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Re-amping Drum Room

Reinventing Space Around Drums in Stereo Mix by Re-capturing Drums

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Music Production

ABSTRACT

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Re-Amping Drum Room
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Needs of a band for a recording session can be in contradiction with the environment they are working in. Lively large room could aesthetically give more desirable drum sound for the record at hand, but the band and their engineer/producer may end up working in a small dead sounding environment. The purpose of this study was to compare techniques to overcome this by creating a livelier yet realistic drum room sound in the mix phase while creating illusion as if the drum ambience were recorded along with close-miked drums. The focus was on recapturing drums in a large space through a PA-system.

Four songs from three bands were recorded in various environments with portable recording system. The songs were then mixed with two techniques. First mix had drum reverb done with the re-amping of the drum room. In the given context, “re-amping” meant playing back the recorded close-miked drums in a big live room of a studio, while recording the sound of the room with several microphones. Second mix of each song was done with alternating digital room reverb. Finally, the resulting mixes were evaluated by seven experts in a blind test.

For each song, both techniques produced good quality drum ambience, while some equipment produced more artificial sounding results than others. This study shows that recapturing drums through a PA can be usable method for recreating drum room sounds, although it takes more resources than more common mixing methods of modern era. When time and money is an issue, algorithmic and convolution based digital reverbs can be feasible problem solvers when used correctly.

Key words: music production, audio engineering, mixing, recording, drums, reverb, ambience, room, microphone techniques

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GLOSSARY

Algorithm – Mathematical calculation done digitally. In the context of this study, used to synthesize reverb tails.

BBD-Chip – Bucket-Brigade-Delay chip, an analogue chip that makes it possible to create time-based effects with transistor technology.

Bleeding – Audio captured by a microphone that is coming out of the focus point of microphones polar pattern. For example, a hi-hat hit that is captured by close-mic on snare drum.

Convolution – Technology that uses impulse responses, audio snapshots, to process sound. Can be used to give tonal qualities of a room or hall to a recording.

DAW – Digital audio workstation, audio recording and mixing program

dB – Decibel, indicator for volume of audio

DIY – “Do It Yourself”

DSP – Digital sound processor, digital processor designed for audio use

hz / kHz – Hertz & kilohertz, indicator for audio frequency. Low number for low sound. Human hearing is from 20hz to 20kHz. 1000hz = 1kHz.

Impulse response / IR – Audio snapshot that is used by a convolution reverb or IR-loader.

“In the box” – Term referring to mixing only in digital domain of computer.

PA/PA-system – Public Address System, a large sound reproduction system used in live-shows, night clubs, sports arenas etc.

Plugin – Additional program that works inside a DAW. Commonly an audio effect.

Polar pattern – The pickup pattern that dictates the directivity of the microphone.

Pre-delay – Time between the original sound triggering the reverb and audible starting point of the reverb tail.

Stock plugin – Plugin that comes along with the DAW. For example, “stock compressor” -refers to compressor plugin that came along with the DAW.

Time-aligning / phase-aligning – Moving of the individual tracks on the timeline of the DAW in a manner that results the tracks to be more in-phase with each other.

Transducer – Mechanical device used in mechanical reverbs to play or capture sound through matter. Basically, a speaker without the woofer or a contact microphone.

Reverb – The ambient decay of sound created by multiple reflections of a sound tailing the original sound.

Ribbon microphone – Ribbon microphones were the original dynamic microphones, that have a ribbon-coil capturing the sound in bi-polar pattern. Tend to have warm sound with reduced hi-frequency content, due to their technical construction.

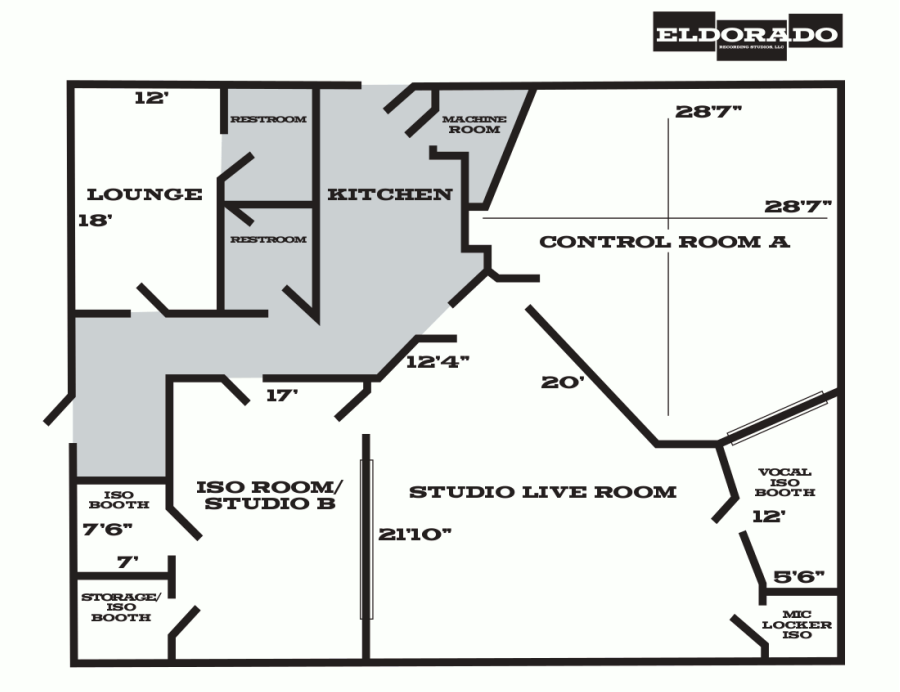
1 INTRODUCTION

I was set to record albums for three different alternative rock groups: Satama, Vuosi nolla and Ongelma. All three of the bands wanted performance-based aesthetic in production that would give the listener an experience of a band playing in a room. To meet the visions of the bands, most of the base tracks would preferably be recorded live with musicians playing together. Usually songs would be recorded without aid of a click track and the drumkit would be treated as a single instrument instead of a collection of separate percussion instruments. When needed, playing mistakes would be corrected with punch-in recording rather than editing, and the effects for guitars and bass would be created at the source with pedals when possible.

The bands did not want to use conventional studios for reasons that varied from complex timetables, logistical issues, budget restrictions and fear of the pressure that being in formal studio could bring. The sessions were recorded with my portable studio set-up in locations changing between sessions. These included an old water tower with Vuosi nolla, my rehearsal room with Ongelma and various rehearsal rooms with Satama. Drums for Satama were recorded in my rehearsal room.

In terms of capturing a good-quality drum sound, there was several things to consider. To support the bands' aesthetical visions of natural sound of the band in a room, quite common solution would be to use room microphones while recording. In the finished mix, the sound of the drumkit would lean heavy on the overhead microphones, and the room microphones would act as the main source of drum ambience. This type of approach to drum-recording is presented for example in the video of ALT-Rock EZX drum-library by Toontrack (Alt-Rock EZX, YouTube 2017). This could be challenging, since big part of the recordings would be done live with multiple sound sources in relatively small and acoustically unflattering rooms, with heavy bleeding from other instruments to drum microphones and noise coming from rehearsal room next door or amplifiers at the hallway. On top of this, in two of the three sessions I would need to simultaneously record large number of sound sources while having limited number of inputs to computer.

To overcome the problem of not having ambience microphones for drums, there are a few alternative techniques that can be used in the mixing phase. The standard option would be to use a convolution or algorithmic based digital reverb plugin or hardware effect to artificially create the sound of the room. Alternatively, I had previously heard of techniques where drum room sound is captured in different room than the original recording took place with a help of PA. One such occasion was the album called “Americana” by The Offspring, released in 1998, produced by Dave Jerden and engineered by Bryan Carlstrom. The album was recorded in Eldorado Recording Studios in Hollywood, where the drums were placed in a smaller dead room for impactful close microphone sound. A live-mix of close microphones over drums were then routed to a PA-system placed in the bigger livelier room with room microphones capturing the sound of the big room (Picture 1.). (The Offspring’s “Pretty Fly”, YouTube 2019.)



PICTURE 1. Floorplan of Eldorado Recording Studios. In Americana sessions, the drums with close microphones were placed in Iso Room, while PA and room microphones were set up in Studio Live Room. (Eldorado Recording, 2020.)

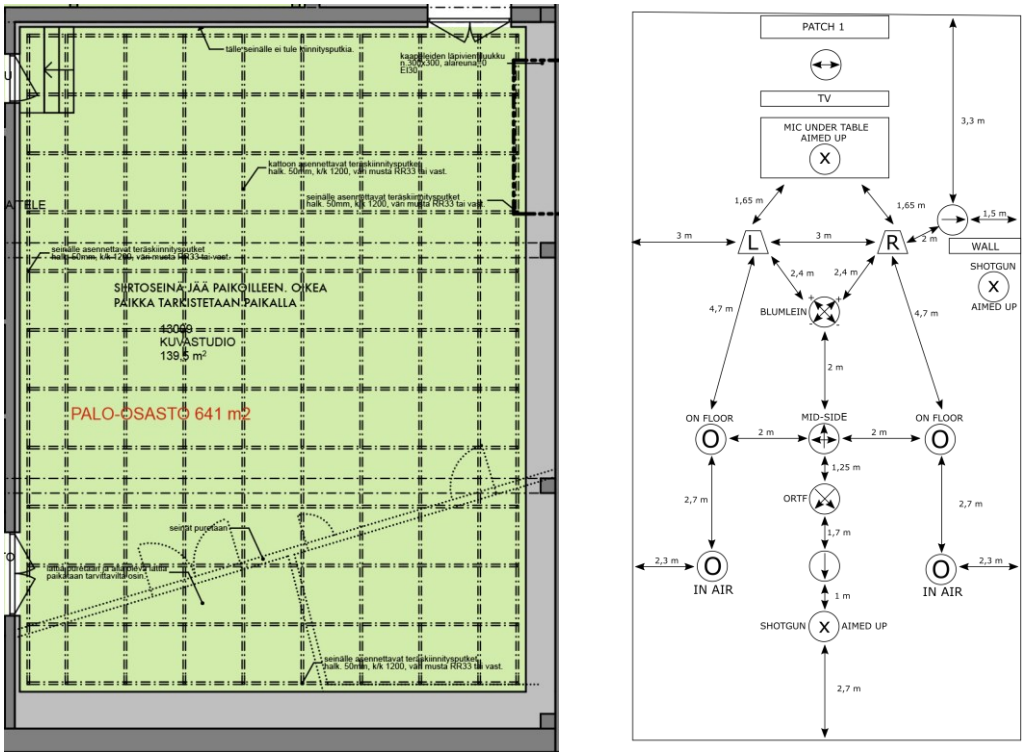
As another example of the method, Astia Studio in Lappeenranta has their drum rooms built in live end – dead end fashion (Astia Studio 2020). This means one side of the room has a low ceiling and is heavily damped yielding little to no reflections (dead end), while the other side has hard surface materials and a much higher ceiling, which builds a lot of reflections (live end). The drums with close microphones are placed in the dead end while a PA-system playing live-mix of the drums is placed to the live end with room microphones. (Homma purkissa – Jakso 4. YLE Areena 2010.)

The aim of this study was to compare two techniques for re-inventing the drum room sound in the post-production phase, to identify the most feasible one in terms of production timeline and the aesthetic result. More specifically, I wanted to study if the room microphones existing in post-production phase could be faked with the help of a PA and what type of resources would this technique need? Finally, I wanted to compare what would be the benefits of using PA and microphones in post-production phase comparing to non-acoustical digital "room" reverbs. For this, I chose four different digital reverbs, covering convolution and algorithmic based technology. After recording the three bands and mixing the four songs two times, the results were evaluated with blind listening of the songs by a small test group of musicians, producers, and engineers.

2 RE-AMPING DRUMKIT

When re-amping drums for the purpose of creating drum room reverb, a mix of drums is played back into a room and recorded with room microphones. In this technique the room, the mix that is played back, the gear used for playback, and the gear used for recording along with placement of speakers and microphones all come to affect the captured sound. (Re-Amping Drums, YouTube 2019.)

In the chronology of my project, the three bands were first recorded in their own sessions in various studios. This part is explained in more detailed manner at chapter four. Then the drums were raw-mixed to a point where volume of the drum channels were balanced, and the drums were panned to stereo-field. Drums were in most cases left unedited. The raw mixes were then re-amped at the TAMK Radiosiipi studios.



PICTURE 3. & 4. Floorplan of the TV Studio of Radiosiipi (Mediapolis, 2020). Notes of microphone placements. Circles stand for microphones and arrows inside them indicate the microphones capturing direction. “O” stands for “omni” and “X” marks a microphone that is pointing upwards. (Hipponen, 2020.)

2.1 Room Recording Techniques

Since it was most time-efficient to record everything in one session, drum room had to be suitable for three bands in one session. This meant that different approaches were going to be needed for different songs, depending on the sound of the band as well as tempo and the arrangement. The room recoding was carried out in TAMK Radiosiipi studios at Mediapolis, in “TV Studio” -room, for it was the largest room of TAMK studios, giving the longest natural pre-delay for the reverb when needed (Picture 3.). To get variations to the sound of the room required by all four bands, 16 microphone setup was used. Some of the figure-of-8 microphones were split further to two tracks in post-production phase, making it total of 18 tracks. This is more microphones in the room than commonly would be used for drum room recordings. No mix had all 16 channels open at once, but most of the channels were used with one song or another. Table with full list of microphones used can be found as appendix 1.

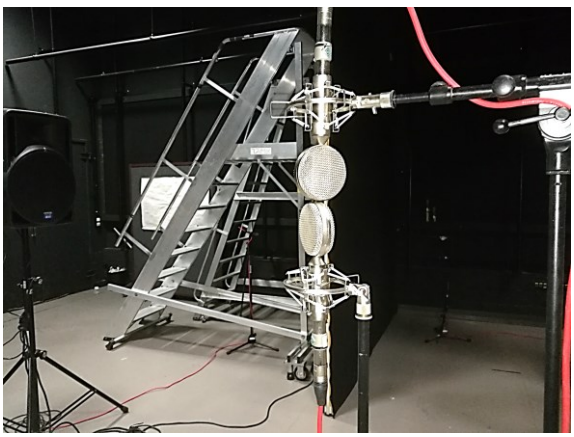
PICTURE 2. Echo chamber of Capitol Records with speakers aimed at the walls. One microphone is seen pointing to the top corner of the room from floor. Cables suggest another microphone is placed just out of frame. (Reverb.com, 2019.)

Several rather standard stereo-microphone techniques were used for capturing drums through a PA, that are commonly used capturing drums being played in a room. These techniques are discussed in more detail below. Some less than standard techniques were also used, in the attempt of finding different flavours and interesting resonances from the room. Some of the microphones were directed out of the sound source, towards a reflecting wall or placed behind a block-

ing obstacle (Picture 4.). This type of methods is reminiscent to microphone techniques used in echo chambers (Picture 2.). By doing this, the microphone will capture only reflections and no direct sound. Technique also extends the pre-delay time, making the room sound larger.

2.1.1 Blumlein pair, or X-Y

In the blumlein technique you use two ribbon microphones with a figure-of-8 polar-pattern placed on top of each other in 90-degree angle to each other in a manner where their bi-polar polar patterns draw imaginary letter X. The membranes of the microphones are placed as close to each other as possible with the positive sides of the microphone facing at the sound source for keeping the phase relation between the microphones as clean as possible (Picture 5.). Using ribbon microphones in the blumlein technique results in a warm sounding stereo-image of drums that leaves a distinct hole in the middle of a stereo-field when panned hard-left and -right. Technique also works well when summed to mono, meaning the phase relation of the left and right side is usually good (Matt McGlynn 2011). When the technique is done with two cardioid microphones (usually a pair of small-diaphragm condenser microphones) it is common to use name “XY” of the technique, and the name of the technique can change with the source. (Rossing, Moore, & Wheeler 2002, 576-577.)



PICTURE 5. Blumlein pair with right side of the PA. Small diagram condenser with cardioid polar pattern is pointing at the wall while being placed under the steel stairs. The shotgun mic at the dark spot of the picture is aimed to the roof. (Hipponen, 2020.)

2.1.2 Spaced omnis, or A-B pair, on the floor and in the air

In an A-B pair two omni-directional microphones are placed at the same length away from the sound source, but on the different sides of the room (Picture 6.). They capture a natural stereo-image with a mixture of straight sound from the source and reflections from coming from every side of the room. The sound of the pair can be tuned by placing them higher above the ground for more hi-frequencies, or closer to the ground for more low-frequency information. In this study, I had two A-B pairs in the room: a pair of small diagram pencil microphones on the floor closer to the PA, and another one at head height at the back of the room. (Huber & Runstein 2010.)

PICTURE 6. Right side of spaced omni pair, or A-B pair, at the close frame. Left side of A-B pair on the floor can be seen further in the image. (Hipponen, 2020.)

2.1.3 Mid-Side

Mid-side configuration is built with two microphones that are split on three tracks. This requires a cardioid condenser microphone pointing forward as a “mid”. As “sides” you take a figure-of-8 microphone, usually a ribbon, while having the microphone’s blind-spot aimed to the focus point of cardioid microphones viewpoint (Picture 7.). The capsules of the microphones are placed as close as possible to each other without the microphones, or stands, physically touching each other. The figure-of-8 microphone is split on two tracks that are panned hard-left and -

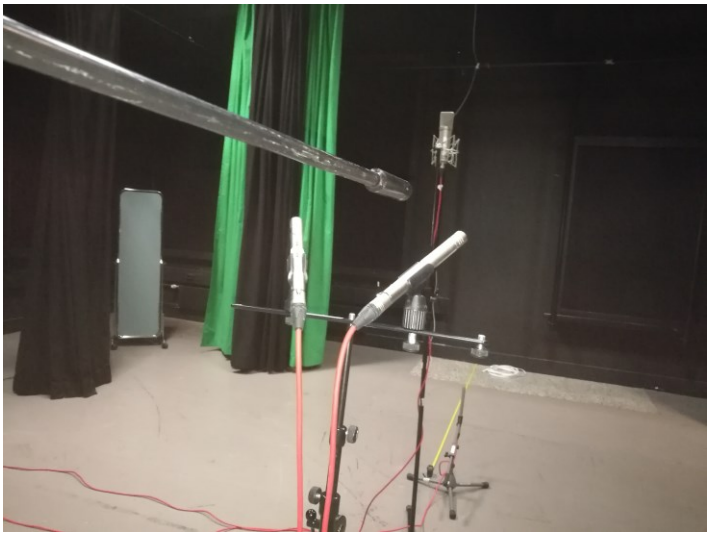
right, with phases switched from one of the tracks on the side. Combining all three tracks results in a “wide-mono” style effect. When all the tracks are summed to mono, the side information is cancelled out, giving emphasis to the middle information. If the side information is panned to the extremes and the volume of the middle signal is lowered, the sound will get wider. The signal of the side microphone on two tracks can be split while recording, but it is usually recommended to do the splitting in the digital domain to avoid natural phase anomalies that can occur in analogue gear, such as microphone pre-amps. (Huber & Runstein 2010, 143-145.)

PICTURE 7. Mid-side and blumlein microphones with the right side of the PA. Small diagram condenser is placed under the table and a flat screen TV can be seen in the back. (Hipponen, 2020.)

2.1.4 ORTF

ORTF – stereo microphone technique was developed in the 1960’s in France, and the name comes from the name used by the Radio France, Office de Radiodiffusion Télévision Française. This technique gives a wider stereo-field than for example the XY technique would, while retaining relatively good phase relations. In this technique two microphones are placed with capsules approximately 17cm from each other, facing outwards in a 110-degree angle (Picture 8.). The technique is used with cardioid small diagram condensers, large diagram condensers

or even figure-of-8 ribbons can be used for wider image or alternative timbre. The width can be fine-tuned by turning the microphones slightly in or out from each other without much effect on phase-relation of the microphones. I aimed my ORTF-pair to the hi back corners of the room, to only capture reflected sound. (Robjohns 2014.)



PICTURE 8. ORTF in the front, aimed to corners of the roof, with cardioid aimed to backwall and shotgun microphone aimed to roof (Hipponen, 2020).

2.1.5 Mono-Room microphones

In addition to the stereo-pairs used in this study, I had a total of six mono-room microphones (Picture 4.). Two of these were shotgun microphones, placed quite low and aimed towards the roof. One was at the back of the room and another one on the right side of the room from audience view (Picture 5., Picture 8.). The live room used for re-amping had a high ceiling with light arrays hanging from the roof. Therefore, pointing microphones to the roof could give unexpected sounds with long pre-delay. (Recording Drums, YouTube 2013.)

A large-diagram condenser with cardioid pick-up pattern was aimed towards the middle of the backwall, at the approximate height of 1,8m from the floor (Picture 8.). This microphone gave an extremely clear sounding slap-back effect when played back along with drums. Another large diagram condenser with figure-of-8 polar pattern was placed right next to the opposite wall, directed towards the sides

of the room (Picture 9.). This microphone was at the backside of the speakers and behind a television screen, so it could capture only reflected sounds.

Two more small diagram condensers with cardioid polar pattern were added to capture resonances. The first was placed under a table that was just behind the PA. This microphone was aimed up, capturing resonance of the table (Picture 7.). The other cardioid small diagram condenser was placed under a set of steel stairs that were at the same plane as the PA while aimed to the wall (Picture 5.).

PICTURE 9. Figure-of-8 behind a flat-screen TV (Hipponen, 2020).

2.2 PA-System

The space to be recorded was rather large, which had to be considered when choosing the PA-system. If the audio were to be played on too low volume, the room would not create reflections and resonances loud enough to be captured without hefty amount of gain from pre-amps. Excessive gain would bring up the noise floor to audible level making the recordings unusable (Owsinski 2006, 105-107). For practicality and safety of the equipment, I chose to use a pair of DB Opera Live 202 active PA-speakers (Picture 7.). This is a two-way speaker with 12” speaker and 1” high-frequency driver with 150w+50w of power while having max SPL at 120dB. Acoustic drums tend to be loud, and can reach peak

levels of over 110db, so this system fitted my needs perfectly while leaving 10db of headroom (Turkovic 2020). The speakers' frequency range goes from 68Hz to 18kHz, which suited this project well, since sub harmonic range below 68hz would not be needed. As a feature, the speakers had a built in soft-clip peak-limiter and a simple one knob tone control. In the middle position the tone would be "flat", and on the extreme ends the EQ stated "music" and "speak", respectively. (Appendix 5.)

2.3 Pre-amps and other recording equipment

Ribbon microphones tend to give a rather low signal in comparison to most dynamic or condenser microphones, and therefore they usually need hefty amount of gain from microphone pre-amps bringing the noise floor up. To overcome this issue, I used Triton Audios Fet Head -pre-amp addons with all the ribbon microphones in my session. The Fet Head goes between the actual microphone pre-amp and a dynamic or ribbon microphone, giving +27db of clean gain to the signal. Fet Heads use phantom power given by the pre-amp, while cutting the electricity flow to the microphone. (Triton Audio 2020.)

PICTURE 10. Outboard gear for drum room recording (Hipponen, 2020).

In addition, Avalon VT 737 SP -tube channel strip was used with Neumann 87 that was facing the back wall. Channel strips are pre-amps that include some

dynamic controls, EQ's, or filters, that may vary from model to model. Avalon VT 737 SP includes tube pre-amp, optical compressor, 4-band EQ and variable 6db per octave hi-pass filter (Avalon Design 2018). AMS Neve 4018 quad pre-amp was used with blumlein ribbons and A-B pair on the floor. The 4018 unit has four channels of legendary Neve 1081 pre-amps built in. (Robjohns 2011) With blumlein ribbons I implemented the "low-Z" function from the pre-amps, that brings the impedance of the pre-amp into more suitable level for ribbon microphones, thus giving a bit more open and clear sound. (Picture 10.)

Rest of the tracks were recorded through with Allen & Heath GL2400 mixing console (Picture 11.). Using the console allowed adding a 12db low-cut at 100hz onto most of the microphones to get rid of the unnecessary low-end rumble and muddiness that may occur when multiplying low-end harmonics created by the room. Using low cuts made the reverb sound less muddy, and face phase relation issues with the kick drum less likely to occur when mixing. Using the console also facilitated easy access to phase-switch and 4-band EQ. (Allen & Heath, 2020.)

For the ORTF-pair, that went through Allen & Heath pre-amps, I used Drawmer DL241 stereo-compressor. Another DL241 was used with the spaced pair at the back of the room. With the help of compressors, I was able to have more audible decay to the reverb. (Picture 10.)

PICTURE 11. Allen & Heath GL2400. (Allen & Heath, 2020)

3 REVERB UNITS AND SOFTWARE

3.1 Which Artificial Reverbs to Use?

Artificial reverbs can be roughly divided into mechanical and digital reverbs. Mechanical reverbs, such as spring- and plate-reverbs, mimic the phenomenon of real-life echo by transducing sound through a resonating material, giving the original sound harmonic tailing sound. This type of reverbs poorly mimics the room ambience in comparison to digital reverbs, so there was little to be gained from comparing mechanical reverbs to real room. In digital domain the two main methodologies, or genres, for creating artificial room reverb are algorithmic and convolution reverbs. (Case 2012.)

First digital reverbs were algorithmic reverbs. Their logic has a lot in common with BBD-chip based delay effects less than decade before first digital reverbs, and many of the early “digital” reverb, delay and echo units used a lot of analogue parts in the help of creating warm tails (TC2290-DT, YouTube 2018.). Algorithmic reverbs are digital effects that that use digital signal processors (DSP) to run algorithms that count repeats, feedback loops and filtering of the fed signal. The result is a synthesized harmonic sound that is tailing the fed signal and perceived as reverb. Noteworthy modern algorithmic reverbs could be Eventide H9000, Lexicon PCM96 and TC Electronic Reverb 6000. (Computer Music, 2014.)

Convolution is a relatively new technology in audio world introduced in late 1990’s, with the release of Sony DRE S777 hardware effect unit (Computer Music, 2014). Few more modern noteworthy hi-end convolution reverbs would be Bricasti M7 hardware unit along with Altiverb and Indoor plugins by Audio Ease. Convolution reverbs use impulse responses (“IR”), recorded audio snapshots, to capture tonal qualities of rooms or hardware. Whereas an algorithmic reverb adds a synthesized tail behind the original sound, a convolution reverb processes the original sound by adding tonal qualities of the impulse response to any audio fed through the effect unit. (Brown 2019.)

In my work the aim was to create a realistic drum room reverb. For this reason, it felt unnecessary to use mechanical reverbs, echo chambers or any plugin that tries to mimic church, cathedral, or any other fantastical type of reverb sound. It seemed logical to use only algorithms and convolutions labelled “room”, “hall” or “studio”, or aiming for a type of sound that could be labelled as such. For comparisons sake, I wanted to use four different reverbs from different manufacturers, including at least one hardware unit, one stock plugin that comes along with my DAW (digital audio workstation), one algorithmic reverb and one convolution reverb. The reverbs chosen for this project are discussed in more detail below.

3.1.1 TC-Electronic M-350, Digital Hardware Unit

The M-350 is a budget friendly rack mountable digital audio effect unit with several very usable features and clean easy-to-understand user interface from TC-Electronic (Picture 12.). TC Electronic is audio hardware company founded in 1970’s, and best known from their digital time-based rack effect units and guitar pedals (TC-Electronic 2019). When doing research on the reference material given by Satama, one of the bands to be recorded, I discovered Don Zientara’s work and Inner Ear Studios that he runs. They have multiple TC-Electronic digital effect units in use (Inner Ear Studio 2020). Although M-350 it is not one of the specific models used at Inner Ear, it shares the TC heritage and the unit has proven itself in live-venues and can be found for example in the “festival-rack” of Prodigy’s front-of-house engineer Jon Burton. (Front of House sound for “The Prodigy”, YouTube 2019.)

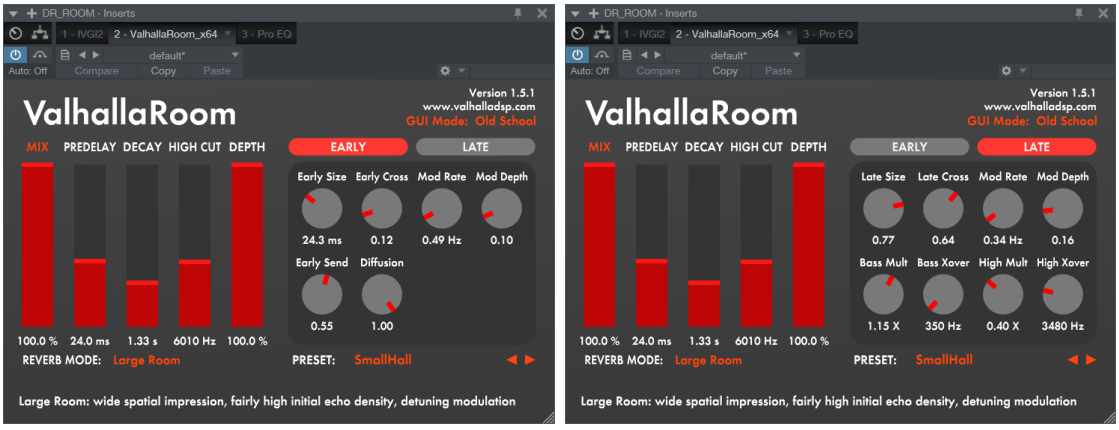
M-350 has a dual engine construction where the first engine is dedicated for delay, modulation, and dynamic effects and second engine for algorithmic reverbs. Both engines can be bypassed individually, leaving only one engine on.
In this work, I only used the reverb engine while the unit was in serial mode to get the reverb working in stereo. M-350 can be plugged with standard analogue TRS-plugs or digital ones to have S/PDif cable. To have it working with the digital connections a sample rate of 44.1kHz or 48kHz is needed. I used the digital connection, as my recording sessions were recorded in 24bit/44.1kHz quality. (TC-Electronic, 2019.)

PICTURE 12. TC-Electronic M-350 (TC-Electronic, 2019).

3.1.2 Valhalla DSP - Valhalla Room, Room Reverb Plugin

Valhalla Room is a relatively cheap algorithmic room simulation plugin that has gained somewhat of an industry standard status. The inspiration for using this plugin in my work was an article of Alan Moulder explaining mixing of Led Zeppelin's Celebration Day -live DVD and album. In the mix he used several reverb, echo and delay plugins and hardware, one being Valhalla Room that was used on kick-drum and snare. (Tingen 2013.)

Operating Valhalla Room is split in three parts, early reflections and late reflections pages and overall controls (Picture 13.). In early reflections page there are six parameters, late reflections page gives eight parameters with five additional parameters to control overall sound of reverb along with a mix knop. Thus, in total there are 20 parameters to tweak with mix knob included, which can make this plugin slightly overwhelming, while it does give the user significant versatility. (Valhalla DSP, 2020.)



PICTURE 13. Screen-capture from Studio One. Valhalla Room by Valhalla DSP with early and late reflections. (Hipponen, 2020.)

3.1.3 Presonus Room Reverb, Room Simulator

I wanted to use one stock plugin from a DAW as a part of my thesis. My main DAW has been the Studio One 3 Professional digital audio workstation, and from the collection of a few reverb plugins come in stock with it, the Room Reverb felt like a natural fit with the topic of my thesis. (Picture 14.)

With this algorithmic room simulator, a virtual cube shaped room of desired size can be created. The features include the length, width, and height of the room as well as dampness of the room to control the liveliness of the reverb. Inside the imaginary room of Room Reverb, there is a mono sound source and two microphones placed in a shape of a triangle, with a possibility to change the height of the microphones and alter the shape of the triangle. However, the microphones will always stay on the same level with each other and you cannot move the sound source so close to the microphones that they would be practically touching each other. Moving the microphones around mostly effects the early reflections, which also have their own volume control. Room Reverb can give a good variety of usable room-sounds. (Learn Studio One 3.5, YouTube 2017.)

PICTURE 14. Screen-capture from Studio One. The Presonus Room Reverb in use. (Hipponen, 2020.)

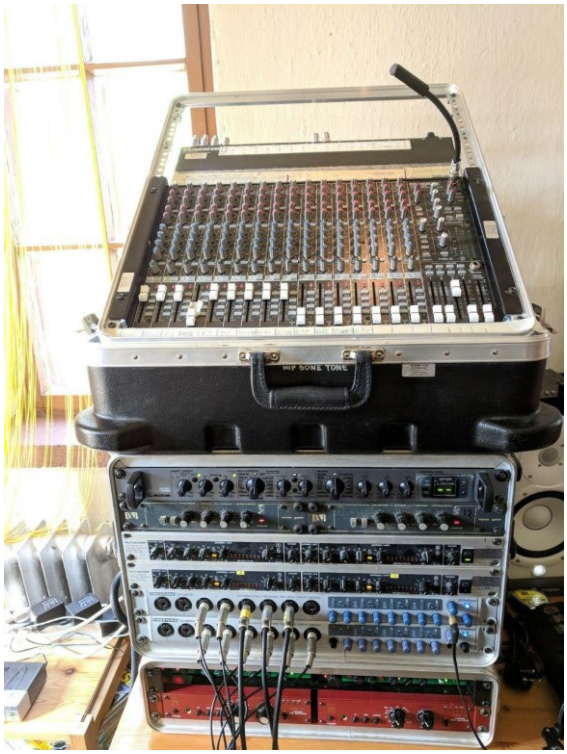
3.1.4 Waves IR-L, Convolution Reverb

Waves IR-L is the most common version of the Waves convolution reverb. It shares the same engine with Waves IR-1 convolution reverb, released in 2004, but has simpler more streamlined interface (Picture 15.). It is commonly included in many of the plugin packs sold by Waves, and thus can be found from the computers of most commercial studios. IR-L can read .wav files that are meant to be used as impulses, but it also comes with four impulses of its own (studio-room, hall, plate, church), all of which are usable. In my work I used the studio-room impulse that came along with the plugin. (Waves, 2020.)

PICTURE 15. Screen-capture from Studio One. Tweaking options of Waves IR-L. (Hipponen, 2020.)

4 RECORDING DRUMS

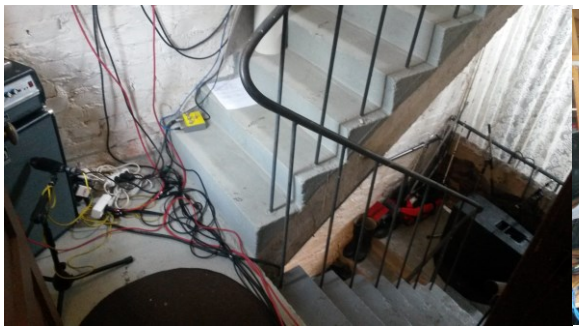
Drum room does matter even in close microphones. This is well demonstrated by Ulf Blomberg from HoboRec Recording Studio in his “HoboRec Bull Sessions #52” -YouTube video (2018). Still similar type of recording techniques was used for drums in all three recording sessions. This including dynamic and condenser microphones on top of the snare and one condenser on the bottom. Dynamic large diaphragm microphone inside the bass drum and varying outside microphone. Dynamic microphones for toms and two large diagram FET-condensers as overheads with changing overhead recording technique. The exact microphones and signal chains used can be found from appendix 2. to 4. The same set of portable recording racks were used for each recording session (Picture 16.). The two Presonus Firestudio Project audio interfaces were daisy chained together giving a total of 16 simultaneous inputs to the computer. The locations and other specific features of each session and band are described below.



PICTURE 16. Recording racks used for all three drum recording sessions (Eetu Hipponen, 2018).

4.1 Luiseva selka by Vuosi nolla

Vuosi nolla is neo-crust punk band with two guitars, bass, drums, and shouted vocals. Instruments are drop-tuned to C and have a hi-gain sound. The song I used for this study was recorded in August 2018 in an old water tower transformed into a summer house. The water tower had concrete walls, an open multi-floor stairway where, and a single high ceiling room on each floor. The drums, recording unit, and musicians were placed into the room on second floor, while the bass and guitar amplifiers were placed to the stairway (Picture 17., Picture 18.). This setting allowed a somewhat decent control over leakage of other instruments to the drum microphones when recording live. Due to high number of sound sources to be recorded at the same time, I used only one room microphone for drums. The placement of the microphone was first and foremost dictated by limited floor space. (Picture 18.)



PICTURE 17. & 18. View from the staircase of the water tower. The empty space for water pipe is located behind the white curtain. View from live room. Taken from behind drums. (Hipponen, 2018.)

The overhead technique in use took some influence from recorder-man overhead technique (Picture 19.). Recorder-man is usually done with bi-polar ribbon microphones. First one is placed approximately one meter above rack-tom while aimed to snare. Second is placed behind the drummer aimed to the snare over the drummer's shoulder slightly from the floor-toms side of the kit. The microphones are kept as close to the kit as practical for tight drum sound. They were then measured the same length away from the snare and kick-drum to nail those drums tightly into centreline with good phase relation. My version was done with large diaphragm condenser microphones with wider cardioid polar pattern. After the

drummer requested more room to move while playing, I placed the microphones a lot further away from the kit than usual for this technique. This altered the sound of the technique closer to A-B pair turned in a way that kick-drum and snare stayed in the middle of the audio field. (Recorderman Technique, YouTube 2017.)

Supporting a large diagram dynamic kick-drum microphone, a DIY-sub-kick microphone was placed in front of the resonance head of kick drum capturing sub-harmonics and to add on decay of the drum. Sub-kick is a dynamic microphone with extremely large diagram. Traditionally, a backwards wired passive speaker cabinet, such as Yamaha NS10 with 10” speaker. Yamaha later released official sub-kick microphone that has already been discontinued (Recording Hacks, 2008-2020). Guitar cabinet could be used as a sub-kick microphone, but this time our sub-kick was built at the session from the equipment already found from the water tower. Speaker was taken from old broken Yamaha organ with 12” diameter and placed it inside a broken Line6 Spider combo-amp that had already lost its speaker. Then we soldered XLR cable straight into the speaker using the broken combo-amp only as a microphone stand. (Picture 20.) (DIY Subkick Alternatives, YouTube 2016.)

PICTURE 19. & 20. Drums, microphones, and the drummer of Vuosi Nolla. Bassist of Vuosi Nolla building a sub-kick microphone. (Hipponen, 2018.)

4.2 Vanha koira by Satama

Satama was an alternative rock band with two guitars, bass, drums, and melodic male vocals. Compared to their previous EP that was recorded in a professional studio, they wanted a rawer presentation of their music for the new album. Yet they requested to record instruments separately due to timetable issues. We ended up recording the album in a few different rehearsal rooms in Musakeskus -rehearsal complex in Kaleva, Tampere. This gave us the possibility to do multiple shorter sessions during winter 2018 – 2019. The drums were recorded first, over one weekend in December 2018.

PICTURE 21. & 22. Soundcheck for drums at the Satama sessions (Vesa Ahonen, 2018). Don Zientara adjusting microphones over Justin Hawkins drumkit in Sonic Highways -sessions (Inner Ear Studios, 2020).

This time there was no bleeding from other instruments and more tracks in use for the drums, giving me a possibility to add additional hi-hat microphone and use stereo room microphones. One of the reference points given by Satama for the desired sound was the band Fugazi, whose albums were recorded in Inner Ear Recording Studios by Don Zientara. Videos from Foo Fighters sessions for Sonic Highways from Inner Ear Studios gave me some insight on how Mr. Zientara would approach recording drums (Making of The Feast and the Famine, YouTube 2015., Picture 22.). The overhead technique in use was quite similar with what was used with Satama while he is using bi-polar ribbon microphones and having the overheads quite far from snare, to fit the cymbals into the microphones frame. The roof of the rehearsal room used in this project was too low for mimicking the

exact placement of the microphones, and the room was much more dead sounding. Drummer of Satama also had his cymbals placed slightly lower. To open the sound, I used cardioid large-diagram condensers instead of narrower bi-polar microphones. (Picture 21.)

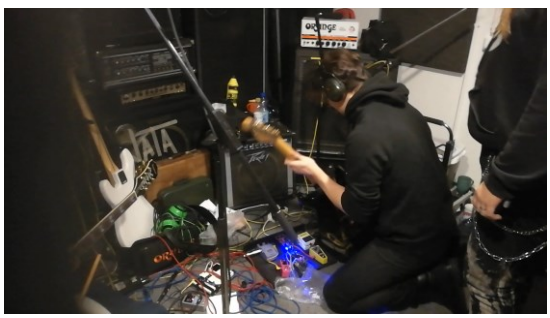
As room microphones, I used a pair of large diagram condenser microphones. The microphones were placed in a single stand in front of the drumkit as ORTF-pair pointing away from the kit while facing the back corners of the room (Chapter 2.1.4.). The idea was to capture only reflections with room microphones while mimicking the natural reverb that the drummer hears when playing. This also gave me the most reflections out of a small rehearsal room. ART Tube MP preamplifiers that were slightly overdriven for tube saturation were used for room microphones. Outside microphone for kick drum was switched from sub-kick to omni-directional large diagram condenser microphone. The aim was to capture natural sounding decay and low end of the resonance head. Rest of the techniques and equipment used for snare, overheads and inside the kick-drum in Satama's session were the same as used in the other sessions.

4.3 Verhon takaa and Tahtasit kuuhun by Ongelma

Ongelma is an old school type of punk rock / new wave / pop band from Kuopio. They had previously made two punk-rock-oriented EPs, one of which I had engineered. For their first full length album, they wanted to include new influences. Before the recording sessions for the previous EP, some of the members of the band mentioned that they had had a red-light-fever when recording their first EP in a "proper studio". At that time, I suggested that we record at our rehearsal room. At the session, I sat in the middle of the musicians with my computer and headphones recording while they were playing. In a such small room there is no need for headphones for the musicians when recording live, which can help to make the recording feel more like regular rehearsals and thereby ease the anxiety (Picture 23.). They requested that we continue working in the same manner in the album sessions, which took place in January 2019.

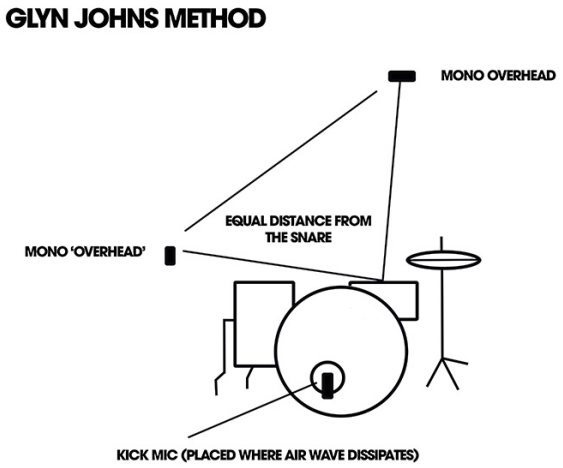
PICTURE 23. Recording without headphones at the Ongelma sessions (Hipponen, 2018).

Because we were recording base tracks live, there was some limitations on how many tracks I could use for drums and how many microphone stands were practical to squeeze in such a tight space. For example, room microphones had to be excluded. The band was placed in between the drumkit and amplifier wall, with less than 3m in between them (Picture 24. & 25.). Bleeding of guitars and bass forced me to use microphones with narrower pick up patterns and put microphones tad closer proximity to the sound sources to gain a slightly louder signal in comparison to the bleeding of other instruments. I switched to condenser-ribbon microphone with bi-polar pickup pattern as the outside microphone on the kick-drum and placed it in the middle of the kickdrum, facing the outer rim in approx. 45-degree angle to reduce guitar and bass bleed.



PICTURE 24 & 25. Guitar players of Ongelma is shown in the pictures, with the wall of amplifiers on the background. Pictures are here demonstrating how limited the space was at the Ongelma sessions. (Hipponen, 2018.)

The drumkit was placed as close to the wall as possible, while giving the drummer just enough space to play the kit. This was to give more room for rest of the band. Thus, a microphone stand could not be fitted between the kit and the wall. The overhead technique was switched to Glyn Johns drum microphone technique. Glyn Johns drum recording method is commonly done with three or four microphones, but I took only the stereo overheads from the technique (Picture 26.). In his technique a close microphone is placed on kick drum (and at times on snare) while two overheads capture the rest of the kit. The overheads are aimed at the snare roughly at same distance. First is capturing the kit from roughly 1 meter above the snare, and the second is placed on next to the floor tom, on the same height as hi-hat. Rest of the microphones and techniques with drums were the same shared with earlier sessions. (Pickford 2018.)



PICTURE 26. Glyn Johns drum microphone technique (Musictech, 2018).

5 MIXING

At the very beginning of any given mix session the engineer should build the routing of the project, balance the volume of tracks, and pan everything in the mix roughly on their place in the stereo-field. If the drums need to be edited or phase-aligned, it should be done prior to the actual mixing process. The project should be balanced in a manner that everything is audible, and the master fader does not reach peak levels over -0db and overload. If there is several microphones on one sound source, for example two top-microphones and one bottom microphone on a snare, it can be a good idea to route them into their own bus to be processed as a group thus saving processing power. Instrument groups (drums, guitars, bass, lead vocals etc.) can be routed to their respective busses before going to the mix-bus, which is placed right before the master fader. This gives the mixing engineer possibility to utilize so called “top-down” mixing method. In the top-down style, mixing engineer tries to focus on the big-picture while moving step by step through the routing, from the mix-bus down to the individual track level, doing minor adjustments to the sound. This approach works well when the sound of a drumkit as an entity is cherished. (Dylan Roth 2019.)

5.1 Vuosi Nolla – Luiseva selkä

As a starting point for the drum mix, I routed all the room tracks in one drum room bus. The original room was surprisingly loud in the drum bus, even after I had cleaned the tom tracks and muted the mono room track that was captured at the water tower sessions. I did not use the room microphone from the water tower for it introduced phasing issues, and the sound was not that pleasing in the context of the mix. The song was quite hi-tempo, so I did not need too long decays, but still we wanted the sense of space where the drummer is playing to be added.
I used blumlein ribbon pair placed in front of the PA in conjunction with small cardioid condenser placed behind the PA, pointed towards a table from underneath it (Picture 4.). From blumlein pair I ended up switched polarity on from one side. This combination of table resonating in the middle and sound of a PA at the sides gave me nice feel of shaking of the room from sheer power of the drums.

This sensation was giving energy to the mix and worked more like a glue, bringing close miked percussion instruments closer to a form of singular instrument.
Re-amped drum room tracks were routed on their own mix-bus. On the drum room-bus I added stock-EQ to hi- and low-pass hi and low-end of the mix respectively, to save energy. I also got rid of a bad resonance created in the room by snare drum at 596hz. After the EQ I added a stock-compressor that was side chain controlled by snare and kick drum to create a “dynamic reverb”. When snare or kick was played by the drummer, the reverb would duck for a few decibels. This gave room for the transients of the close microphones. After EQ and side chain compression I had Waves S-1 Stereo-Imager that I used to widen the reverb bus to give room for centre-field of the mix, while having the room surround the listener.

Waves IR-L convolution reverb was used for the comparison mix of Luiseva selkä, with the “Concert Hall” -impulse response that comes along with the plugin. At first, the whole drum-bus was routed to effect-bus that had IR-L plugin. Unfortunately, there were harsh sounding resonances in the high frequencies from cymbals, and the plugin was overloading from the subharmonic content. In the end, only the inside kick-drum microphone, toms, and snare-bus (that I used to sum my three snare microphones before they went to drum-bus) were sent to the IR-L reverb. Presonus Pro EQ was added in front of Waves IR-L to fine tune the sound that was going into the reverb. I added a slight pre-delay before the convolution to give more room for the transient attacks of close miked drums and shortened the reverb time so the decay would fit better with the tempo of the song.

5.2 Satama – Vanha koira

The arrangement of the song was rhythmically frantic, and the drums had plenty of information. The song included playing on the rims of toms, ghost notes on snare and fast short tom fills. The vision of the band was to create more dirty representation of the band’s music for this recording. I decided to try to place the drumkit behind the band in the mix, slightly further away from the listener.

Replicating Steve Albini's room microphone techniques of blending blumlein pair in front of the kit with a spaced omni pair laying on the floor worked well (Recording Drums with Steve Albini. YouTube 2017). The PA represented the drumkit when recreating the room sound. In addition to the stereo-pairs I added a large diagram condenser that was pointing towards the backwall from distance of 2,7m. This microphone gave me nice slap-back. Neumann 87 also gave me bright top-end against dark sounding stereo pairs. (Picture 4.)

Backwall microphone was kept in the middle while blumlein pair was panned 75L – 75R and spaced omni pair was placed hard left – hard right. Polarity of left side blumlein microphone was switched. All the room microphones were routed to a room-bus where I had stock EQ and stock compressor in side-chain mode. The EQ was used to fine tune the reverb. The side-chain compressor was used for the "dynamic reverb" trick.

TC-Electronic M-350 rack mounted hardware effect was used for second mix of Vanha koira. TC-Hall pre-set was used with shortened decay while pre-delay was increased to give room for the transients. Colour filter was used to darken the bright digital reverb (Tc Electronic M350 Review Part 1. YouTube 2016). I ran overheads, toms, snare, and kick-in microphones through the unit. In the DAW I reduced some ugly resonances from the reverb by hi-hat and further darkened the TC-Hall with ProEQ plugin. Even more room for transients of the drums was created with a side-chain compressor (controlled with kick, snare, and toms) placed on reverb-return.

5.3 Ongelma – Verhon takaa

Verhon takaa had a more mellow tempo, allowing room for reverb. I used my mid-side pair on the mix (Picture 7.). To get the "sides" I split the bi-polar ribbon track on two tracks panned hard L-R and switched the polarity from one side. This way listener would hear positive side of the microphone on one side, and negative on the other, while leaving a hole to stereo-field for the middle microphone. EQ was added to the "middle" track, for the sound of the condenser microphone was rather aggressive.

The three room tracks were routed into room-bus where I had Klanghelm IVGI2 saturator to push the reverb a tad further away and to round off some harsh edges in the sound, ProEQ to get rid of low-end rumble and ugly resonances, and two side-chain compressors controlled by kick and snare drum respectively.

I checked the size of the TV-Studio from the website of Mediapolis and used the given sizes as a reference for my settings inside Room Reverb plugin. Floor area of the room was 133,3 m² with length of 13,2 m and width of 10,1 m while height of the room was 4 m (Mediapolis 2018). I tuned the dampness and balance between early and late reflections by ear and moved the virtual microphones to preference. To make reverb sit with the other parts of arrangement, an EQ was placed in front of and behind the reverb to tweak the sound going into and out of the reverb. Waves S1 Stereo Imager was used last in the fx-signal chain. It was used to spread the reverb wider in the mix giving more room to centre-field.

5.4 Ongelma – Tähtäsit kuuhun

Tähtäsit kuuhun was the slowest of the four songs used in my thesis with arrangement that was quite loose, giving room for even longer reverb tail than Verhon takaa. I decided to use the head high AB-pair of AKG 414's with omnidirectional polar pattern, placed at the back corners of the TV-Studio. I had them panned hard left and right. In the centre-field I added the Shure 81 that was placed underneath a table behind the speakers. The microphone was aimed at the table to give resonances that should give the listener a feeling that the band is playing loud in a room.

The drum mix to the PA included kick-in, snare-microphones, both toms, overheads, and percussions. The shaker and tambourine and vocals were the only elements of the song that were recorded afterwards. Rest of the song was recorded live. This meant that guitars and bass was also going to the PA in the form of bleeding to the overhead microphones. To glue the percussions to the live feel, I had them as the loudest elements going into the reverb with the drums. I also

re-recorded vocals through the PA as a separate take to place the vocals into same space with the rest of the band.

In the mix-bus for drum-reverb tracks I had Klanghelm IVGI2 saturation plugin to add harmonic content and to push the re-captured tracks slightly further back, Presonus Pro EQ to get rid of some nasty harmonics and low-end rumble, and two Presonus Compressors in side-chain mode controlled by kick and snare to give more room for the transients of these elements of the drumkit.

Valhalla Room reverb plugin was used for the second mix of Tähtäsit kuuhun. I made FX-track for the reverb and tried to create a similar sub-mix of drums and percussion going into the reverb as had gone through the PA. From the pre-sets of the plugin “Small Hall” seemed to be the closest to the reference room. I adjusted the settings of the plugin by ear to get it sounding even closer to the TV-Studio at TAMK Mediapolis studios.

5.5 Blindfold evaluation and comparison of two mix versions

After producing two mixes of each song using re-amped room ambience and reverb effect, the tracks were sent to four producer-musicians and the three main songwriters of each of the bands taking part in the thesis mixes for listening and evaluation in a blindfold manner. Each listener was asked to identify the technique used for drum ambience and to choose the mix they preferred. The results are shown in Table 1.

The listeners were able to spot the real acoustic reverb over a plugin 68% of the time. Yet, no one was able to spot all four mixes that used real space for creating drum reverb. Nor no one was unable to guess at least one of the acoustic mixes right. All four digital reverbs were able to fool at least one of the seven listeners to believe that the space that it created was acoustic. Most of the comments I got from the test-group included a notion that the listener could not tell why they thought one reverb was acoustical or digital. They simply went by their gut feeling and got it mostly right.

TABLE 1. Results of the query presented to songwriters of the three bands and producer friends.

SONG	**CORRECT ID**	**PREFERRED THE MIX THAT USED ACOUSTIC ROOM**	**PREFERRED THE MIX THEY BELIEVED TO USE ACOUSTIC ROOM**	**FX-UNIT**
Vanha koira	6/7	6/7	5/7	**TC-Electronic M-350**
Verhon takaa	4/7	3/7	4/7	**Presonus Room Reverb**
Luiseva selkä	6/7	6/7	6/7	**Waves IR-L**
Tähtäsit kuuhun	3/7	4/7	4/7	**Valhalla Room**
Total (%)	19/28 (68%)	19/28 (68%)	19/28 (68%)	

6 DISCUSSION

In my work I recorded three bands and took total of four songs from those recording sessions to be mixed two times. Once with re-amped drum room and second time with alternating digital representation of a drum room. The mixes were then blind tested with small group of people consisting of music producers, live-engineers, and musicians. The test-group was asked which of the mixes they preferred and which of the mixes they believed to have re-amped drum ambience.

As a starting point, I believe that if you have the resources available to record the drum ambience along with close-miked acoustic drums, you should always do it just in case it would be needed in the mix. If you cannot do it, there are good reasons for choosing to re-amp drum room just as there are for using plugin or a hardware unit for faking drum ambience. Also, it should be stated that in some projects more “Spielbergian” representation of the world is desirable, and at times it can be easier to achieve with effects than by capturing natural world.

But let us assume that realistic sounding drum ambience is preferred artistically, as it was with the bands that I recorded for the project. In such cases, re-amping of drums seems to give more pleasing results then digital reverbs. But it all comes down to artistical vision and resources. If for technical reasons the engineer is not able to record a decent drum room sound while recording the drum-set, it is likely the production will not have resources to re-capture drums through a PA either. Extra day for re-capturing drums in a proper studio will take money and time. I believe in future I will be experimenting more with room microphones when recording drums, even if I am working in small room or capturing the band live.

The control over sound on plugins such as Valhalla Room or Presonus Room Reverb is quite impressive. Producers and engineers tend to like having lot of control, and this type of plugins give you access to a vast array of sounds in mere seconds. Yet complete mimicking of the sound produced by TV-Studio took a lot of tinkering of settings and results still were not bulletproof. While anybody could buy these plugins and obtain the sounds they provide, not everybody would be able to go into a certain space to record (i.e. exact studio or an old water tower).

The room sounds I captured were unique for that re-capturing session in that studio, as would have been the result with a live-drumkit. If I tried now to replicate the room sound that I created in the original session, I would most likely get slightly altered end results. Replicating the exact placement of all the pieces in the room would be difficult. Including not only placement of microphones and the PA, but the exact settings on pre-amps and other gear, placement of tables, drapes, chairs etc. While some being minor, all these pieces do some alterations to the sounds in the room and add up to the coloration of the sound.

Re-amping room ambience can give results that help the mix feel unique and fresh with sounds hard to be replicated. I believe it could be a vital tool not only for acoustic drums but for big guitar leads, to give realism for autotuned vocals on a pop-song, make loops, programmed drums, or VST-synthesisers sit better with recorded instruments etc. I think this is the true essence of why mixing engineers should consider using acoustic space as a mixing tool even in the 2020's. There is also a danger that a mix that uses the new hip reverb nails itself heavily into the era it was produced, such as happened with a lot of -80's records with larger than life gated-reverb snare sounds. If someone uses a gate-reverb now, it is considered "retro". Trends do come and go. The sound of a drumkit in a room in my opinion is at this point so classic that it will live on as long as bands are using acoustic drumkits. That is a sound that bands (aka. clients of the studio), and audiences who see live acts (aka. consumers of music), will be familiar with.

When mixing several songs for an album, it is not unusual to change the reverb algorithm, convolution or even the effects unit between songs. The reverb tail and pre-delay time can be matched to the tempo of the song. The timbre of the reverb could also be altered between songs to better match the thickness of the arrangement and sounds used in other parts of the song. Drum ambience tracks may not be quite as limber as some of the plugins, but in my work I did some alterations to timbre, stereo width, pre-delay time and length of a reverb tail by changing to different microphones placed in various parts of the studio for each song. For example, choosing a microphone further away or turned away from sound source increased pre-delay time. Microphone with wider polar pattern or facing out of the sound source would gather more reflections giving longer reverb tail. Different stereo-microphone setups have wider stereo-image and different microphones

naturally have different timbre. I was also able to put different microphone pairs together. Engineer could also process the tracks furthermore in the mixing stage with stereo-wideners, EQs, compressors etc. when needed.

To further research the topic, drums could be recorded in a lively space with ambience microphones and mixed three times with three separate drum ambience techniques. The source of the drum room ambience would be the same acoustic space. First mix would be done with the ambience microphones and live-drumkit in the room. Second mix with re-amping of the same drum room. Third mix would use impulse response of the room. Everything between the mixes would be standardized but the technique to create the represent the drum room in the mix. The placement of the drumkit and PA would be the same, as would be the placement of the ambience microphones. Same signal paths and settings on outboard gear would also be used for the microphones. This would give more light on what the audible difference is in a mix if the drums are played live, through a PA or if impulse response is used. Unfortunately, these further studies were beyond the scope of the thesis.

As a conclusion, after reviewing the results, I do not feel it is necessary in most cases to go as far as re-create drum room sound afterwards by using speakers and microphones in acoustic space. The value it would give to most productions is in my opinion limited when considering the resources needed. However, this gives the most realistic representation of acoustic space of techniques reviewed in the thesis. Despite the technical aspects included in mixing it is also an artistical craft. When there are resources to be spared and realistic room ambience would be artistically preferred, re-amping is a viable option. While the reverb is also unique to the session and more realistic representation of drums played in a room, it is not ultimately better sounding.

The project first and foremost taught me to think of the speakers, microphones and even parts of my home as mixing tools. Not only in terms of monitoring sound, but by effecting sound by re-capturing it. While sound exploration by taking audio outside the digital domain of computers may or may not benefit the quality of a mixing sessions, it does provide fun ways of experimenting. At times this is enough.

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APPENDICES

Appendix 1. Table listing the microphones used at TAMK Mediapolis TV-Studio for room recordings

Manufacturer	Model	Membrane	Polar-pattern	Technique
T.Bone	RM700	Ribbon	Figure of 8	Blumlein pair
Oktava	MK012	Small diagram condenser	Omni	Spaced pair, on the floor
CAD	E60	Medium diagram condenser	Cardioid	Mid-Side, mid-microphone
AIR	Peacemaker	Ribbon	Figure of 8	Mid-Side, side-microphone
AKG	C 451B	Small diagram condenser	Cardioid	ORTF -pair (directed toward corners of the roof at the back end of the room)
Neumann	U87	Large diagram condenser	Cardioid	Facing backwall
AKG	414	Large diagram condenser	Multipattern, omni was used	Spaced pair at the back of the room
Rode	NTG3 (silver shotgun)	Small diagram condenser (shotgun)	Super cardioid	Back end of the room, directed from low to the roof
Rode	NTG2 (black shotgun)	Small diagram condenser (shotgun)	Super cardioid	Side of the room, directed from low to the roof
Shure	SM81	Small diagram condenser	Cardioid	Facing wall at the side of the room at the level of the speakers / Facing a up underneath a table behind the speakers
Microtech Gefell	UMT 70 S	Large diagram condenser	Multipattern, figure of 8 was used	Facing the sides of the room, behind a television placed behind the speakers

Appendix 2. Table explaining signal-chains used when recording Vuosi Nolla's drums

Track No.	Instrument	Microphone	Pre-Amp	Signal Prosessing
1.	Kick-Drum In	EV PL33	GAP PRE-73 MK1	-
2.	Kick-Drum Out	DIY Sub-Kick	Mackie 1604 VLZ Pro	D&R Noise Gate
3.	Snare Top 1	Audix D3	GAP PRE-73 MK1	-
4.	Snare Top 2	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter from VLZ Pro)
5.	Snare Bottom	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter (from VLZ Pro) Phase Shift (with Sontronics - ST-Pad/Phase)
6.	Rack Tom	Beyerdynamic TG30Vs	Mackie 1604 VLZ Pro	-
7.	Floor Tom	Beyerdynamic TG30Vs	Mackie 1604 VLZ Pro	-
8.	Overhead Left	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)
9.	Overhead Right	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)
10.	Room	AKG C414B-ULS (Figure-of-8, -10db, low-cut@75hz)	ART Tube MP	-

Appendix 3. Table explaining signal-chains used when recording Satama's drums

Track No.	Instrument	Microphone	Pre-Amp	Signal Prosessing
1.	Kick-Drum In	EV PL33	GAP PRE-73 MK1	-
2.	Kick-Drum Out	AKG C414B-ULS	Mackie 1604 VLZ Pro	-
3.	Snare Top 1	Audix D3	GAP PRE-73 MK1	-
4.	Snare Top 2	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter (from VLZ Pro)
5.	Snare Bottom	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter (from VLZ Pro), Phase Shift with Sontronics - ST-Pad/Phase)
6.	Rack Tom	Shure SM57	Mackie 1604 VLZ Pro	-
7.	Floor Tom	Shure SM57	Mackie 1604 VLZ Pro	-
8.	Overhead Left	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)
9.	Overhead Right	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)
10.	Room Left	Audio Tech-nica AT2020	ART Tube MP	-
11.	Room Left	Audio Tech-nica AT2020	ART Tube MP	-

Appendix 4. Table explaining signal-chains used when recording Ongelma's drums

Track No.	Instrument	Microphone	Pre-Amp	Signal Prosessing
1.	Kick-Drum In	EV PL33	GAP PRE-73 MK1	-
2.	Kick-Drum Out	Superlux R102	Mackie 1604 VLZ Pro	-
3.	Snare Top 1	Audix D3	GAP PRE-73 MK1	-
4.	Snare Top 2	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter (from VLZ Pro)
5.	Snare Bottom	Beyerdynamic MCE530	Mackie 1604 VLZ Pro	Hi-Pass Filtter (from VLZ Pro), Phase Shift with Sontronics - ST-Pad/Phase)
6.	Rack Tom	Beyerdynamic TG30Vs	Mackie 1604 VLZ Pro	-
7.	Floor Tom	Beyerdynamic TG30Vs	Mackie 1604 VLZ Pro	-
8.	Overhead Left	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)
9.	Overhead Right	MXL 770 (-10db, Hi-Pass filtter)	Joe Meek VC3	Compressor (from VC3)

Appendix 5. Print of the sound7.be store page of dB Technologies Opera Live 212 active PA-Speaker.

dB Technologies Opera Live 202

Product no.: DTOL202

This product is not part of our current product range anymore.
Possible delivery methods: Click & Collect, Delivery in Zone 3, Delivery in Zone 1, Delivery in Belgium, Delivery in Switzerland, Non-standard package delivery, Shipping to Parcelshop

Description **Price reductions**

12" 150W + 50W Bi-amplified ABS Speaker
OPERA - high quality active speakers, with professional audio performance and a superior price-performance ratio.
LIVE-SERIES has been adapted to the requirements of musicians and DJs. As a result of its switchable sound set-up, it offers the best possible characteristics of sound reflection for live music as well as playback or speech. The new, more compact multi-functional cabinet creates an ideal connection between acoustic necessity and practical handling, in a very modern design.
The LIVE SERIES offers maximum flexibility and unique features such as a slanted rear side for monitor applications, integrated flange for stands, and 3 integrated M10 threaded fly points. Together with the bass speakers that have been specially designed for the OPERA LIVE series, the cabinet presents a very full and clear bass sound reflection (high sound pressure) with reduced resonance and little noise. The integrated tweeter offers a clear dispersion of 90°x60°. Three handles, one on the top and two on the side make it very easy to carry.
All models are bi-amped and are monitored by an integrated audio controller. In addition to the active splitting of the two ways, the audio controller facilitates a particularly clear sound, by phase and delay adjustment. Furthermore, the audio controller guarantees a flat and linear reproduction of all frequencies across the entire audio range. The limiter ensures a maximum of operational reliability, even when driving the speaker beyond its limits, indicated by a control LED.
All models offer three switchable sound setups - FLAT (neutral), MUSIC and SPEECH. This makes it possible to adapt it to the respective application without any further external equipment.
Technical specifications
- Power (RMS): 150 + 50 W
- Power (Music): 300 + 100 W
- Speaker 12" dB Bass, 2" Voice coil, 1" HF
- Frequency response: 68-18000 Hz
- Max. SPL: 120dB
- Crossover: 2000 Hz
- Sensitivity: -40 bis 0 dB
- Input connection: 6,3mm Jack unbal. / XLR bal.
- Output connection: XLR bal., parallel
- Impedance: 20 K Ohm bal., 10 K Ohm unbal.
- Dimensions: 406 x 650 x 350 mm
- Weight: 16,9 kg

https://www.sound7.be/dB-Technologies-Opera-Live-202