

User places “Trigs” to the wanted step, which tells the instrument to trigger the sound. These Trigs have own setup menu, where user can program the velocity, note length, pitch and adjust the Trig Condition for the chosen Trig. (Octatrack User Manual 2018. 36.) With this setting user can decide, when the Trig activates. Trig Conditions are great way to add variation to the patterns automatically, which saves lots of time. User has possibility to make Trigs reliant to the other Trigs or adjust the probability for wanted steps. For example, user can decide, that Trig 1 has 33% chance to trigger the sound and next Trigs 2 and 3 do not trigger until Trig 1 is played. That way random variations can be introduced. (Analog Rytm MKII User Manual 2018. 45.)

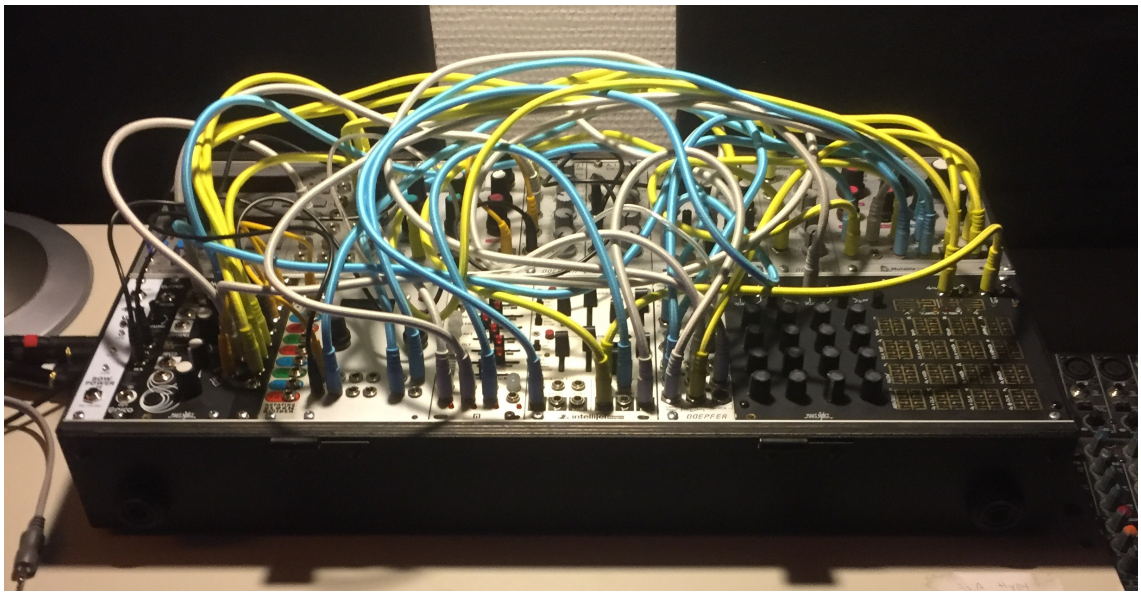
User can program other data to the Trigs as well. This function is called “Parameter Locking”. User can program almost any parameter value to the Trigs. Parameter Locks can be also recorded in real-time. Each trig can contain multiple parameter values. For example, each Trig of a sequence can have different filter and LFO setups. With parameter locking it is possible to have a different sound on each of a Trigs in the pattern. (Analog Rytm MKI User Manual 2014. 39–40.)

Sequencer lets the user even add “Trigless Trigs” on the sequence. These Trigs will not trigger the sound, but instead change the parameter values programmed to the Trig (Octatrack User Manual 2018. 33). This is really powerful tool for adding variation to the sound and patterns. By combining these functions with editing and recording possibilities of a computer, user can have lots of variation in arrangement and save time by programming only 16 step-sequences with Trig conditions and Parameter Locks.

Once user gets to know the instrument, the sequencing workflow becomes really fast and effective and the programming is easy to do even in live situations. When this aspect is combined with the internal memory and saving capacity, these instruments really let the artists to express themselves, while they still have easy access to go back to the original state of any part of the projects.

3.2 Eurorack system

The Eurorack system used in this project, was built to generate evolving sequences and soundscapes (picture 7). The idea behind the system was to create an instrument, which lets the user to set boundaries for modulation and pitches and make the instrument to generate content by following the set guidelines. That way it is possible to get unpredictable melodic and tonal results. After the patch is done the system plays itself and generates ever changing sound and sequences because of the interaction between modules. It can act as a source of creativity and ideas without any input from the user. (S. Riesterer 2018.) This system is a mixture of Analog and Digital modules (table 3). It uses samples and digital and analog synth voices as a sound sources. (the set of sound sources varied a bit depending on the song I was working on) It has lots of modulation sources such as LFO, Random Voltage Generators and sequencers for generating interesting sound design and compositions.



PICTURE 7. The Eurorack system used in the project patched to generate randomised soundscapes and textures (Kouvonen 2019).

The system offers wide scale of sonic possibilities. Even though individual modules and their functions can be descripted, the amount of possible combinations and interactions between the modules feels almost infinite and the only limitation is users' creativity. The control voltage can be routed in any CV input and although modules are intended to be used for some specific function, they can be patched to do something totally different. Great example of this is the usage of sequencer. It is intended to send CV for controlling the pitch of a sound source, but because of the freedom of patching, the CV can be used for controlling any parameter with CV input in any module. This abuse of functions of the modules makes the modular synthesizer even more versatile and powerful tool for composing and sound design.

Modern Eurorack modules can be analog or digital and the system can include both. The benefit of digital modules is the fact that lots of functions can be packed inside one module. Before the digital modules, basic synth voice patch would need all the fundamental sections as a separate module and the modules had pretty much one function they were used for. Today one module can have sound source, filter, envelope and amplifier and in top of that many other functions to affect the output with. Thanks to that user can have flexible system filled with possibilities by only having few modules, without any need to buy gigantic modular system. Downside of the amount of functions compared to the simple analog module designs is the complexity. I have noticed that because of the complexity, patching on with digital modules can take more time than with analog modules.

Every Eurorack system is unique collection of modules. The freedom of choosing the modules makes it possible to build own instrument that perfectly reflects needs and preferences of the owner. That definitely makes the instrument to feel more personal and shapes the users´ sound and workflow.

Module	Description
Orthogonal Devices ER-301	4-channel Sound Computer. 12 CV-Inputs, 4x Gate in, 4x audio In/Out. User can create new instruments from units. Has wide range of sound sources (Sampling, Oscillators), utility- (VCAs, Filters, Clock) and Effect-units. Modular system inside one module.
Endorphines Furthrrrr Generator	Dual Oscillator. Offers wide range of sound possibilities. Lots of CV-inputs for creating changes in sound and blending two oscillators together by with modulation.
Mutable Instruments Rings	Rings is resonator that is based on physical modelling. It can be used as a sound source or for manipulating external audio signal. Very musical module with lots of control over harmonic content.
Mutable Instruments Braids	Digital sound source. Offers wide range of digital “pre-set” sounds. Have menu for setting up the module and the way it functions, which makes it possible to achieve complex timbres or complete synth voices by only using this module.
Mutable Instruments Clouds	Granular audio processor based texture synthesizer. Modifies the input audio signal in real-time, using buffer that contains 1-8 last seconds of the input signal. Eight CV-inputs provide lots of modulation possibilities. Powerful tool for creating generative soundscapes.
ALM Busy Circuits Akamie’s Taiko	Drum Voice. Offers wide range of percussive sounds. Almost every parameter is CV controllable, which makes it really good for making evolving sounds and rhythmic patterns.

Doepfer A-120 VCF1	Voltage Controlled low-pass Filter. Has two CV-inputs for cut-off frequency modulation.
Doepfer A-313 VCA	Voltage Controlled Amplifier with two audio-inputs and CV-input for gain.
Doepfer A-147-2 VCD LFO	Analog LFO with VCA and Envelope for shaping the signal of the module or an external CV source. LFO rate, Envelope and VCA are all voltage controlled.
Make Noise René MK1	Sequencer with 16 programmable steps with touch plates. Have four clock inputs and sends quantized CV for pitch controlling and non-quantized output for modulating parameters of other modules. It also has two independent gate outputs for X- and Y-axis. Clock inputs can be used simultaneously. Clock inputs tell the sequencer in which direction it will advance when the pulse is present. Applying random clock pulses to the X- and Y-axis clock inputs makes it possible to create unpredictable sequences. Touch plates can be used for playing, locking the sequence to cycle on specific steps, muting specific steps and performing by changing sequencing modes.
Make Noise Wogglebug	Random CV generator. Inspired by Don Buchlas random voltage source. Generates seven different random control voltage values simultaneously on seven individual outputs. Can be synchronized on the master clock and output can be affected by CV-inputs.

Intellijel Dual ADSR	Dual four-stage Envelope generator with three different speeds (fast, medium, slow). Two gate inputs for triggering the envelopes. Has also buttons for manual triggering. Cycle mode lets the user to “loop” the envelope and that way it is possible to use the envelope as a LFO.
4MS Rotating Clock Divider	Divides the rate of clock pulse on eight outputs, each with different divider from one to eight. Rotate input can be fed with CV, resulting the dividers to rotate on the outputs. Great tool in combination with Make Noise Renés clock inputs for creating inconsistent melodies.
Erica Synths Black Polivoks VCF	Voltage controlled low-pass / band-pass filter with two CV inputs for cut-off frequency modulation.
Ornament & Crime o_C	CV generator. Open-source code based digital module. Have lots of applications, coded by community, to choose from (Sequencers, LFOs and other control voltage generators). Really flexible CV generator for creating modulation. The parameters can be affected with eight CV- and trigger-inputs and results are patched to destinations from four CV-outputs.
Malekko Heavy Industry Varigate 4	8-step gate sequencer. Four individual channels. Individual probability, repeat and delay setting for each step. Capable of saving patterns. Functions as a main clock source if needed, but can also be synchronized on external clock.

TABLE 3. The list and descriptions of the modules used in the project (Modulargrid.com, Suitcase. 2019).

3.3 Studio signal flow

The studio signal flow used in the project was created in the way that everything can be recorded simultaneously on computer. Every instrument was following the same clock from the computer music software. That way recordings can be edited easily, to pick up the best parts of the performance and shape the arrangement without having problems with synchronization of the recorded tracks. This signal flow enabled me to improvise and perform the songs in real-time and pick the best parts of the performance.

Synchronization was made through the audio interface, which offered MIDI output and input for synchronizing the external instruments with computer software. Since the Analog Rytm and Octatrack had MIDI inputs and outputs it was easy to make them communicate with the computer by connecting these instruments with MIDI cable. To synchronize the other gear with Eurorack system, the MIDI signal needed to be converted to a control voltage. For that purpose, I used Arturia Beatstep Pro. It is a MIDI/CV sequencer with two control voltage outputs and ten gate outputs. It also has MIDI input and output for receiving and sending MIDI data so the sequencer can be synchronized with other devices. CV/Gate outputs are used for controlling the control voltage controlled equipment. I connected the Beatstep Pro to the other gear with MIDI cable. After the Beatsteps sequencer was synchronized, by using the Gate outputs, it was possible to send clock signal for the sequencer modules and that way have the Eurorack system synchronized with other gear. (figure 4.)

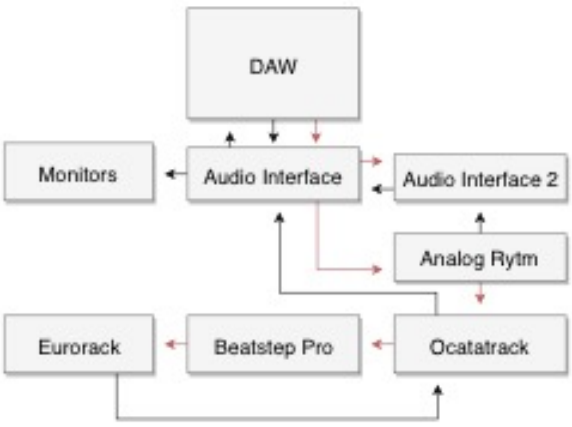


FIGURE 4. Studio signal flow. Black arrows present the audio signal flow. Red arrows present the synchronization signal (Kouvonen, 2019).

4 WORKFLOW

This topic contains the observations from the album making process of an album “Research of Humanity” (APPENDIX 1). I will go through the workflow in chronological order and introduce the working methods. I will focus more on creative side of the process and observe how the use of hardware instruments affected the end result and workflow.

4.1 Pre-production

Term ‘pre-production’ covers the tasks that are carried out before the actual recording process begins (Knightley 2008). In this phase goals of the project are defined. When this is done properly, it is possible to identify the possible problems and find solutions in advance before they even exist and save time and effort during the production process.

Based on my observations, this is the part where lots of the experimentation should be done. It is much better to know in advance what can be done and what kind of working methods are leading into the results that are relevant for the current project. Pre-production should lead to the base idea of the end product and make it easier to keep everything under control through the process.

What I have found out, is that when working with the hardware instruments this part becomes even more important. Significant amount time and effort can be saved by setting the guidelines and aims for the project and working methods in the pre-production phase. This way it is possible to know what kind of sounds to look for, organize the workflow and produce aesthetically homogenous album wholeness.

4.1.1 Artistic approach

Before I turned the machines on, I wanted to decide what the atmosphere and theme of the album will be. Setting the clear aim for what my album is going to present was really important, since this main goal affected greatly on the choices

I made through the production. Theme for “Research of Humanity” (APPENDIX 1) was humanity and the atmosphere of the modern world. How technology affects to humanity and vice versa. I felt it fitted on my plans about the working methods and tools I wanted to use for composing and sound design.

After this idea, it was easy to start to think about the style of sounds and arrangements I would like to have in my album. I wanted that the end result and production process presents the collaboration of modern technology and human mind and investigates how technology and human creativity influence each other. It is stated that instruments like Eurorack synthesizers tend to interact with the user and that can lead to unexpected result which is a sum of users’ creativity and technology (Youtube 2015. MODULO: The analog synth documentary).

One of the strengths when working with hardware instruments, is that it is possible to let the machines do part of the composing. By playing with probabilities and by setting the guidelines such as scales and range for modulation, it is possible to guide the machines to the wanted direction but still have unexpected, yet usable, results that have nothing to do with the rules and musical norms that human mind learns and uses unconsciously. I wanted to use that benefit and mix the result with more static patterns to find balance between predictability and variability (Youtube 2015. Transforming Noise Into Music, Jackson Jhin, TEDxUND).

4.1.2 Sound palette

In this project, the aim in sound design was to create dark distant drones, punchy in your face drums and plucky industrial leads. First step towards that was to pick up the right techniques for sound design to reach the goal. In this phase I did experiment with many different working methods and synthesis techniques. When I found the sounds that felt right, I recorded or saved them, depending on the platform the sound was created on.

One of the weaknesses of the hardware instruments, especially Eurorack system, is that if user just keeps patching without a clear plan the achieved sound will be lost. There is no undo or save button, so user needs to know what he did if he

wants to go back, which could be sometimes impossible because of the amount of interactivity between the used modules. On the other hand, this is also one of the strengths of the Eurorack system. When using this instrument, user will always explore something new and that can lead to the unique results (Youtube 2015. MODULO: The analog synth documentary).

I recorded lots of samples for creating textures with the Eurorack system, which I found the best and time efficient way for making evolving unpredictable drones and soundscapes. By using modulation sources on the certain parameters of the sound sources and sequencer, all the generated randomness helped me to create living evolving textures without too much effort which let me to focus more on the performance and arrangement. In this phase of sound design I also listened through my field recordings and picked up the suitable material. After finishing this phase, I got folder filled with samples and sound files I could use in my sound design and compositions.

4.2 Sound design

Term ’sound design’ is used to refer the tasks related to recording, manipulating and mixing audio for creating new sounds (N. Mars 2015). The term in this context, includes synthesizer patching and electronic sound creation. I did not use any pre-set sounds and that was one factor to take in count when I selected the instruments. Even though sound design with modular synthesizer is tons of fun, I really like to have more simple tools for completing routine tasks like drum sound design to save some time. That is where the hardwired instruments, like Analog Rytm, become handy tools.

The instrument designers have already created the simplified selection of parameters that can be adjusted to shape the sound, which makes the workflow fluent and time efficient. The Analog Rytm has a fixed signal path, but its sequencer opens up many possibilities for modulating and affecting the sound with. Also, the saving capability was the one reason why I wanted to use Analog Rytm for creating the drum sequences and sounds. That made it possible to easily experiment with the rhythms and sounds without a risk of losing everything that was already programmed.

The drum sound design on the songs in overall is fairly simple and in most of the cases it is based on Analog Rytms parameters and rather traditional synthesizer signal path. Of course, there are few exceptions. A number percussive sounds are made on Eurorack system, which in some cases became more efficient way for making randomised sounds and rhythms. While Analog Rytm offered fast way for sound design, programming of the sequencer was needed to create more dramatic changes in the sound and the end result was fairly repetitive.

With Eurorack system this would be done without programming, just by feeding random modulations on the modules, leading to random non-repetitive results. The best and fastest tool for that on my setup was ALM Busy Circuits Akamie's Taiko. It creates percussive sounds and has lots of control over the sound via CV inputs. By feeding the inputs with control voltages and gates it was possible to generate ever changing sequences of different sounds only by plugging in few cables.

The downside of this method was, that the result was always random and the sounds I got out of the module were not always what I was looking for, but that problem was solved by the studio signal flow, which let me to edit the recordings the way I wanted. In the end, this working method did not save that much time, but the benefit came from the random sounds and sequences the synthesizer created, which both were something that I would not have achieved by programming everything by myself. Use of modulation influenced the sound design and compositions and by feeding random values of control voltage on the sound sources I found lots of content, which were used in the end product, only by listening and recording the modules playing alone.

This was also one method I used a lot for creating samples. After recording a bunch of sounds, I could cut out the ones I liked and load them to the Octatrack. On the Octatrack the edited sounds could be mangled radically and used for making sequences. Octatrack was still mostly used for composing purposes and its role on sound design was minimal. Reason for that was that I had all the drum

and synth voices covered with other tools and the usage of the sampler was usually focused on the playing back of the sounds I had already created on other devices.

For me the most interesting and inspiring part of the sound design were the making of the textures and background ambiences. Almost all of them were based on the same working method, which was the use of granular synthesis. In this working method, instead of using the traditional oscillator, which creates a static raw audio tone, as a sound source, I used Mutable Instruments Clouds module to manipulate samples I had collected.

Clouds records the input signal in to its audio buffer in real-time and transforms the audio to the grains. Grain is a short part of the source material, which length in this module, can be anything between 1ms-16ms. The Clouds will play back the grains over and over again in adjustable speed and density. When the density is low, the grains will be played back in so slow speed that the individual grains can be distinguished. When the density is turned up, the playback rate of the grains gets so fast that the grains start to overlap, resulting to a constant tone. The grains have an envelope and pitch control to shape them with. The point where grains fill be played from the buffer, length and other parameters be changed in real-time. (Mutable Instruments 2019.) many of the controls can be controlled with CV, which makes it possible to generate complex tones and textures.

By feeding the inputs of the Clouds with long samples, it was possible to generate evolving, living textures out of the field- and synthesizer recordings I had collected. In top of that I got lots of good recordings by feeding the Clouds with live input from my sound sources. By using a lot of random modulation on different parameters the module created beautiful dynamic ambiences, which could be later on edited and used as a background drones to get a nice contrast for more static drum and synth voices. The results I got out of this working method was something that really shaped the end product and made the songs to come alive.

The sound design process with Eurorack is filled with happy accidents. Even though I had pretty clear plan about what I was looking for, the patching process

was always more or less about exploration. Trying out different signal patches and turning the knobs could sometimes lead to unexpected pleasant results. The exploration side could also inspire the whole new song and I think that is something really unique about the instrument. Albeit all the experimenting and patching could be seen as a problem and waste of time, I saw it more as a possibility and endless source of ideas and creativity.

The generation of randomised content is the task where Eurorack really shines. The drawback of Eurorack is that the achieved patches and sounds cannot be saved. It means that after messing up or clearing the patch, it cannot be recalled. Lots of patience is needed on the recording process and the user needs to listen and analyse the recordings really carefully to make sure that everything is alright. If the user later on finds out that the recording is unusable or something crucial is missing for any reason it is impossible to get back on the patch and fix that. It means that the whole process needs to be done again from the very beginning and in worst case the whole song can be ruined.

4.3 Composing

Electronic domain offers many different methods for the artist to get inspired and compose music. Some of them are based on the methods, where devices generate content. in some cases, the content creation can happen without any input from the user. (C. Otchy 2016.) While traditional music composing with pen and paper focuses more on the notation, electronic music composing can focus heavily on the sound creation and manipulation (C. Roads 2015). I noticed that the sound design and composing on hardware instrument strongly blended together. Usually some of the sequences were done during the sound design, since creating a pattern that plays the sound I was working on, helped a lot for understanding how the sound would work in the arrangement.

The composing part is fairly hard to observe and analyse since that was something that kind of automatically happened during the sound design. That is something that is not happening for me when working on computer software. The “now I play this melody” – moments did not exist. I think one of the reasons why this happened was the fact that I did not use traditional keyboards in this project.

Everything was composed by programming, creating synthesizer patches or playing the sounds in alternate way, like using the touchpads.

The sequencer programming was in huge role in the composing. During the project, I used four different sequencers. The Anlaog rytms and Octatracks sequencers were handy for more static patterns. They were used in almost all drum sequencing tasks on the album. The workflow on these sequencer is magnificently intuitive once you get familiar with it. The creation of rhythmic patterns was really fast and I did lots of patterns just by placing random triggers in random places and trying out what would work.

After I got the trigs in the steps I felt comfortable with, I started to add variation to the pattern and sounds with parameter locks. In Analog Rytm, the usual parameter values I parameter locked, were filter frequencies and some of the sound source parameters, depending on the chosen machine. Also, the volume parameter value was often changed for some steps individually to reach some dynamics and accents for certain steps. The danger of the step sequencers is that the end result can sound too mechanical and by adding parameter locks this trap was avoided effectively.

On Octatrack, parameter locking included the changes on sample play speed and direction. Octatrack was handy tool for composing, since the random content created on Eurorack could be arranged in the form that supports the song. The parameter locking was not the main focus of programming the Octatrack. The most powerful tool it offered for me was the crossfader. By programming parameter values on the scenes, it was possible to introduce changes in the sound in real-time. Crossfader enabled morphing between different pre-programmed parameter values. The scenes often included parameter values like filter frequency, play speed and direction and parameters from effect units. This way it was possible to create more controlled content out of randomised sounds and change the sound radically between the parts.

Last but not least, both of these sequencers offered chance to add trig conditions on each of the steps. That was great opportunity and made the programming process much faster. I mostly used maximum of sixteen steps for each sequence.

In some cases, this was enough since I was looking for repeating looping patterns, but in some situations the repetitive loop was something that I did not want to have. By playing with probabilities it was possible to create variation on the sequences inside the sixteen steps and that way reduce amount of the work and programming that would be needed for creating longer sequences. The trig conditions are also available for the trigless trigs and that way random variations on sound could be included to the pattern as well. Trig conditions made it possible to create random fills, drum hits and changes in sound and that way make the sequence feel longer because of the variation. After the recording, I could pick up the best parts and ideas created by the variation and re-arrange them to happen in right spot of the song.

The other sequencers used in the production were used for controlling the Eurorack modules. I had two different sequencer modules that I used in the project. In the end, they could be considered as a one sequencer which was combination of their functions, since the method I used needed them to work together to achieve the principle I wanted to use them for. The idea of this sequencing method was that I could create random melodies and musical events by specifying and programming voltage values that the system could use as guidelines for the randomisation.

The base of this idea was the Make Noise René sequencer. I wanted to take an advantage of two-dimensional step sequencing and the possibilities it brought in. Normally the sequencer works in the way that when the clock pulse is present it proceeds to the next step going through all the steps from left to right on the constant tempo. René works in the same way, but it offers individual clock inputs for two different directions, X- and Y axis. By feeding random clock pulses to the inputs, it is possible to have an altering movement in different directions instead of having repetitive movement from left to right all over again. Each of the steps can contain the exact CV value that the user wants. By setting the steps to send the certain CV values and feeding the clock inputs with randomised clock pulses, the sequencer will run through the steps randomly, creating random order of programmed CV values.

Sometimes I wanted the melodies and modulations created by the René to be in the same tempo than the drums and other instruments. For that I needed a clock source which would be synchronized to the tempo, yet having the possibility to send pulses on random steps for the René. My solution was to use Malekko Heavy Industry Varigate 4 module. It is a four track, eight step gate-sequencer. Each of the steps has probability control and some other useful parameters. By synchronizing the Varigate to other instruments through Beatstep Pro, it was possible to send short synchronized random gate pulses to the Renés clock inputs, resulting the René to advance in the random directions in a tempo. The Renés CV output could then be used to modulate any CV input of the other modules.

The idea of pre-programmed random voltage values turned out to be a true treasure and was used for randomisation in many different situations, including melodies, percussion sequencing and adding modulation on the timbre and harmonic content of the sounds. This sequencing method reduced the amount of curating and editing needed for the generated random content and made the results I got out from randomisation more usable on the composing process.

The fact that no keyboard was used, highly affected the end product. Without traditional black and white visual feedback about the scales and notes I achieved strange melodies that I would not have done in traditional keyboard overlay. The form of visual feedback about the notes was totally different, mostly lights and numbers and the arrangement was based on turning the knobs of the instruments, listening, recording and editing. That experience was really refreshing and the basic manners of playing and composing that I have had before this working method were all gone. I found myself constantly trying out new things and exploring the harmonies in totally different way.

4.4 Recording process

Development of studio technology have made it possible to edit the recordings easily to achieve the final arrangement. It has enabled a whole new way to record and handle the audio and create songs. (A. Dixon. n.d.) The recording process with the hardware instruments on album production turned out to be the

most challenging and time-consuming part of the project. Most of the challenges were related on the fact that once the recordings were done, there was no way to go and fix the sound or performance later on. The only way to fix a bad sound or recording was to record it again. This issue is not present when working in the software instruments on computer, since the sounds and the performance can be polished and fixed anytime if needed. This is why I think that playing and recording music with hardware instruments is much closer to the traditional instrument recording workflow than computer based music making. While computer music making workflow seems to be more about arranging and polishing the sounds and the performance through the production, the workflow with hardware instruments and sequencers is all about practising to perform the compositions and sounds as good as possible.

Usually the first step towards the recordings was practising and exploring the possibilities of the sounds and synthesizer patches I had made for the song. I focused on the things like how to make the arrangement interesting and dynamic, which sounds and patterns should play simultaneously and how the sounds could transform during the song. I found jamming and recording the most efficient way for building the overall idea of the song structure. By just playing with the sequences and sounds and listening them back it was easier to find out which ideas were good and what should be changed to achieve a good arrangement. Also, some of the recordings during the practising could be used for the final songs.

Before I started the project, I tried out different approaches on the studio signal flow. I found this aspect important since having the studio signal flow right had an impact on the recording workflow. I ended up having two different audio interfaces to record with. The other was dedicated only for the drum machine. This decision was really valuable for the workflow, since it offered me possibility to record each sound on individual track and that way it was possible to use the best parts of the tracks from each take even if I messed up something on other tracks. Octatracks samples and Euroracks output were recorded on individual tracks through the other audio interface. This way I could hit the record button on computer and record all the instruments live at the same time. After finishing playing I had each drum track and all the other sounds all as an individual recording, ready for editing and to be used for building up the final arrangement.

I did the recordings by doing long really long takes. Some of those recordings could be over 10 minutes. The fact that I have only two hands, made it impossible to do all the things I wanted to happen during the song simultaneously, so I needed to focus on one or few things at the time during the recording. Editing the recordings afterwards made it possible to introduce the majority of events that I wanted to have on the final song on one take.

After the recordings were done, I started to edit the recorded tracks on the computer and created the base of an arrangement. After listening through the result, I decided if I needed to do some of the recordings again or add some new content on certain parts of the song. Even though the goal was to record all the source material for the final song in one take, multiple overdubs were needed. There were number of things in the arrangements that I wanted to have on the songs, which were not possible to do live. One limitation which drove me to do the overdubs was the fact that I did not have enough modules on the Eurorack system for playing multiple patches simultaneously. Usually the ambiences and textures were recorded individually, because of the amount of the modulation and functions they required for generating the random content.

Even though the computer editing was proven to be fantastic tool for getting the best out of the recorded material, the workflow had its weaknesses. Editing was sometimes laborious and required lots of fine tuning to achieve unnoticeable edits. One factor that made it sometimes impossible was the use of effects like reverb and delay. If the track was recorded with lots of effects in it, the transition between the audio clips was sudden and the sound and sense of space changed so much that the edit was easy to hear. For that reason, some of the reverb and delay effects were done on computer software. I did also highlight some events that happened in the songs by emphasizing the performance with effect parameter automation on the computer. By drawing automation on the music making software it is possible to “modulate” certain parameter of the effects. Example of this is that I wanted the ending of the recording to have a sense of huge space where the sound disappears. That was achieved by increasing the reverbs time parameter on the last hits of the sound by drawing automation.

The editing of the recordings can be considered as a part of composing. It enabled the creative use of randomised content. Lots of the content that is heard in the final album, could not be there without the hardware instruments that drove me to use these working methods and the possibility to edit and rearrange the recordings. The power of computer editing and recording cannot be ignored. The combination of those features and the hardware instruments functions and ability to create interesting content, turned out to be powerful tool for creating music.

5 DISCUSSION

The musical hardware instrument design and the electronic music making has taken a huge leap since the early days of synthesizers. The modern instruments can offer magnificent number of functions and possibilities and some of the instruments and modules can be considered as small computers. The interfaces that some of the instrument designers create are extremely intuitive. Even though the communication with instruments happens through knobs, blinking lights, small LED screens, cables and sound, at its best, the interaction between the instrument and artist can lead to unique discoveries.

During the process, I noticed that the interfaces I was working on had a huge impact on the compositions and sound design. In this project, no keyboard was used and everything was done by programming or playing with other kinds of interfaces. That led to the unexpected musical results. It felt more intuitive and primitive way of making music and released the chains of the musical norms that I have been growing up with. Lots of basic knowledge about the sound synthesis and logical thinking was required to make complex synthesizer patches, but that is something that I have been learning by doing and exploring the sounds and possibilities of the instruments.

Based on my observations, the biggest downside of the hardware instruments during the production process turned out to be that the workflow was rather slow in some points. Practising the performance, recording the song and editing required lots of time and there was a risk that the recording was not good enough and everything needed to be done again. This is something that could be a reason to pick up a computer over hardware instruments.

I could see that the time, that was spent on rehearsing, recording and editing was paid back as uniqueness, creativity and inspiration. The hardware instruments shine on sound design tasks and the possibilities of modulation really expanded my ideas about how music can be made. The working methods were clearly leading me in the certain directions and the content created by generating random sounds, events and rhythmical sequences really shaped the end result. The experience of working in collaboration with the instrument, that responds and helps

me to be creative and express myself through the knobs and cables, was inspiring. The same experience is shared by many musicians around the world.

As a recording and editing device computer is invincible. It was in big part on tightening up the arrangements and enabled curating of the recorded content. That helped a lot and made generation of randomised sounds and rhythms more valuable and usable. After doing long recordings of randomised soundscapes and textures they could be edited to support the dynamics of the song.

I am satisfied with the end result and I think that the working methods and choice of doing composing and sound design on hardware instruments shaped the final album. The instruments helped me to find my sound and style of making music and that way they have affected on my artist identity as well. From my opinion, the working methods supported the ideas behind the albums concept. I could say that the hardware instruments even had an effect on the album concept itself, through the inspiration I got by playing with them before the project even started. Then end product will be released as a LP and Digital release.

The music software is evolving all the time and lots of artists use a laptop for making their music. The software makes it possible to have electronic music studio with you anywhere you go and it is capable of imitating almost any instrument. However, the hardware instruments keep on going and the business around them has been developing for many years. People are interested in the new devices and the community around synthesizers is active. Many of the modules and instruments have adapted the power digital possibilities and computing. The instruments and working methods I used during the project were just a small piece of the possibilities what the hardware instruments are offering. The process made me interested on the possibilities of generating randomised sounds and musical content and I cannot even imagine how the electronic sound creation will develop in the future. Only the imagination of the users and designers is the limit.

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APPENDICES

Appendix 1. Otto Kouvonen – Research of Humanity
(https://soundcloud.com/otko2/roh-001-master/s-FCWl2)