# RESEARCH INTO AND DESIGN OF A DIGITAL SOUND SAMPLE LIBRARY FOR ACOUSTIC DRUMS.

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**Mini-thesis presented in partial fulfillment of the requirements for the degree of Master of Philosophy in Music Technology in the Faculty of Arts, University of Stellenbosch.**

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## Declaration

This thesis contains no material that has been accepted for the award of any other degree or diploma at any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

Signature

Date

**DEDICATED**

**TO**

**MY PARENTS,**

# PIETER AND RINA MEIJER

**FOR**

**YOUR BLISSFUL MUSICAL INSPIRATION**

# ABSTRACT


Sound sample libraries represent the format in which huge collections of sampled sounds are made available for use within digital samplers and/or other digital audio workstations (DAW's). Although in use for many years, little or no academic research has been done on the methodology of compiling a commercial sound sample library.

In this endeavour, the factors influencing the design, recording and publishing of a sound sample library are investigated through the actual design of a drum sample library. The rationale behind the sampling of a drum kit is carefully depicted in the light of various other factors influencing the instrument, as well as being influenced by the instrument itself.

A professional drummer was engaged to play a state-of-the art Gretsch acoustic drum kit. Samples of the kit, consisting of various individual instrument parts, were recorded in three locations within the Konservatorium of Stellenbosch University, for reasons carefully explained in the text.

These numerous drum hits were mixed and cut into individual drum samples. The samples were mapped into a digital software sampler, GigaStudio, creating five distinct collections of drum samples that faithfully represent the quality of the drum kit, the recording rooms as well as the equipment used in the process.

The outcome of the study is a professional product in the form of a Gretsch drum sample collection, prepared for commercial release. Many of the drum samples have already been used successfully in commercial music releases over the past 12 months.

Whilst the drum sample library is currently being published, the product and documentation clearly depict the viability of the study in terms of the artistic and academic expectations that have been met. The study anticipates future research on the subject.

# OPSOMMING

Klankbiblioteke heet die formaat waarin versamelings van klankmonsters beskikbaar gestel word vir gebruik in digitale *samplers*[1] en/of ander digitale klankprogrammatuur. Nieteenstaande die feit dat klankbiblioteke reeds jare in gebruik is, is geen studie waarin die ontwerp en saamstel van so ‘n biblioteek beskryf word, bekend nie.

In hierdie navorsingsprojek word die faktore wat die ontwerp, opneem en vrystelling van ‘n klankbiblioteek beïnvloed bestudeer deur die skep van so ‘n biblioteek. Die oorwegings vir die keuse van ‘n tromstel is noukeurig uiteengesit in die lig van die faktore wat betrekking het tot, en wederkerig beïnvloed is deur die instrument en opname-omgewing.

‘n Professionele tromspeler is vir die projekdoeleindes gekontrakteer om ‘n Gretsch akoestiese tromstel te speel. Klankmonsters van die tromstel se individuele komponente is in drie lokale binne die Konservatorium van die Universiteit van Stellenbosch opgeneem, met redes soos uiteengestip in die teks.

Klankopnames van die talle tromslae is gemeng en opgesny in individuele klankmonsters. Laasgenoemde is in *GigaStudio*, ‘n digitale sagteware *sampler*, gekarteer sodat vyf duidelik-onderskeibare klankveramelings geskep is. Hierdie versamelings lig die kwaliteit van die tromstel asook die verskeie opnamelokale en toerusting wat gebruik is duidelik uit.

Die resultaat van die studie is ‘n professionele produk in die vorm van ‘n Gretsch kommersiële klankbiblioteek, waarvan verskeie klankmonsters reeds oor die afgelope 12 maande in plaaslike musiek-vrystellings gebruik is.

Hoewel die klankbiblioteek huidiglik vrygestel word, toon die produk en dokumentasie duidelik die artistiese en tegniese waardigheid van die studie. Die studie antisipeer toekomstige navorsings-moontlikhede wat uit die onderwerp mag voortspruit.

[1] Die term *sampler* word gebruik in die afwesigheid van ‘n formele Afrikaanse alternatief.

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Helmut Meijer
January 2004

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# CHAPTER 1

# INTRODUCTION

## 1.1. Motivation for this study

*Sampling* is a rising trend amongst contemporary composers and producers, and it is increasingly becoming fashionable amongst electronica artists and performers. Although not formally defined within the academic music environment, *sound sample libraries* have become synonymous with modern-day commercial music production. Collections of high quality sound samples in the form of sample libraries provide a source of raw recorded material for music production in all genres. These sample libraries are typically associated with digital [software] samplers, capable of managing extreme quantities of high quality audio samples, for numerous applications. *GigaStudio*, a giant amongst software samplers, is a "state of the art sampling and sample playback program" (New Notations London: 2003) and has established itself as a benchmark sampling platform for creating and hosting the best of sound sample libraries.[2] Gigastudio allows the construction of "sample libraries gigabytes in size, recreating truly expressive, dynamic and rich sounding instruments" (New Notations London: 2003).[3] Little research has been performed on the actual sound design and application of sample libraries, although they have been in use for many years.[4] The primary motivation for the study is the author's personal interest in the construction of a sound sample library that is associated with the most advanced and accessible digital sampling technology. The availability of the necessary resources, in terms of literature and production materials, furthermore increased the motivation to personally research and design a digital sound sample library.

[2] Visit http://shopteac.com/Merchant2/merchant.mvc?Screen=CTGY&Store_Code=SG&Category_Code=SL for the latest sample library releases for GigaStudio.
[3] Comprehensive reviews on GigaStudio were done by e.g. Krogh (2003), Metts (2001) and Walker (2000).
[4] Database searches at DDM, IIMP, RILM and UMI have been completed.

## 1.2. Purpose of the study

For reasons extending beyond the scope of the study, music technology in the local [South African] context may be regarded as underdeveloped and/or under-exploited. The reasons for the state of affairs are moot; the broader South African music scene nevertheless shows an irrefutable void with regards to innovative technological research. The main purpose of the study is the construction of a commercial sound sample library, researching and incorporating applicable digital production principles, materials and methods. Furthermore, the purpose of the study is to illustrate the viability of merging innovative (creative) and academic ends into a synergistic whole. The outcome is an original product with its related academic documentation.

## 1.3. Sources

As depicted in the text, the thesis covers a variety of academic and creative disciplines that draw from a complex system of information sources. With this in mind, the primary academic sources of information include a range of printed publications on the main themes of digital sampling and samplers, as well as their supportive peripherals and foundations. These include official published information on the application of the various software platforms,[5] as well as a vast collection of specification sheets, manuals and information brochures on all the equipment used throughout the project. The Internet also proved invaluable in providing the most recent information on sampling and sample library developments, as very little academic information was available on [especially] the latter subject. On the creative side, primary sources included many informal trial sampling sessions and the evaluation of records that utilize samples and/or sample collections. The *Samplehead* drum sample library, *Peter Erskine - Living Drums* (Sampleheads: 2003), was used as a primary creative reference, firstly for its simplicity of design and secondly for its product layout style. Secondary and other sources of information included personal interviews with professional mastering engineer Tim Lengfeld and personnel from Stellenbosch University's Division of Infrastructure. Lateral thinking was imperative in coordinating the many disciplines involved.

[5] For example GigaStudio and ProTools' User's Guides.

## 1.4. Research methodology

The project was executed over a period of approximately 18 months and was performed according to a premeditated schedule. Preliminary research consisted of an extensive literature study, incorporating as much of the scope of the project as possible. During the preliminary phase, practical experience was gained through many hours of becoming acquainted with *ProTools* and *GigaStudio*. This inevitably demanded familiarization with various user's manuals, specifications of the recording equipment, recording techniques, sample library applications etc.

The literature study was followed by an all-embracing production phase, discussed in detail in Chapter 5. The study was documented as the research progressed. Due to the innovative nature of the study, new challenges surfaced as the project expanded. The result was that the literature research continued throughout the course of the project. Chapter 5 deals extensively with the actual project methodology.

## 1.5. Problems specific to this study

Difficult as it is to evaluate the study in an objective way, the main problems of the project were all time-related. Any creative process, however scientifically supported, is time-consuming. Most of the production and documentation was performed as a part-time study and proved very frustrating. The scope of the project only fully emerged as the study evolved, which slowed down the documentation significantly. This in turn resulted in an even more time-consuming process of unifying the different focus areas.

Further problems encountered were the dependence on various role-players, as well as the slow process of documentation, which in turn slowed down the actual production. The unwanted low frequency 'rumble' of the air conditioning system of the Konservatorium building was the core impediment of the production stage. Skillful application of mastering algorithms successfully eliminated all unwanted rumble from noisy samples. For a discussion of this process, refer to *Appendix A.*

Throughout the project, tedious mistakes and detailed procedures often delayed certain phases. In hindsight, all of the above problems are probably perceived more intensely because of personal impatience. In summary, in can be said that a project of this nature stands to benefit from being subjected to less pressure, and from a reasonable amount of endurance.

## 1.6. Structure and scope of the study

**Chapter 1** introduces and outlines the motivation and purpose of this study, sources and methods employed, problems encountered as well as the structure of the thesis. **Chapter 2** sketches an outline of and definition for sampling[6] and samplers, as well as providing a short background on the history of sampler development. This purpose of this chapter is to outline the sampling theme of the thesis. **Chapter 3** provides the background and rationale for the preference of sampling a drum kit, as well as an overview of the applicable room acoustics encountered. Chapter 3 furthermore classifies and describes the drum kit in terms of its individual instrument parts, general acoustic specifications and describes the specific Gretsch drum kit sampled during the study. **Chapter 4** describes each of the different stages of the creative process, providing an overview of all the equipment specifications, materials and methods employed. **Chapter 5** draws from the conclusions of the preceding chapters and describes the final construction of the drum sample library. The conclusions of the thesis are drawn in **Chapter 6**, followed by the **References** section and **Appendices.** The **glossary** for the thesis is included as the final appendix.

For reasons of copyright protection, a decision regarding the inclusion of the complete sample library with the thesis documentation had to be made. This boiled down to including only a selection of samples with the printed thesis. The complete sample library is due to be published commercially.

[6] Chapter 3 deals with sampling as a musical technique, and not with the quantification of analog signals into discreet values. The latter subject extends beyond the scope of the study.

# CHAPTER 2

# AN OVERVIEW OF SAMPLING

## 2.1. Defining sampling and samplers

*Sampling* – a term borrowed from the [technique of analysis][7] that forms part of a digital recording process (Davies 2001b: 219) – is simply a method of recording sound. Originally, this process involved taking sound directly from a recorded medium and transposing it onto a new recording (Fulford-Jones 2001: 219). The term is used less restrictively nowadays, as it may refer to any recording where the material is edited for use as sound samples in other, or to produce new recordings. This technique is referred to as *sample posing*.

Digital sampling is based around the following three electronic devices:

- Analog-to-digital converters (ADC)
- Memory/storage devices like RAM and flash EPROM, etc.
- Digital-to-analog converters (DAC)

These three devices constitute a digital[8] *sampler* and carry out the three major sampling functions:[9] recording, storing and replaying the stored sound (Russ 1996: 203). Since samplers are electronic musical instruments with no sound of their own, sounds are entirely derived from recordings (Davies 2001b: 219). The term *sampler*[10] hence refers to a piece of electronic musical equipment, which – based on any form of recording mechanism – records a sound, stores it, and replays it on demand (Russ 1996: 196).

[7] "The process of encoding an analog signal in digital form by reading its level at precisely spaced intervals of time." (Vail 2000: 329) For more detail on the sampling theorem, quantization noise, Nyquist theorem and aliasing, see e.g. chapter 1 of *Computer Sound Synthesis for the Electronic Musician* by Miranda, E.R. (1998: Oxford, Focal Press)
[8] Samplers are commonly regarded as digital instruments, although the technique of sampling dates back to the analog era.
[9] Sample players are playback-only units. Aside from recording capability, samplers and sample players are similar in features, functionality and specifications (Rothstein 1995: 69-70).
[10] Recorded collections of material from more than one source are also called 'samplers' (Russ 1996: 197).

In contrast to its straightforward design, Rothstein (1995: 67) states that samplers are "one of the most versatile MIDI instruments". For the purpose of this endeavor, it is therefore important to define a sampler in terms of its functionality as this enables a wide range of equipment to be classified as samplers. A sampler works in three modes: record, edit/store, and replay.

During recording, the continuous analog signal is converted into a numeric digital representation, which is then stored in RAM. The second mode enables editing of the sound. Edited data is stored in some form of permanent storage like a hard disk, which in turn can be reloaded into the sampler's RAM memory, when required (Russ 1996: 204). Samplers usually allow recorded samples to be distributed across a keyboard and played back at various pitches (Vail 2000: 329). See *section 2.2* for further detail on sampler functionality.

Many modern electronic instruments feature both sampling and synthesis, consequently making it difficult to distinguish between a sampler and synthesizer (Davies 2001b: 219). The generic term, *sample and synthesis*, refers to many methods of sound synthesis, which use variations on a sample playback oscillator as the raw sound source (Russ 1996: 179). Though a very complex concept, this in short defines the basis for modern sample posing.

In the past, sampling technology was constrained by and limited to the memory capacity of samplers.[11] Bitstream technology – the direct streaming of huge samples directly from a hard disk – nowadays allows for very realistic sample playback and this effectively brings modern day sample technology in close proximity with real-time recording and playback performance. Refer to *section 2.4* for more information on bitstream technology and GigaStudio.

[11] These include self-contained 'black box' samplers of the 1980's and the increased use of microcomputers in the 1990's (Davies 2001b: 219).

## 2.2. A concise history of digital sampling

Sampling, as commonly understood by producers and musicians, was originally[12] associated with DJ's mixing recordings from original vinyl sources with other records as part of a DJ set, and later during live performances (Fulford-Jones 2001: 219). In terms of the musical technique, sampling is so ubiquitous in contemporary music styles like rock, pop and R&B; the propensity is to forget that it is a relatively new art form (Dayen 2001). Using prior recordings to create new music is however not a new concept. Weitz (2002) states that the practice of copying music can be traced back to the dawn of man and is seen throughout all musical eras, whereby composers commonly created new works upon the musical themes of earlier composers. This phenomenon is referred to as *musical quotation*.[13]

Moving from the various imitations of the past towards creating new musical ideas, sampling has become an integral part of the larger electronic synthesis system. Synthesizing new sounds without utilizing sampling is paradoxically becoming a novel concept. Therefore, the definitions of both synthesizer and sampler become more open-ended when viewed in the larger context of the two broad technologies, analog and digital. Samplers span these two chronologically related technologies with similar instruments and consequently form a bridge between analog and digital synthesizers (Russ 1996: 197).



A survey of the literature reveals that the history of sampling can be seen in a very different light compared to the history of samplers. Development or progress in the area of sampling is considered independent of actual sampler development. This section will briefly[14] discuss the development in the area of samplers (and subsequent sampling techniques), dating from the pre-analog era through modern day digital sampling platforms. Table 1 summarizes the main events in the history of sampler development between 1963 and 1988.

[12] Cutting, splicing and manipulating recordings to produce new musical works actually predates modern sampling (Weitz 2002), though the focus here falls specifically on the historical overview of sampling, in terms of sampler development.
[13] According to Weitz (2002), a "musical 'quotation' is the analog corollary to digital sampling. A musical 'quote' is the taking of a distinctive and recognizable portion – relatively brief, according to Burkholder (2001: 689) - of another era's or composer's music and using it in a new context." See Sample posing.
[14] Refer e.g. to *Electric Sound: The Past and Promise of Electronic Music* by Joel Chadabe (1997) for a comprehensive overview of electronic music and the contributions of systems, composers, approaches and technologies to this field.

#### *2.2.1. Tape-based sampling*

The use of samplers – although more commonly associated with the past 10 years (Wiffen 2002) – date back to the late 1940's and is firmly anchored in the French tradition of *Musique concrète*. Pioneered by Pierre Henri and Pierre Schaeffer, Musique concrète – itself having a long history before its first appearance in 1948 – is regarded as the first type of electronic music associated with modern-day sampling (Musespace 2003).

The first samplers were based on tape recording techniques, although the first 'tape' recorders ironically used metal wire instead of tape. Plastic tape covered with iron oxide offered much more handling and splicing advantages[15] (Russ 1996: 197). Developed in 1963, the British designed *Mellotron* was the first[16] electromechanical keyboard instrument (Davies 2001a: 354) to use recordings of actual instruments by utilizing a clumsy tape replay system.

The technology of the Mellotron limits the user to 'onboard' (prerecorded) samples. Sounds are produced from a series of parallel lengths of magnetic tape, individually controlled by keys on the keyboard. When a key is pressed, the corresponding tape is drawn over a replay head; when released, a spring mechanism returns the tape to the starting point. Maximum sample duration varies between 7 and 10 seconds, for different models (Davies 2001a: 354). Because of the difficulty of recording sounds onto tape – due to physical limitations of the tape itself – these[17] samplers should rather be regarded as sample replay instruments. Popular names like *Genesis*, *The Moody Blues*, *The Beatles*, *Led Zeppelin* and the current *Oasis* are all associated with the Mellotron (Yamaha Coporation 2002a).

For comprehensive information on the Mellotron, refer to: *Mellotron – Pillar of a Musical Genre* by Mark Vail in *Vintage Synthesizers*. Also, visit the UK Mellotron Archives site at http://www.vemia.co.uk/mellotron/ (Martin 2002).

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[15] See e.g. chapter 4 of *Sound Synthesis and Sampling* by Russ, M. and chapter 1 of *Audio Electronics* by Hood, J. L. for detail on tape recording mechanisms.
[16] Disputes amongst historians exist. According to Davies (2001b: 219), less well-known analog samplers date back to the 1930's.
[17] Although several other manufacturers produced variants on this idea, the Mellotron is the best known (Russ 1996: 199). After bankruptcy of its worldwide distributor in 1977, it was renamed the 'Novatron', although the original name continues to be used widely (Davies 2001a: 354).

### 2.2.2. Analog sampling

Experiments in sampling, utilizing analog technology, were first performed in a clandestine manner by underground musicians in the late 1970's (Dayen 2001). Analog sampling covered any method not utilizing tape or digital methods[18] to store the audio signals and was commonly associated with a technology known as the 'bucket-brigade' delay line, or analog delay line. An analog delay line stored and then transfered an input voltage along a series of capacitors connected by switches (Russ 1996: 201). Because of simplicity of control and application, the analog delay line became popular in the 1970's and early 1980's.

Limitations included imperfect capacitors causing signal loss, distortion and noise, due to leaking charges. Sampling and transfer of charges required a high frequency clock signal, which tended to become superimposed on the output signals, degrading the usable dynamic range of the system (Russ 1996: 202). Other variants of analog samplers included the use of metal springs or plates to carry audio signals acoustically and optical film to store the audio signal. None of the analog sampling methods proved successful against digital competitors (Russ 1996: 203).

### 2.2.3. Digital sampling

The era of digital sampling dawned with the appearance of the Australian designed *Fairlight CMI* - the first commercially[19] available digital sampler using computer chips – in 1979. Though outrageously expensive and crippled by its clumsy physical structure and poor sound quality, it was capable of recording and replaying any sound (Wiffen 2002). Included was an internal sequencer – the once legendary *Page R* – and a graphical representation of sample waveform on a green-on-black display, with light pen functionality for creating and editing waveforms on-screen (Yamaha Coporation 2002a). The Fairlight was successful in applying digital technology to the idea of keyboard-controlled tape playback (Chadabe 1997: 185). The Fairlight CMI re-emerged over the years as the Fairlight Series II and III (Yamaha Coporation 2002a). Fairlight users included *Peter Gabriel*, *Thomas Dolby*, *Stevie Wonder* (Vail 2000: 214) and *Art of Noise* (Yamaha Coporation 2002a).

[18] Davies (2001b: 354) does not distinguish between analog and tape-based sampling.
[19] A dispute exists as to whether the Fairlight CMI was aimed at a consumer or professional market, in which case the 1985 Ensonique Mirage would be considered the first commercial sampler (Russ 1996: 213). Affordability may very well be the issue at stake.

Commercially released in July 1979 (Chadabe 1997: 186), the New England Digital *Synclavier* only became popular in 1985 and was soon replaced by the *Synclavier II*. Although three models were designed, they were collectively known as Synclavier. The very expensive Synclavier was ahead of its time as digital sampling synthesizer. Features included a sound editing facility for tweaking harmonics, built-in FM synthesis and an external hard disk storage option. A reintroduction of the Synclavier in 1984 featured a full-sized and weighted keyboard with velocity and aftertouch. It also featured 64 voice polyphony, 32 MB of waveform RAM (expandable to 768), 32 outputs, music printing output and up to 16 tracks digital recording (Friedman 2002b) at 50 kHz sampling with 16-bit resolution (Dayen 2001). An onboard arpeggiator, a robust 200-track sequencer and an optional DSP effects package was also available for the Synclavier. Users included *Sting*, *Foreigner*, *Michael Jackson*, *Pink Floyd*, *Kraftwerk*, *Depeche Mode* and *Genesis* (Friedman 2002b).

In 1981, the US synth manufacturer Emu launched the *Emulator*: a dedicated digital sampler without synthesizer and sequencer functionality. Though similar in specifications to the Fairlight (8-bit, 8 voice), the Emulator weighed in at approximately half the price. The Emulator had a four-octave keyboard, split into two halves. Every sample was a fixed two seconds in length and editing functionality was limited. The Emulator was succeeded by the Drumulator and later the Emulator II (Vail 2000: 220-225), with over half a megabyte of memory. It allowed more than 17 seconds of sampling at an unparalleled 26.6 kHz rate (Wiffen 2002). Emulator users included *Kraftwerk, Genesis, OMD* and *Depeche Mode* (Yamaha Coporation 2002a).

The 1984 *Ensoniq Mirage* was the first affordable commercial sampler (Vail 2000: 33). Although limited by 8-bits of sample resolution, 8-note polyphony and restricted memory capacity, the Ensoniq Mirage had LFO modulation and separate filter and VCA envelopes, with a velocity sensitive keyboard. The discreet user interface featured a 2-digit LED display. Other features included low-pass filters with resonance control, keyboard tracking, looping and a simple sequencer (Russ 1996: 213).

Manufactured in 1986, the crude *Casio SK-1* was a 38 key sampler with 8 preset sounds, 11 rhythms and a memory function. A built-in microphone allowed recording of 1.4 seconds of audio. Features included reverse playback and the ability to edit the sound using built-in filters. The SK-1 was followed by the more elaborate *SK-5*, with its eight triggering pads and ability to hold four different samples (Casio Electronics Co. Ltd. 2003).

*Akai* was the first company to produce digital samplers for the mass market (Yamaha Coporation 2002a). Also emerging in 1986, the *Akai S900*, with only 12-bits of sampling resolution, was the first professional rack-mount sampler. Limited to 8-note polyphony, the Akai S900 had eight individual outputs, software “to make it almost a *de facto* standard for sampling for several years” (Yamaha Coporation 2002a) and a floppy disk format which later became the common exchange medium of choice. It also featured a maximum sample rate of 40 kHz, giving 11.75 seconds of high-quality monophonic sampling, and a capacity of 32 samples to be distributed across a keyboard. Refined facilities such as cross-fading and cross-fade looping were also included. Up to 32 sampler setups (available at any one time) could be saved to disk (Russ 1996: 214).

The S900 were superseded by the *S1000* in 1988 (by way of the *S950*), and 16-bit stereo sampling, with 16-note polyphony, eight outputs and increased memory capacity were finally introduced (Yamaha Coporation 2002). Additional features included front panel controls, compatibility with the S900 and an optional SCSI hard disk interface. Standard sampling time was almost 50 seconds at 22 kHz for monophonic samples. The modifier section included LFO modulation and separate filter and VCA envelopes whilst sample playback control included all features expected on a “second generation professional sampler.” (Russ 1996: 215)

In 1989, *Roland* released the *S770*, “Rolands finest sampler ever” (Sonic State Ltd. 2004). Apart from its high fidelity, stereo sampling capacity (Wiffen 2002), features include excellent filters, resynthesis and external display – much the same as the Fairlight user interface. The S770 continues to be unmatched by many modern day samplers.

Throughout the 1990’s, sound quality, features, facilities and programmability of samplers have increased as dramatically as prices have dropped. Companies manufacturing electronic instruments have contributed to and ushered huge development over the past 10 years. Memory capacities have been increased and developed as such that *sampling* is now synonym to direct-

**Table 1:** Summary of the main events in the history of sampler development – 1963 to 1988.

| *First release* | *Manufacturer* | *Model* | *Type* | *# voices* | *Sampler Resolution (bits)* | *Sampling rate (kHz)* | *Sampler memory* | *Notable features* |
|---|---|---|---|---|---|---|---|---|
| 1963 | Streetly Electronics | Mellotron | tape-based | - | - | - | 7 – 10 secs | - |
| 1970 – 80 | - | - | analog | - | - | - | - | analog delay lines |
| 1979 | Fairlight | CMI | digital | 8 | 8, 16 | 24 | 8 x 16 Kb | on-screen editing using a light pen |
| 1979/1984 | New England | Synclavier | digital | 64 | 16 | 50 | 32 Mb onboard | sequencer, DSP effects, optional hard disk, weighted keyboard |
| 1981 | Emu | Emulator | digital | 8 | 8 | 26.6 | 17 seconds | four octave keyboard |
| 1984 | Ensoniq | Mirage | digital | 8 | 8 | 32 | 144 Kb | velocity sensitive keyboard, LFO modulation, filter and VCA envelopes, LP filters with resonance |
| 1986 | Casio | SK-1 | digital | 4 | 8 | 9.38 | 1.4 secs | mini keyboard |
| 1986 | Akai | S900 | digital | 8 | 12 | 40 | 11.75 secs | rack-mount unit, cross-fading and cross-fade looping |
| 1988 | Akai | S1000 | digital | 16 | 16 | 44.1 | 25 secs | optional SCSI interface, LFO modulation, filter and VCA envelopes |

to-disk recording. Low-latency, bit-stream technology and hard drive (optical) memory enables real-time playback, fusing recording and performance applications into a creative whole, under the direct control of the user (Wiffen 2002).

## 2.3. The basic geography of digital samplers

The power and versatility of samplers lie in the accessibility and endless possibilities of manipulating the recorded data, typically stored in RAM. Hardware digital samplers may take the form of rack-mount units (controlled via MIDI) or synthesizer-style keyboards – often essentially stand-alone samplers with an added keyboard. However, computer-based or software samplers, like *GigaStudio*, offer much more advanced sampler functionality and capability. Discussed below is the basic design of typical digital samplers. Sampler design can best be discussed in terms of three modes of operation: recording, editing/storing and playback (Russ 1996: 204).

### *2.3.1. Recording*

At the input stage, an audio source is fed into an ADC where the input signal is *sampled* at regular intervals, in effect looking at the height of the input waveform, and converting this to a sample value. This rate is referred to as the 'sampling frequency'. The series of sample values (numbers), over a period, provides a digital representation of the sound,[20] which can be stored either in RAM or to hard disk (Yamaha Coporation 2002b).

### *2.3.2. Editing/Storing*

The most important editing function is the trimming of unwanted sections of the raw samples. Also termed 'top and tail', the trimming process allows the user to set the start and end of a sound. This is particularly important in noisy samples, for rendering the noise content as less apparent. Advanced samplers provide automatic trimming functions. The ability to manipulate start and end times of samples is essential when using a sampler as a synthesizer, rather than merely a sample replay instrument. Sample editing facilities allow changes to be made to individual samples, rather than global filtering made available in a modifier section (Russ 1996: 204). According to Russ (1996: 204), the three most important editing techniques are looping, stretching and re-sampling.

[20] Currently the typical sampling frequency equals 44.1 kHz and the bit-depth, 16 bits.

*Looping*

According to Rothstein (1995: 69), *looping* allows indefinite repetition of the same portion of a sample, which can optionally be controlled by an envelope generator, changing the volume of the loop over time. To avoid hearing a 'glitch', it is important that the start and end of the loop have the same level, which can be made possible when these two levels are the same, have the same slope or their slopes have the same rate of change. Looping is best executed between two *zero crossings*, i.e. where the audio waveform crosses the zero axes. Cross-fading between end and start times of a loop can eliminate 'clicks' or minimize cyclic variations in timbre, produced by the differences in timbre quality at the start and end times of samples. The fixed timbre of a looped sample tends to sound unnatural, compared to the change-over-time in the timbre of real instruments. This is compensated for by applying an envelope generator and thus changing the looped timbre over time. Depending on the hardware and software of the sampler, another possibility is multiple loops, each with envelope, pitch modulation and velocity switching facilities (Russ 1996: 204-207). Looping of samples is primarily a solution for memory constraints (Rothstein 1995: 69), which no longer present a problem in hard disk samplers.

*Stretching*

This is the process of independently adjusting the pitch or timing characteristics of a sample. In contrast to *transposition*, affecting both pitch and timing, stretching aims at altering either pitch or timing, without changing the other. Both timing and pitch changes involve analyzing the sample and adding or removing sections, depending on whether a sample is being shortened or lengthened.

*Re-sampling*

The facility of recording the output of a sample replay, is termed re-sampling, which in digital samplers allows for changes in the sample rate or any changes in the original sample to be stored as part of the new sample. Re-sampling thus enables 'snapshots' to be made of the output of the sampler for re-use as raw material for additional editing and sample manipulation (Russ 1996: 207-208).

A related technique, *multi-sampling,* is used to provide for changes in sound across the keyboard (Rothstein 1995: 68). This applies especially for instruments with huge differences in timbre (harmonic structure) across their range. According to Russ (1996: 208), applying the use of multi-sampling demands complex and very exacting work, and large amounts of sample memory (Rothstein 1995: 68) are needed. This is compensated for by using sample transposition, which in turn can cause severe unwanted effects and thus changing the character of the instrument noticeably. Transposing certain percussion-like instruments produces sounds that merely sound wrong (Russ 1996: 208-209)!

Storage in samplers is categorized as being either short-term (internal) or longer-term, in which case storage is often external to the sampler device itself. RAM is used to hold samples as they are recorded or replayed. Dynamic RAM chips are cheaper than static RAM chips and are more likely to be found in low-cost samplers, but as a result, dynamic RAM requires backing up to a more permanent storage facility before powering down the sampler. Longer-term storage is often associated with the following:

- Magnetic media
- Optical media
- Flash EPROM
- Memory cards

Flash EPROM can be internal to the sampler, or on a plug-in memory card. Magnetic and optical media include floppy disks, as well as hard disks and CD-ROMs. These can be either fixed or removable devices. Memory cards may include a miniature hard disk – typically using the PCMCIA / PC card format - or can be either RAM or flash EPROM based. Samplers typically use a SCSI interface to connect to external memory devices. Implementation of a local area network (LAN) allows networking of samplers, like sharing common storage devices. A large storage capacity is required to store digital audio signals.

Table 2 indicates the storage requirements for stereo audio samples. A reduction in bit-depth causes a significant loss in sound quality whereas a reduction in the sampling rate restricts the bandwidth of the recorded samples (Russ 1996: 209-210).

### *2.3.3. Playback*

Sampler data can be reloaded into the sampler's RAM when required. The playback or replay mode takes sample data in the sampler memory and converts it back to an analog signal (Russ 1996: 203-204). In computer-based samplers, signal conversion (ADC and DAC) is often carried out in a separate unit outside the computer in order to optimize conversion accuracy or as a solution to conveniently host all connection sockets (Russ 1996: 211).

**Table 2:** Digital storage requirements for stereo audio samples.

| Stereo bit-depth | Sampling rate (Hz) | Storage/second (Mb) | Storage/hour (Mb) |
|---|---|---|---|
| 8 | 44100 | 0.09 | 317.52 |
| 16 | 44100 | 0.18 | 635.04 |
| 24 | 44100 | 0.26 | 952.56 |
| 24 | 48000 | 0.29 | 1036.80 |

## 2.4. Introduction to GigaStudio

Against the backlight of sampler development, this section introduces the *GigaStudio*[21] software platform. Developed in 1998 by Texas' Nemesys Music Technology, Incorporated, GigaStudio is currently owned[22] by TASCAM/TEAC America. Drawing from and expanding on the basic design of digital samplers, GigaStudio has many advanced features, rendering GigaStudio as "the world's biggest, fastest, best sampler" (TASCAM/TEAC America 2001c).

The GigaStudio product consists of the following:

- GigaSampler – the software sampler that plays GigaSampler instruments.
- GigaSampler Instrument Editor – for creating GigaSampler instruments.
- Sample Wrench XE – for editing sound waveforms. This option is available only with certain software packages.
- GigaSampler Sound Collection I - including GigaPiano, a gigabyte-sized Yamaha Concert Series grand piano.

For optimal computer performance, GigaStudio demands a system with the following specifications: 266 MHz Pentium II MMX processor, 128 MB RAM, 6 GB of hard disk space on Ultra DMA, Ultra ATA, or Ultra/Ultra Wide SCSI hard drives with 512K cache (Nemesys Music Technology, Inc. 1998). Note that these specifications are subject to change and are applicable to *Microsoft Windows* operating systems only.

*GigaStudio 160* was used for the final sound design and compiling of the sound sample library of this study. Refer to *Chapter 5* for technical specifications of the recording hardware and software used.

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[21] It is unclear whether the actual software program is called *GigaSampler* or *GigaStudio*, as both names are used without clear preference to one or the other. *GigaStudio* collectively refers to *GigaStudio 32*, *GigaStudio 96* and *Gigastudio 160*, the three flagship software samplers of TASCAM. The sampler shall hence be referred to as GigaSampler, whilst GigaStudio shall refer to the software package as a whole. Refer to the GigaSampler User's Guide (1998: Nemesys Music Technology, Inc.) for extensive reference to GigaSampler™ and GigaStudio™.

[22] GigaStudio was developed by, and owned by Nemesys Music Technology of Austin, Texas, until July 19, 2001. It was acquired, and is currently owned by TASCAM/TEAC America (Tascam/Teac America 2001a). For reference purposes, GigaStudio remains an original product by Nemesys Music Technology, Inc. For more detail on matters concerning TASCAM GigaStudio, visit http://www.nemesysmusic.com and/or http://www.tascam.com/company.

### *2.4.1. Hard Disk Sampling Workstation*

Offering a revolutionary[23] new framework for sampling, synthesis and sound design, GigaStudio 160 is a "fully integrated sampling environment"[24] featuring 160 voices of polyphony (all disk-based), 64 MIDI channels, zero-latency multi-effects, a comprehensive instrument editor, enhanced network streaming and more. GigaStudio can stream gigabyte-sized samples in real-time from a PC-based hard drive and allows ultra-fast download times and real-time performances. RAM is no longer a limiting factor (Nemesys Music Technology, Inc. 1999). According to Nemesys (1999), GigaSampler 160 offers the following additional features:

- Patented hard disk sampling technology
- 32-bit audio signal processing
- 32-bus automated digital mixing with level, pan, inserts, and effects controls
- Support for 24-bit / 96 kHz hardware
- Enhanced sample format conversion utilities for Akai S1000, S3000, GigaSampler and WAVE
- 32-bit DSP Station
- QuickSound™ real-time interactive sound database
- Dimension articulation switching / cross-fading
- Patented EndlessWave™ technology
- Instrument Editor featuring multi-mode resonant filters (low-pass, band-pass, high-pass and notch) with external Q factor (Q) and center frequency ($f_c$)
- Release triggered sampling for natural instrument resonance
- Enhanced support for GigaSampler file formats: intelligent auditioning, up to 5x faster loading times and extended instrument information
- Embedded Help System
- Selected *Soundware* and sample collection demo's

[23] Hans Zimmer, Academy Award® winning composer states: "Unless you explore it, emotionally you cannot understand how revolutionary GigaStudio is." (Nemesys Music Technology, Inc. 1999)
[24] "…a fully expandable software framework that integrates enhancements, advancement and upgrades." (Nemesys Music Technology, Inc. 1999)

### *2.4.2. Sound Sample Libraries and GigaStudio*

Sound Sample Libraries, though not a formal collective entity, attempt[25] to define the retail format in which sample collections or compilations are made available. These sound sample collections are produced using several hardware and software sources, but demand the most apt sampling workstation for the final sound design and library assembly, in which case GigaStudio served optimally.

Within context, a Sound Sample Library is assembled by creating one or more complex GigaSampler Instruments from prerecorded sound samples. The GigaSampler Instrument Editor allows the mapping of Regions, each consisting of a number of Sub-Regions. A Sub-region can be a Stereo Split, Velocity Split or a Dimension Split (for controlling playback) and each Sub-Region can have its own sound sample. Advanced sample mapping features include Layering and Crossfade Layering, Release Triggers, Sub mixing, Resonant Filters, Envelopes and much more (Nemesys Music Technology, Inc. 1998). Refer to *Chapter 5* for a discussion of the specific GigaStudio features used during this project.

The process of mapping and fine-tuning of a sample library (GigaSampler Instrument) is very creative, yet time-consuming. It demands pain-staking precision in all aspects of sample production. The higher the quality of the raw sound samples, the less problematic the sound design and finalizing of the sample library. A final GigaSampler Instrument is compiled as a sound sample library, and released (published) in compact disc data and/or audio format. Apart from the included amount of sound samples, the dimension (size) of a sound sample library is determined by many factors: average length of sound samples, amounts and types of layering, sampling rate, bit-depth etc.

At the time of printing, Tascam had already released more than 90 sound sample libraries, 11 of which were drum or percussion sample libraries. Visit for example the Sonic Control Gigasampler Users Network at http://www.soniccontrol.com/gigasampler/samplelibraryidx.shtml or the official Tascam GigaStudio website at http://www.nemesysmusic.com/index.php for a complete index of sample libraries currently available for GigaStudio.

[25] No formal academic definition was found during the study.

# CHAPTER 3

# THE DRUM KIT AND ACOUSTICS

## 3.1. Background and rationale

Why a drum sample library? Probing this question lay at the heart of the project, and involved careful consideration of many causal factors. In answering this question, the attempt was to provide a rationale – an outline to the academic and creative approach – for the *drum kit* as ideal source instrument for the sample library. Assuming a considerable need for commercial drum samples, the instrument choice was, from an academic perspective, mostly influenced by the subject of *acoustics*. From an artistic point of view it was mostly influenced by considerations like popular demand; drums, for example, have been known in almost every culture and age (Blades and Page 2001b: 601). Rumsey and McCormick (1996: 41) state that popular music is rarely recorded live, as the emphasis lies on multitracking – where each instrument or instrument part is recorded onto a separate track. This ensures full autonomy of each recorded part in the editing and mixing stage. Hence, sampling of the individual instrument parts of a drum kit is very much self-explanatory. Refer *to section 3.3*.



From a research and sound design perspective, the production of a drum sample library – discussed in detail in *Chapters 4* and *5* – held the following advantages and consequent appeal. Drum sounds (each having a single transient peak) contain[26] many inharmonic partials and include frequencies ranging from about 30 Hz (low end of the bass drum) to well above 18 kHz (upper harmonics of the cymbals). According to White (1999a: 64), this range nearly covers the entire audible spectrum, quoted by Howard and Angus (1996: 79) as the frequencies ranging from 20 Hz to 20 000 Hz. This also correlates to the frequency response range of many studio condenser microphones and monitors.

A drum kit has a huge dynamic range, able to generate enormous sound pressure levels, which makes the instrument particularly suitable for recordings in a variety of acoustic environments. In addition, the recording of a drum kit offers several alternatives for the use of different microphones and microphone placements, which in turn allows for capturing many tonal nuances. As a result, specific

[26] Characteristics of drum sounds are discussed in section 3.3.

acoustic settings and microphone placements play an integral role in the tonal quality of a sampled drum kit. Creative musical phrases, as well as an infinite number of individual drum hits can be sampled. Finally, a drum-sampling project allows for a vast array of signal processing possibilities.

## 3.2. Instrument definition and classification

All musical instruments can be classified as belonging to one of four original[27] instrument classes: *aerophones*, *chordophones*, *idiophones* or *membranophones* (Wachsmann and Kartomi 2001: 419). According to Adler (1982: 329), each of these groups can further be divided into:

- Instruments of definite pitch
- Instruments of indefinite pitch
- Instruments which can be tuned to an approximate pitch

Though "the range and variety of percussion instruments in use today defies description and categorization" (Adler 1982: 328), Campbell and Greated (1987: 409) defines "any instrument excited by striking", as a member of the percussion class – the oldest musical instruments with exception to the human voice (Rossing 1982: 233). The five types of percussion instruments include drums, mallet instruments, cymbals/gongs, steel drums and bells. All of these instruments are characterized by a prominence of inharmonic partials, as well as a constant change in amplitude of their sounds – rising rapidly at the onset and dying away immediately without reaching a steady state (Howard and Palmer 2001a: 118). Combining the different viewpoints of percussion instrument classification, the drum kit is defined and classified in terms of its constituent parts.

*Drum kit configuration and classification*

The basic configuration of a modern drum kit includes: a bass or kick drum,[28] snare drum,[29] and a variety of cymbals, tunable tom-toms[30] and a hi-hat[31] These are all classified as being either

[27] Later development added a fifth instrument class, *electrophonic instruments*. Further divided into three subcategories, this group was later termed *electrophones*. In 1980, the term *corpophones* was introduced for instruments that form part of the human body (Kartomi 2001: 420).
[28] The bass drum of a drum kit is smaller than the orchestral bass drum, with a head diameter of about 50 cm. Larger sizes became popular in the 1930's (Blades and Page 2001a: 610). The bass drum is alternatively called a *kick drum.*
[29] The upper or playing head is known as the 'batter' head and the lower head as the 'snare' head. Across the 'snare' head are stretched 'snares', which are strings of gut, wire, wire-covered silk or nylon (King and McLean 2001: 610).

percussion membranophones, “in which the struck object is a stretched membrane” (Campbell and Greated 1987: 409), or percussion idiophones, producing their sound through vibrations set up in the structure of the instrument itself (Brown and Palmer 2001: 73). The drum kit, as percussive instrument, is thus classified as follows:

- Idiophones, with indefinite pitch: cymbals and hi-hats (Adler 1982: 341).
- Membranophones, with indefinite pitch: bass drum and snare drum (Adler 1982: 354-356).
- Membranophones, with approximate tunable pitch: tom-toms (Adler 1982: 354, 357).

*Playing the drum kit*

A single, seated player[32] plays a drum kit, using both hands and feet (Holland and Page 2001: 333). With exception of the bass drum and hi-hat, both operated by a foot pedal (Nisbett 1995: 135), the drum kit can be played with an array of beaters. According to Adler (1982: 360), these may include hard sticks with wooden or plastic tips (King and McLean 2001: 611), rutes, mallets or wire-brushes. The snare drum is normally played with wooden sticks, although wire brushes are often used for soft effects. Tom-toms are played with mallets (Adler 1982: 355) or regular drumsticks (Blades and Holland 2001: 579-580), and cymbals are normally played with regular drumsticks, wire brushes or mallets, depending on the required effect (Adler 1982: 342).



[30] Tom-toms are membranophones that occupy the “grey area between definite and indefinite pitch”. These tenor-like drums, without snares, are tunable to approximate pitches – very much like roto toms (Adler 1982: 354) – and come in two pairs of four varied-size drums. One or two drum heads may be present (Adler 1982: 357).
[31] A hi-hat is a pair of cymbals, struck or operated by a foot pedal mechanism (Robinson 2001: 616).
[32] By definition, a drummer (Allen 2002: 625) or percussionist (Allen 2002: 654).

## 3.3. Acoustics of a drum kit

By definition, *acoustics* is "the science of sound" and [also] the most basic of sciences (White 1991: 8). Acoustics moreover refers to the properties of a physical environment (like a room, hall etc.) governing the quality of the sound heard (Allen 2002: 7). A detailed study of the acoustics of any instrument should essentially incorporate a glimpse into the anatomy, creation and transmission of the musical sound that it produces. As this extends well beyond the discussion, this section will focus exclusively on the applicable acoustic properties, or sound behavior within a medium (White 1991: 7), of percussion idiophones and membranophones. The question at stake is this: how do drums sound, and why?

### *3.3.1. General acoustic properties*

The drum kit is a synergistic total of its various constituent percussion parts, and a single discussion concerning the applicable acoustic qualities, is rather convoluted. Any percussion instrument is excited (produces its sound) when the resonating surface is struck (Kennedy 1996: 555). When struck normally, a wealth of overtones (McIan and Wichman 1994: 139) constitute a musical sound without a steady state part. Consequently, percussion sounds consist only of a transient part (Campbell and Greated 1987: 13) – the loudest part known as the transient peak. At onset, the timbre of percussion idiophones and membranophones rises rapidly in amplitude (the *attack* or *onset* transient), and decays very swiftly at first, before the rate of decay slows down and vibrations remain evident for several seconds after the stroke (Campbell and Greated 1987: 14). This phenomenon describes drum sounds as having a single, but definite attack transient with no steady state part, followed by a decay transient[33] (Campbell and Greated 1987: 158). The timbre of the individual drum parts also varies significantly, depending on the manufacturer. With exception of the tom-toms, and for the following reasons, none of the instrument parts of the drum kit has a definite pitch. Firstly, the lowest tone or fundamental – which in a musical sound defines the pitch (Nisbett 1995: 14) – is either too low to be distinguished, or is very powerful and rich in overtones, with little harmonic quality. Secondly, as is the case with cymbals, the mode of frequencies are not harmonically related and results in "a profusion of high-pitched tones" (Nisbett 1995: 16), without any sense of pitch to it. In the same way, the snares disguise the pitch of the snare drum. In cymbals, "a large number of closely spaced normal

[33] Campbell and Greated (1987: 158) states that the decay transient is a less important characteristic of the timbre of an instrument, than the attack transient.

modes of vibration contribute to the sound" (Campbell and Greated 1987: 448). The drum kit has a huge dynamic capacity – to some extent due to the enormous amount of sound pressure released when the various parts sound simultaneously, but particularly due to the huge dynamic capacity of the respective instruments parts.

### *3.3.2. Properties of the instrument parts*

*Bass drum*

According to Campbell and Greated (1987: 426), any circular drumhead may be liable to produce a pitched sound. The bass drum consists of two similar plastic heads, with a diameter of about 50 cm (Blades and Page 2001a: 610), stretched on either side of a wide, but shallow, cylindrical wooden shell. The heads are tensioned by threaded rods along the shell rim (Blades and Page 2001a: 608) and should be tuned to the same nominal pitch. The bass drum is operated by a foot-pedal that strikes the center of one head, producing a very short, pitchless sound (Campbell and Greated 1987: 427). Having a characteristic bass 'thump' around 80 Hz (White 1999b: 95), frequencies produced by the bass drum range between 27 Hz and 146 Hz (McIan and Wichman 1994: 30). The beater adds attack transients varying between 2 kHz and 6 kHz. Consequently, the beater striking the drumhead contributes all the high frequency components of the bass drum sound (White 1999a: 64).



*Snare drum*

The snare drum consists of a cylindrical shell (wood or plastic), covered at each end with a head of plastic or calfskin. The heads – usually about 35 cm in diameter – are tensioned by means of threaded rods. The playing head is known as the 'batter' head and the lower head as the 'snare' head. The depth varies between 10 and 40 cm (King and McLean 2001: 610). The eight or more snares, vibrating against the lower, resonant head, disguise the pitch and give the snare drum its characteristic timbre.[34] A mechanism allows the snares to be lifted from the lower head (Campbell and Greated 1987: 427). A set of distinct pitches is usually distinguished when the snare is played with the snares off (Campbell and Greated 1987: 427, 429). According to Lewcock and Pirn (2001: 118), the four lowest mode frequencies of the snare drum are 182, 330, 278 and 341 Hz. The snare drum has a low frequency 'thump' between 90 and 140 Hz, while the snares vibrate between 3 kHz and 7 kHz (White 1999a: 66).

[34] According to Campbell and Greated (1987: 427), the interaction between the vibrating snares and the snare head is acoustically complicated, and has not been studied scientifically.

*Tom-toms*

Similar to the orchestral tenor drum, tom-toms are "cylindrical rod-tensioned drums with wooden shells" used in mounted sets of three or more. The larger 'floor tom' is normally mounted on a floor stand (Robinson 2001: 616). Varying between 12 and 90 cm in depth, tom-toms are usually double-headed (plastic), with a diameter of 25 – 46 cm. According to McIan and Wichman (1994: 138), the tom-tom heads should be tuned to the same nominal pitch, causing the two heads to resonate sympathetically. Depending on the size, tom-toms are characterized by lower frequencies (80 to 120 Hz), with the mid- and higher frequencies introduced by the stick impact (White 1999a: 66).

*Cymbals*

Cymbals are characterized by high frequencies with an indefinite pitch – a large number of closely spaced normal modes in the region between 500 Hz and 6000 Hz (Campbell and Greated 1987: 448). In a normal drum kit configuration, cymbals include the hi-hat, a foot-operated double cymbal (Nisbett 1995: 135), and a variety of suspended cymbals. The hi-hat, operated by a pedal or played with handheld drumsticks, was cultivated "as a superior substitute for the dampened cymbal stroke". According to Robinson (2001: 616), the range of cymbals – each with a depicted function and sound – varies significantly in size: splash cymbals (about 10 cm in diameter), crash cymbals (about 36 cm), choke cymbals (10-20 cm), large sizzle cymbals and even larger ride cymbals (up to 66 cm).

The most prominent feature in the sound spectrum of cymbals, is the concentration of sound energy in the 3 – 5 kHz range, providing the 'shimmer' or after sound (Campbell and Greated 1987: 448) – a prominence caused by a rapid decrease in level for frequencies below 700 Hz, immediately after a cymbal is struck (Lewcock and Pirn 2001: 119). When played with hard sticks, modes of high frequencies are excited, while mallets emphasize modes of lower pitch (Campbell and Greated 1987: 450).

### *3.3.3. Resonance and damping*

Probably one of the most distinct acoustic features of a drum kit is the sympathetic interaction between the different drum parts, when played individually or simultaneously. Because of the infinite amount of partials excited when any part of the drum kit is struck, the other parts resonate sympathetically – causing the drum kit to 'ring' (McIan and Wichman 1994: 138). This obviously makes the drum kit sounds complete and real, and should be taken into stern consideration when sampling individual drum hits.

The term *close-miked* defines a microphone placement focusing directly and very closely on a particular instrument or instrument part – minimizing spill from other instrument parts. This almost exclusively entails the use of a cardioid microphone setting (refer to *Chapter 5*). Recording any drum sound from this perspective delivers an illusory sound, emphasizing frequencies that are not normally heard from a moderate distance. The advantage, though, is suitable isolation from other instrument parts. Resonance moreover refers to the 'ringing' of an individual drum part, depending much on the type and quality, as well as the tuning of the instrument part. According to McIan and Wichman (1994: 138), *damping* is "the process of reducing excess resonance or ringing", usually by applying tape to certain areas on the drumhead.

### *3.3.4. Tuning of the drum kit*

Proper tuning of a drum kit is a subject of critical importance and should be considered carefully before sampling any of its parts. As mentioned, the drum kit is a synergistic whole of many parts sounding and resonating together, and for this reason it should be tuned fairly precisely (McIan and Wichman 1994: 138). This places an enormous restriction in terms of the usability of prerecorded drum samples, as the tuning remains fixed. All drum parts (except for the cymbals) can be tuned, although their sound may be of indefinite pitch!

### *3.3.5. Acoustics and waveform representations*

Considering the acoustic properties of each instrument part, an important feature is the recorded waveform representation of each drum sound or instruments part. Waveforms – graphical representations within the time domain[35] – clearly illustrate the sound composition in terms of amplitude and time (implicitly depicting the frequency content). A waveform of a bass drum sample, e.g., shows the attack transient (beater striking the drum head) as a high frequency of lower amplitude, followed by a peak and concentration of low frequencies, with higher amplitude.

[35] The *time domain* refers to a graphical representation where the amplitude (y-axis) is plotted against time (x-axis).

Each recorded waveform converses the following:

- Attack and decay transients (depicting the transient peak and partials)
- Frequency composition over time
- Change in amplitude over time (envelope)
- Time-span or duration of the sound
- Actual sound, resonant spill and room reflections

A well-isolated (close-miked) drum sample reveals a cleaner waveform than an ambient drum sample, which contains spill from other resonating drum parts as well as ‘leakage’ from the room itself. Ambient drum samples are thus more ‘contaminated’, as resonant spill and room reflections introduce many additional frequencies. This phenomenon can be very useful, or quite destructive. Samples of single, close-miked drum hits have the advantage of being cleaner, more controllable and slightly more convenient to employ, whereas ambient samples capture a more realistic image of the drum kit. Close-miked drum hits are often inevitably recorded as mono samples, whereas even slightly more ambient microphone placements allow for very effective stereo imaging.

## 3.4. Principles of room acoustics

Although the acoustics of enclosed spaces is a science extending well beyond this discussion, an overview of room acoustics is essential to the nature of the sampling project.

The ambience of the room in which a drum kit is recorded has a significant effect on how the drum kit sounds (McIan and Wichman 1994: 137), as it altogether determines the type of drum sound, and consequently the functionality of the drum samples. White (1999a: 184) states that percussion sounds “benefit from a sense of space and depth” provided by the acoustic surroundings, as this makes them sound ‘real’. Even the smallest amount of ambience helps to create the illusion of spatial identity. The better the room ambience (quality of absorption, reflection, diffusion, coloration etc.), the more beneficial to the sound of the instrument recorded within that room.

A few major features determine the sound quality of an enclosed space: its shape, its size (or volume), the amount and type of furnishing (sound absorbers and diffusers)[36] and the nature of the reflective surfaces. According to Borwick (1997: 112), a regular series of standing waves exist within any room. This arises from the reflection of sound by all major surfaces of the room and is known as natural modes or *eigentones*. These qualities primarily determine the reverberation within a room, but even more important, the coloration imposed onto the recorded sound (Nisbett 1995: 37-38).

*Reverberation and coloration*

Sounds in a room are reflected, with part of it being absorbed at each reflection. This rate of decay defines the reverberation time of a room, which is the time taken for a signal to be reduced by 60 dB, or to one millionth of its original intensity. Reverberation time depends fundamentally on the distance that sound must travel between reflections (Nisbett 1995: 38). In a large room, an *echo* may be heard. An echo is defined as a time gap exceeding an eighteenth of a second (56 milliseconds), which is equal to a sound path of roughly 18 m (Nisbett 1995: 38).

A smaller room might add *coloration* – the selective emphasis of certain frequencies, or frequency bands, within reverberation (Borwick 1997: 113). Reflections from hard surfaces (including the ceiling), with less than 20 ms delay, harshly interfere with the direct sound and cause cancellations at regular frequency intervals. This is known as the *comb filter* effect. Parallel surfaces result in *ringing*, caused by reflections back and forth along the same path. Absorption occurs mostly at the same frequencies, leaving others clearly audible after the rest has decayed. The natural frequencies of air resonance (*eigentones*) corresponding to the room dimensions are always present. In a small room, this is often audible as additional ringing (Nisbett 1995: 38).

*Room size and sound*

Sound interacts with the physical environment, and as seen, the size of a room determines the characteristic sound of it. The question, for a project of this kind, is which room size is, and was found most suitable for sampling a drum kit? A smaller room has a more controlled sound, as "the sound of the drums basically stops right after the initial attack of the stick," so that less of the room is heard (McIan and Wichman 1994: 137). Even though less reverberation time is depicted, a greater risk of coloration effects, like comb filtering and eigentones, exists in a smaller room. Reverberation is of greater concern in a large room, as it dampens the clarity of the direct sound source.

[36] Nisbett (1995: 37) states that the absorption and diffusion qualities of objects vary significantly with frequency and therefore any furnishing will impact the ambient quality of a room. This includes all reflective surfaces: walls, ceilings etc.

Reverberation, on the other hand, adds a unique sense of space and depth, resulting in a 'larger' sound. The matter at stake is the type of drum sound required, as the unique character of each room emphasizes different tonal characteristics of an instrument (Nisbett 1995: 39).

For the drum sample project, the above principles guided the process of selecting three suitable rooms within the Konservatorium building (Stellenbosch University 1999). The following rooms, with distinct and diverse acoustical qualities, were selected in order to experiment with the effect of differences in ambience on the actual drum sounds:

- The *floating studio*: a chamber music studio with a 'live room' sound[37]
- The *Fismer Hall*: a medium-sized rehearsal hall, and
- The *Endler Hall*: a large and well-known concert hall

## 3.5. The Gretsch Renown Maple drum kit

A professional drummer (refer to *Appendix* E) was chosen as the sole musical performer in the sample library project and performed on a *Gretsch Renown Maple* drum kit – a strong incentive itself for a project of its kind – and agreed upon disclosing the following invaluable information concerning the instrument.

### *3.5.1. Specifications of the drum kit*

*Bass drum*

The 8 x 20" Gretsch bass drum was operated by a *Gibraltar Intruder 2* double pedal.

*Snare drums*

Three snare drums were sampled:[38]

- *Pearl* free floating snare, with brass shell – 5½ x 14"

[37] A 'live room' is depicted by hard walls and, optionally, a concrete or tiled floor (McIan and Wichman 1994: 137).
[38] Originally, only the brass and maple snare were sampled. During the second recording event – executed in October 2003 – an additional 14" Gretsch stainless steel snare was sampled in the floating studio and Fismer Hall. All samples were included into the final drum sample library, although the focus fell on the brass and maple snares.

- Ten ply *Gretsch Renown Maple* snare – 5 x 14”
- *Gretsch* stainless steel snare – 5 x 14”

*Tom-toms*

Three *Gretsch Renown Maple* toms were sampled, all constructed of 6 ply wood:

- First rack-mounted tom – 8 x 10”
- Second rack-mounted tom – 9 x 12”
- Floor tom – 11 x 14”

*Cymbals*

The hi-hats and range of cymbals are all manufactured by *Zildjian*. The following cymbal collection was sampled (in ascending order of size):

- 6” *A Custom* splash
- 10” *A* splash
- 12” *A Custom* splash
- 13” *K/Z* hi-hats
- 15” *A Custom* crash
- 17” *A Custom* crash
- 18” *Oriental China* trash
- 20” *A Ping* ride



*Drumskins*

**Table 3:** Drum skins fitted to the respective drum heads (Pierre Tredoux 2003).

| Drum head | Bass drum | Snare drums | Tom-toms |
|---|---|---|---|
| Batter | *Remo Powerstroke 3* | *Remo coated Ambassadors* | *Remo Pinstripe* |
| Resonant | Factory default skin | *Remo snare Ambassadors* | *Remo clear Ambassadors* |

*Accessories*

All stands and pedals, as well as the drum kit rack – for mounting certain cymbals and toms – are manufactured by *Gibraltar*.

*Beaters*

The drumming was performed with the following selection of *Vic Firth* beaters: 16” *5A American Classic* nylon and wooden tip sticks (Hickory wood), 16½” rutes, jazz brushes (heavy gauge wire, 6” spread) and *American Custom T3 Staccato* mallets. Nylon tip drumsticks produce a brighter sound, whilst also being more durable than wooden tip sticks (Vic Firth Incorporated 2000). Refer to http://www.vicfirth.com/product/sticks.html for more detail. The following URL’s are also recommended: www.kamanmusic.com and www.remo.com for comprehensive information on racks, pedals, stands, drumskins and other drum kit accessories; www.zildjian.com for more information on cymbals and hi-hats; www.vicfirth.com for more information on drumsticks; and finally www.pearlmusic.com and www.gretschdrums.com for more information on drum kits and related parts and products (Pierre Tredoux 2003).

### *3.5.2. Drum kit setup*

Figure 1 illustrates the drum kit configuration utilized throughout the entire recording:

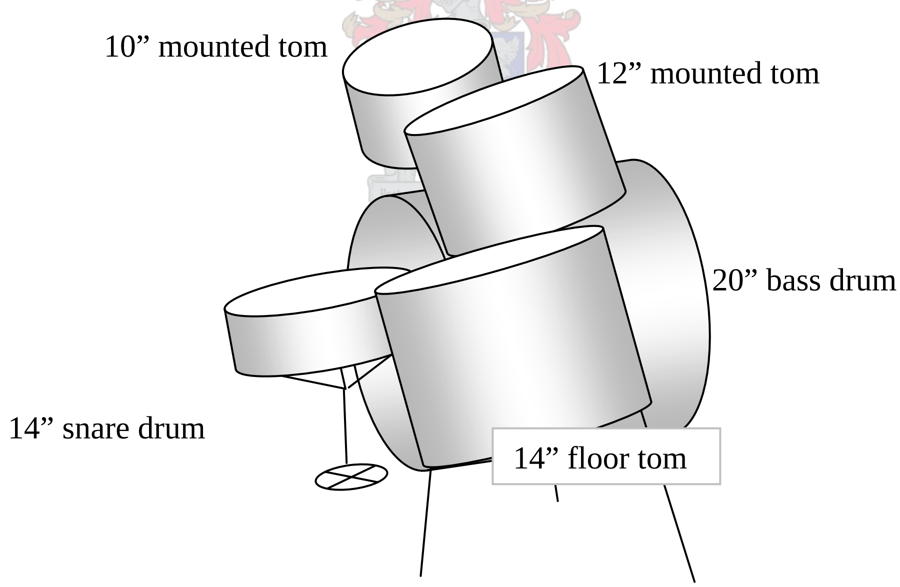
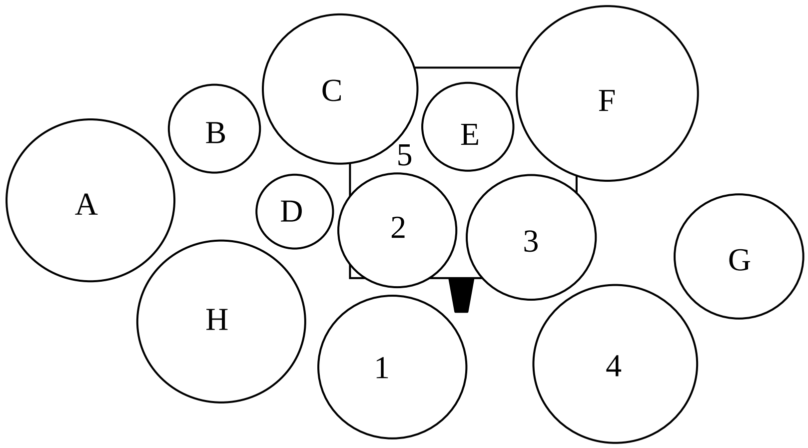



**Figure 1:** Drum kit setup – side perspective without cymbals (Pierre Tredoux 2003).




| | | | |
|---|---|---|---|
| 1 – Snare drum | 5 – 20” bass drum | D – 6” A Custom splash | H – 13” K/Z hi-hats |
| 2 – 10” mounted tom | A – 18” Oriental China trash | E – 10” A splash | |
| 3 – 12” mounted tom | B – 17” A Custom splash | F – 20” A Ping ride | |
| 4 – 14” floor tom | C – 17” A Custom crash | G – 15” A Custom crash | |

**Figure 2:** Aerial diagram of the complete drum kit (Pierre Tredoux 2003).

# CHAPTER 4

# PROJECT METHODOLOGY

## 4.1. The production chain

The sequence of events or stages in the production of the drum sample library is collectively termed the *production chain.*[39] Each stage of the project demanded careful consideration and painstaking precision, and was characterized by specific materials and/or techniques employed, which are discussed later in this chapter. However methodological, a fair amount of artistic input contributed to the experimental nature of the project, which resulted in a complex symbiosis (interactive relationship) between the materials and methods (techniques) employed. Figure 3 depicts the main stages of the project.

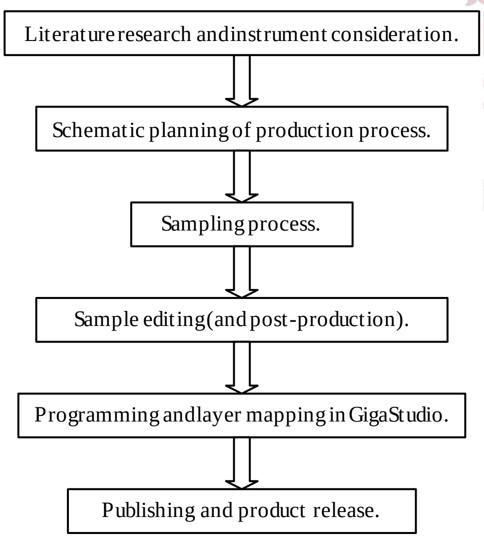



**Figure 3:** Outline of the production chain.

[39] In commercial music production, this sequence is termed the *recording programme chain*. These events are typically ordered as: planning (composing and arranging), recording, mixing/editing and post-production (Borwick 1997: 4-7). In the specific context, this reference may be restricting, as the project itself entailed a fair amount of experimentation as means to both an innovative and academic end. The process was however not limited by any set format.

The project consisted of two distinct phases – the production chain, of which the above figure clearly depicts the successive stages, and an academic or research phase, of which the thesis served as main objective. Apart from the mastering and publishing stage, a professional drummer was the only other role player participating in the execution of the project, outlined as follows:

*Literature research*

The literature research served as background for the project and facilitated data collection. A criterion for the choice of instrument was established, which provided the academic basis for the first three chapters. The literature review mainly constituted the first stage, although it proved an ongoing process, even throughout the creative stages.

*Planning phase*

Studying the available resources, the objectives of the recording phase, within the greater intent of the project itself, was stipulated. This was followed by a planning phase, conducted with calculated precision, as much of the product outcome[40] would have been determined by what was actually sampled. The first step was to predetermine the largest part of the actual content of the sample library. The impediment of selecting and compiling a list of possible drum samples was consequently introduced. Clear objectives, in terms of the final product, were of critical importance. Based upon these decisions, a logical order of events – a recording schedule – was compiled. This firstly acted as a task description for the professional drummer, and secondly as a reference for steering the creative process. During the planning phase, several practical questions and/or factors were considered: the most suitable recording rooms, the type of microphones and placements, and the recording techniques to be employed etc. This phase remained open-ended, however, in terms of its innovative nature.

*The recording*

The third stage involved the actual recording of the drum kit – a fourteen-hour main recording event with the drummer, during which all raw material (hits and loops) were sampled. Executed in August 2002, the recording was divided into three smaller sessions, each performed within a different room: The *floating studio*, the *Fismer Hall* and the *Endler Hall*. In each different room, the entire drum kit had to be set up, engineered and recorded using specific microphone placements and precise performance. Proper communication between the engineer (the producer) and the artist ensured

[40] A comprehensive knowledge of the GigaStudio software proved essential as planning of samples and sample mapping altogether depended upon it.

excellent progress throughout the recording stage. Using a *ProTools 24 MIX plus* system, all recording was multitrack-based and was performed in 24-bits, at a sampling rate of 44.1 kHz.

*Editing and preliminary post-production stage*

Though mostly a routine procedure, the fourth stage involved the slow process of editing the raw recorded material into usable sound samples and loops. The main function of the editing stage was the trimming of unwanted sections of the raw samples – to set the start and end of each sound. This was notably imperative for the Fismer and Endler Hall samples, as the air conditioning systems in the respective halls greatly interfered with the clarity of the ambient samples. This stage also encompassed minimal mixing – and little or no processing – of the different recorded tracks into raw, stereo samples. The incentive was to produce raw samples that would ensure maximum usability later – where necessary, minimal filtering and processing were applied. Finally, the intensity levels of each of these were optimized and samples were exported for use as wave files. All signal processing was performed digitally within ProTools, in 24-bits at a sampling rate of 44.1 kHz. The concise, preliminary post-production phase involved basic audio restoration (room noise reduction). Mastering was performed by a professional mastering engineer (refer to *Appendix* E) using *Sequoia* 7.

*GigaStudio phase*

The mastered samples served as raw material for stage five, the compiling of the actual drum sample library. GigaStudio was found most suitable[41] for assembling the sample library, as an endless array of possibilities allowed tweaking of samples exactly to preference. Since this would have rendered an open-ended application of both the individual drum samples and the sound sample library as a unit, the initial verdict was to compile three simple GigaSampler Instruments – one for each set of samples recorded in the three respective rooms. GigaSampler Instruments are user-defined collection of samples layered and adjusted to exact preference, and regarded as a unit (instrument) within the GigaStudio environment. The compatibility of the original samples also allowed the release of a collection of independent drum samples: in 24-bit wave file (.WAV) and 16-bit audio file (.AIFF) format. The objective of phase five was to illustrate few possible examples and applications of sample mapping into usable collections, rather than producing a set product. Again, this process emphasized the flexibility of GigaStudio.

[41] Despite being a matter of personal taste, this was governed by the fact that GigaStudio was the only available software resource of its kind at the time of release.

*Publishing stage*

The final stage involved the publishing of the sample library for commercial release: a photo shoot with the drummer, a cover design by a professional designing company, registering of the sound recordings with an external music rights organization, final mastering of the sound recordings, and duplication and distribution by an independent distribution house. All of these events and related financial and copyright matters were coordinated by local record company and publishing house, Merchant Records (Merchant Records and Publishing 2003). The project involved input and participation from various sources, whether company and/or individual, financial or informative resources, as well as the possible future exploitation of the e-commerce facility of Stellenbosch University. These factors shall corporately influence the prospective distribution of commercial royalties, for which the precise terms of the legal framework still had to be decided on by the time of printing.

## 4.2. Recording rooms and acoustic specifications

The entire drum sample project was recorded, engineered and produced at the Konservatorium Studios using three different recording rooms. All editing, mixing and finalizing of the sample library was performed in the two available control rooms. Although briefly described in the previous section, the following provides an acoustic overview of each of the three recording venues, namely the floating studio, the Fismer Hall and the Endler Hall. The air in the Konservatorium building is kept constant at a temperature of 21°C and a relative humidity of 50%. Air temperature and humidity is controlled and regulated by the BMS Johnson's MetaSys system (Stellenbosch University Division Physical Infrastructure 2003a). Refer to *Appendix A* for more information on the effect of the central Air Handling Unit (AHU) of the Konservatorium on room sound levels.

### *4.2.1. The floating studio*

Also known as the *Submarine,*[42] the floating studio [Room A211] is an asymmetrical, quadrilateral room with a surface area of 39.5 $m^2$ (Stellenbosch University Division Physical Infrastructure 2003b) with a ceiling height of 3.9 meters. With no parallel surfaces, the entire room 'floats' within a rubber shell, apparently capable of withstanding a strong earthquake. The interior consists of hard walls

[42] It is called this for two reasons: firstly, due to its floating design and secondly due to the main door having a small port window like a submarine.

treated with movable sound absorbers, for eradicating any prospective standing waves, a hard ceiling and soft-tiled floor. A large double-window connects the floating studio with the main control room – ideal for communication. With its combination of hard surfaces, asymmetrical shape and well-spaced absorbers, the floating studio has a natural and compact sound with a controlled reverb time of roughly 0.6 seconds. The room is ideal for close-perspective recordings. When flooding the room with high sound pressure levels, like that of a drum kit, room microphones tend to portray a distorted sound picture. Sensitive microphones – condensers, typically – may pick up unwanted room reflections, if the sound source lacks intensity, or if not decently close-miked. The floating studio served mainly as a facility for recording samples from a truly close perspective. The majority of the samples were also recorded here.

### *4.2.2. The Fismer Hall*

Named after Prof. Maria Fismer, principal of the Conservatory from 1938 to 1951 (Stellenbosch University Library 2003b), the Fismer Hall [Room A207] seats 170 persons and is a spacious rehearsal hall with excellent acoustics, ideal for smaller orchestral, choir and chamber music performances. Built with a trivial auditorium lift to the rear, the Fismer Hall has a wooden surface area of 234.9 $m^2$ (Stellenbosch University Division Physical Infrastructure 2003b). The Fismer Hall is connected to the main control room via a large double-window, facing the stage from the rear right side. The wooden stage and floor, together with proper acoustic dampening in the ceiling and odd-shaped walls add to the smooth, controlled reverb time of roughly 1.3 seconds. The reverb of the Fismer Hall added a significant amount of ambience to the drum samples, though in comparison to the floating studio, the greater distance between the sound source and the actual walls and ceiling generally delivered more transparent drum samples. Fewer samples were recorded in the Fismer Hall than in the floating studio. The air conditioning system interfered greatly with the clarity of the drum samples. Refer to *Appendix A*.

### *4.2.3. The Endler Hall*

Internationally renowned, the Endler Hall [Room 206] – synonymous with the Konservatorium and the greater art music culture of Stellenbosch – is a 556-seater concert hall with exceptional acoustical qualities (Stellenbosch Tourism and Information Bureau 1999b). Equipped with a state-of-the-art Marcussen tracker-action organ, the Endler Hall is designed for symphonic, choir and other art music performances. The Endler Hall has lately been made available for non-art music performances and selectively for use as a national and international conference facility. The auditorium style hall with its large wooden stage, elaborate acoustically treated walls, and very high stage ceiling, has a wooden surface area of 573.2 $m^2$ (Stellenbosch University Division Physical Infrastructure 2003b) and a ceiling height of approximately 15 meters. Lower than expected from the sheer capacity of the hall, the reverb time equals approximately 1.8 seconds – due to the absorbent nature of the auditorium style seating and odd-shaped walls. In order to protect the delicate features of the Marcussen organ, the air temperature inside the hall is regulated at a constant 21°C at 50% humidity. Prominent in the sound decay, the air conditioning system (refer to *Appendix A*) in the Endler interfered greatly in the lower frequency range of the recorded samples. Equal amounts of samples were recorded in the Fismer and Endler Halls.

#### *4.2.4. Control rooms*

Two control rooms were used during the project. The main control room of the Konservatorium [Room A206] was used for all recording, editing and signal processing in the production. Equipped with a superb ProTools TDM system, Soundcraft Spirit Studio console and Genelec 1031A near field monitoring speakers, the otherwise vintage control room has a very asymmetrical shape with a surface area of 20 $m^2$ (Stellenbosch University Division Physical Infrastructure 2003b) and a ceiling height of 2.4 meters. The room sound is transparent and well controlled, although the computer system reduces the signal-to-noise-ratio of the control room significantly. Both the floating studio and Fismer Hall are clearly visible from this room.



GigaStudio is hosted on a Windows-based operating system in the secondary control room [Room A204], used primarily for electronic music productions. Equipped with Yamaha NS-10M near field monitoring speakers, this asymmetrical room has a floor surface area of 21.1 $m^2$ (Stellenbosch University Division Physical Infrastructure 2003b) and a ceiling height of 2.8 meters. Though less of a concern, as this venue was used mainly for sample layering, the ambient sound of the secondary control room, compared to the main control room, was less favorable in terms of room acoustics.

#### *4.2.5. The Mastering Studio – TL Mastering*

Situated on Wechmarshof Farm in the Banhoek valley outside Stellenbosch (Von Wechmar 2000), the Mastering Studio was the only external link in the production chain, though wholly integral to the project in terms of sound restoration[43] and finalizing of the drum sample library. Built around a pair of BMW Nautilus Series Model 803 midfield reference monitors (Tim Lengfeld 2003), the Mastering Room of TL Mastering has a surface area of 26.7 $m^2$ and a ceiling height of 2.6 meters. The combination of natural room acoustics and state-of-the-art audio equipment facilitated clean and accurate mastering of all the sampled material. The product was finalized in the Mastering Studio before the reproduction phase.

## 4.3. Recording equipment and specifications

This section provides an overview of all hardware and software equipment used throughout the production – recording, editing, mixing, and signal processing and mastering – but excludes reference to fine art, designing and reproduction materials and equipment used. Throughout the production, standard electric wiring was implemented for electric and electronic devices.

### *4.3.1. Microphones and cabling*

A selection of professional dynamic and condenser microphones were used for sampling the drum kit in the three recording rooms. Dynamic microphones, capable of handling higher sound pressure levels, were almost exclusively applied for close-miking of the individual drum parts, while condenser microphones – more sensitive and less capable of handling high sound pressure levels (Borwick 1997: 40) – were primarily used as overhead microphones and/or to capture room ambience, for the following reasons:

- Individual drum parts, like any other instrument, needed some distance for their sound to 'shape'. At any certain distance away from an instrument part, the actual sound pressure level was lower, for which purpose condenser microphones were more suitable.
- Condenser microphones were better capable of capturing the more subtle harmonics of the different instrument parts.
- Overhead and ambient microphone placements allowed for capturing the stereo image of the drum kit as a unit, for which purpose condensers were also more suitable.

[43] The noisiness of the central air conditioning system of the Konservatorium demanded comprehensive noise reduction for the samples recorded in the Fismer and Endler Halls.

Ten microphones[44] were used in different combinations, depending on the room and the actual musical content. Criteria for the choice of microphones included microphone type, frequency response, sensitivity and the availability of polar pattern and/or attenuation switches. Table 4 depicts the microphones used during the sampling project. Different combinations of these were implemented for samples of specific instrument parts, as well as for the general microphone setup in each of the respective rooms. Refer to *Appendix C* for microphone response curves and descriptions.

**Table 4:** Microphones and specifications (AKG Acoustics 2003; Shure Inc. 2003)

| *#* | *Model Name* | *Type* | *Frequency Response* | *Polar Patterns* | *Bass Attenuation* | *Attenuation Switches (dB)* |
|---|---|---|---|---|---|---|
| 3 | AKG C414 EB | Condenser | 30 – 20 kHz | HC, C, 8, O | 75, 150 Hz | -10, -20 |
| 2 | AKG C452 EB | Condenser | 20 – 20 kHz | C | 75, 150 Hz | - |
| 1 | AKG D112 | Dynamic | 20 – 17 kHz | C | - | - |
| 1 | AKG D224 E | Dynamic | 20 – 20 kHz | C | (50 Hz) | -7, -12 |
| 1 | Shure Beta 52A | Dynamic | 20 – 10 kHz | SC | - | - |
| 3 | Shure SM57 | Dynamic | 40 – 15 kHz | C | - | - |

C = Cardioid / Unidirectional, HC = Hyper-cardioid, O = Omni directional, SC = Supercardioid, 8 = Figure of eight / Bi-directional



*The floating studio*

The majority of the samples were recorded in the floating studio. All instrument parts (excluding the individual cymbals) were close-miked, using a stereo pair of condensers as overheads and another stereo pair of condensers for capturing the stereo sound image of the room. The general microphone configuration was as follows:

- Bass drum – 1x Shure Beta 52A
- Snare drum – 1x AKG D224 E
- Toms-toms – 3x Shure SM57
- Hi-hats – 1x AKG C414 EB [Cardioid, filtered at 150 Hz, un-attenuated]
- Overhead pair – 2x AKG C452 EB [Cardioid, unfiltered]
- Ambient pair – 2x AKG C414 EB [Cardioid, unfiltered, un-attenuated]

[44] A second recording event was held in October 2003, during which all bass drum samples were re-recorded using an AKG D112 dynamic bass drum microphone, placed inside the bass drum. See section 4.4.

Where individual samples of the snare drum were recorded, two Shure SM57 microphones were used for capturing the body resonance (side) and snares (bottom) of the snare drum. This demanded an inevitable phase reversal of any or both of these microphones channels. Only one of the additional channels was utilized during the mixing phase.

*The Fismer and Endler Hall*

The same microphone configurations were used in both the Fismer and Endler Halls. Fewer samples were recorded in these rooms, and the microphone configuration consisted of a very basic setup. This setup is called *triangular miking* (McIan and Wichman 1994: 148) and uses a single microphone on the bass drum and a stereo pair on overheads. An additional room pair was employed:

- Bass drum – 1x Shure Beta 52A
- Overhead pair – 2x AKG C452 EB [Cardioid, unfiltered]
- Room pair – 2x AKG C414 EB [Omni directional, unfiltered, un-attenuated]

Samples recorded in these rooms sounded more ambient than the samples from the floating studio. Cardioid dynamic microphones boost bass frequencies when in very close proximity to a sound source (Woram 1982: 110-111). This creates "a warmer and richer bass sound than farther away" (Shure Bothers Incorporated 1998: 1) – typically when the sound source is less than 6 mm from the microphone. This phenomenon is called the *proximity effect* and explains the darker sound of the close-miked samples. For this reason, the samples recorded in the Fismer and Endler Hall sounded more transparent, tone-rich and less dark than samples from the floating studio. Finally, the many different microphones on the drum kit in the floating studio introduced a fair amount of phasing problems, as all the microphones picked up every other sound source. This was solved with little effort during the editing phase. All microphones were connected to the console via a studio patch bay, using balanced XLR microphone cables. The condenser microphones were powered with 48 Volts (+48V) of phantom power supplied by the Soundcraft Spirit Studio console (Soundcraft Electronics Ltd. 1990: 10).

### *4.3.2. Studio console – main control room*

Powered by a 19" CPS 150 linear power supply (Soundcraft Electronics 1989: 5, 8), the main control room is equipped with a 16/4/2 Soundcraft Spirit Studio console – a 16 channel in-line mixing desk with multitrack monitor inputs doubling as extra line inputs (Soundcraft Electronics Ltd. 1990: 2).

The desk has four stereo mix groups, and four auxiliary sends, post-fade direct sends and a 4-band EQ section per channel (Soundcraft Electronics Ltd. 1990: 10-21). Each EQ section consists of ±15dB HF and LF shelves and ±15dB HMID and LMID semi-parametric sweep filters (Soundcraft Electronics Ltd. 1990: 12-13). A built-in talkback system allows for communication with the artist.

Each microphone was connected to an individual channel input on the console, while condenser microphones were supplied with +48V of phantom power. Microphone signals were sent directly to the ProTools audio interface, without any equalization applied. The console was mainly used for signal routing to and from ProTools during the recording stage, as well as provision of a fold back mechanism for the artist.

### *4.3.3. Digital recording and editing*

The main control room is equipped with a ProTools 24 MIX plus system. The term *ProTools* shall hence collectively refer to ProTools 24 MIX plus, a ProTools 5.1 TDM system[45] (Digidesign Inc. 2001: 1). The core system consists of a MIX Core and MIX Farm card, the ProTools software and the Digidesign 882/20 audio interface. The audio interface, while hosting the ProTools ADC and DAC, is a separate 20-bit I/O unit supporting eight analog inputs and outputs (Digidesign 1999b: 3-4). The unit is connected to a Macintosh PowerPC G4 computer with 733 MHz processing speed, hosting the ProTools software. A 24-bit ProTools session allows a maximum of 64 audio tracks (ProTools 24 MIX plus only) sampled at 48 kHz sampling rate (Digidesign 1999b: 3), although for the Fismer and Endler Hall sessions only 5 tracks (microphone channels) of audio were recorded respectively; many more channels of audio were recorded during the floating studio session. Each of the three recording sessions was hosted in separate ProTools sessions, with sampling performed in 24-bits at a sampling rate of 44.1 kHz. Finally, all editing and signal processing were also performed within the same respective ProTools sessions.

The secondary control room hosts the GigaStudio software on a Pentium III (1 GHz processor with 512 MB RAM) with a *Windows 98* operating system. All sample layering, sample mapping and finalizing was performed within GigaStudio. See *Chapter 5*.

[45] The ProTools TDM system specifications fall outside the scope of this discussion. Refer to www.digidesign.com for more information.

### *4.3.4. Monitoring*

Monitoring is, without exception, always the most important link in any production chain, as this is the only reliable reference to the quality of all other links within that chain. This same principle applied in the sample library production. The main control room is equipped with a pair of bi-amplified Genelec 1031A (refer to http://www.genelec.com/products/1031a) near field monitoring speakers. Designed as active speakers, the units contain drivers, active crossover filtering and protection circuitry. Each monitor is also supplied with an integrated amplifier unit, with both bass and treble amplifiers producing 120 watts of short-term power. Peak output levels are in excess of 120 dB at a distance of 1 m (Genelec 1994: 2-3). The secondary control room is equipped with a pair of Yamaha NS-10M near field monitoring speakers. Very little technical monitoring was required in the secondary control room. For this reason the specifications for the NS-10M's extend beyond this discussion.

The drummer was supplied with a Fostex T40RP stereo dynamic headphone, powered by the Fostex PH-50 headphone amp distributor. The "enclosed type" Fostex T40's has excellent transient characteristics with a reproduction range of 20 – 25 kHz (Fostex Corporation 1998: 1-2, 4). Additional referencing during the editing stage was performed using Fostex T40 headphones.



### *4.3.5. Mastering software*

A professional mastering engineer performed the entire mastering process. This was executed using the Digital Audio Workstation, Sequoia 7.1[46] – a unique object-based mastering platform that allows track manipulation without affecting other tracks, or the need to reset processors. Sample data was submitted for mastering in 24-bit, 44.1 kHz sample-format. Data was up-sampled and all signal processing performed in 32 bits[47] at a sampling rate of 88.2 kHz. Mastered samples were subsequently down-sampled to 16-bits with a sampling rate of 44.1 kHz (Tim Lengfeld 2003).

[46] For more information about Sequoia 7, refer to http://www.samplitude.com/de/seq.htm and www.tl-mastering.com for more information on the mastering equipment used.

[47] IEEE 32-bit float point format processing ensured signal integrity, whilst also optimizing the signal-to-noise ratio (SNR). Visit http://www.psc.edu/general/software/packages/ieee/ieee.html for comprehensive information on the IEEE 32-bit floating-point arithmetic (Pittsburgh Supercomputing Center 1999).

## 4.4. Recording methodology

The methods employed during the recording process revolved primarily around suitable microphone implementation (microphone types, placements, pick-up patterns etc.) and thus obtaining proper microphone signals. No analog or digital processing was applied during the recording stage.

### *4.4.1. Microphone placements and techniques*

Microphone implementation was influenced solely by what was to be sampled. In terms of the available literature,[48] all microphones were set up in a standard drum miking style, but more important, the choice of microphone placements was influenced mostly by many months of personal experience gained, using the available microphone collection in the specified recording locations.

The majority of samples were recorded in the floating in studio, whereas a collection of straightforward, more commercial samples was recorded in the two halls. The microphone setups in the respective rooms showed strong resemblance. All stereo samples in the floating studio and Fismer Hall were recorded from a *drummer's perspective* – i.e. from "behind the drum kit", rendering the hi-hats to the left and the tom-toms to the right of the stereo sound image. Samples recorded in the Endler Hall were captured from an *audience' perspective* (hi-hats right, tom-toms left).

*Floating studio*

The drum kit was set up to the rear of the floating studio, facing the main control room window. Sampling of the individual parts followed a simple microphone technique: close miking of the instrument part as well as two stereo pairs of microphones – one pair on overheads and one ambient or room pair. Overhead microphones (AKG C452 EB on cardioid, unfiltered) were placed roughly 50 cm above the drum kit, as X-Y coincident[49] pair facing downward from behind the drummer. The spaced ambient pair (AKG C414 EB on cardioid, unfiltered) was placed in the opposite side of the room, facing the drum kit. The *bass drum* was recorded with a Shure Beta 52A supercardioid microphone facing the resonant head. An additional Shure SM57 (cardioid, phase reversed) was placed on-axis with the beater. No sound hole was cut in the resonant head, resulting in a very dark

[48] Numerous literature sources (e.g. *Sound on Sound* magazine) have documented the art and science of drum microphone techniques, but as this relies mostly on artistic motivation, specific references are excluded.
[49] Diaphragms cross each other at a perpendicular angle.

and undefined sound. The additional microphone on the beater delivered a bass drum sound with a brighter, well-defined attack. The *snare drum* was recorded using 3 microphones: an AKG D224 E (cardioid, unfiltered) facing the center of the batter head at 30°, but pointing away from the hi-hats, and 2 Shure SM57 microphones (cardioid, phase reversed) – one facing the side (body) of the snare drum and the other facing the resonant or snare head. A combination of any two microphones was possible in the final snare mix, due to phasing restrictions. The close miking of the snare drum delivered a fat sound with sufficient 'snap'. The *hi-hats* were recorded using an AKG C414 EB microphone (cardioid, HP filter on 150 Hz) facing the hats off-axis, from below. The three toms were each recorded with a Shure SM57 cardioid microphone, each facing the center of the respective batter heads at approximately 30°. The cymbals were captured by the two stereo microphone pairs only. No attenuation was applied to any of the microphones.

*Fismer and Endler Halls*

The drum kit was set up in the center of both the respective stages, facing the 'audience'. This approach was decided upon to capture the instrument from an authentic performance point of view.[50] All samples recorded in these halls utilized the same classic, 4-piece microphone setup: two AKG C452 EB (cardioid, unfiltered) overhead microphones, and two AKG C414 EB (omni directional, unfiltered) ambient microphones, except for the bass drum samples, using an additional Shure Beta 52A. The overhead pair was placed exactly as in the floating studio – roughly 50 cm above the drum kit and slightly behind the drummer, capturing the drummer's perspective in the Fismer Hall and the audience' perspective in the Endler Hall. The ambient pair in the Fismer Hall was placed to the rear of the room, facing the drum kit; the ambient pair in the Endler Hall was hung from the ceiling, roughly to the sides of the drum kit and higher than in the Fismer Hall. In both halls, the bass drum samples were recorded using the additional Beta 52A (supercardioid), facing the resonant head. These signals contained very little definition, although the overhead microphones compensated quite effectively. In general, the close-miked samples were darker and less tonal, whereas the ambient samples were rich sounding and transparent. In this regard there was a huge difference in tonal quality between the samples recorded in the floating studio and samples recorded in the halls, and a notable correlation between the samples recorded in the respective halls. Condenser microphones were responsible for sensing a significant amount of room noise, discussed in *Appendix A*.

[50] Not to be confused with *audience* / *drummer's perspective*, discussed earlier in this section.

### *4.4.2. The recording sessions*

The main three-session recording was held in August 2003, with each session executed in four stages: drum kit setup, microphone setup and cable patching, signal levels and finally, performance and recording. Microphones were patched to the studio console and connected to the audio interface of ProTools. A talkback system was also set up for communication with the artist. Signal levels were obtained and optimized for digital sampling by the artist performing the 'loudest' drum hits and/or musical phrases. These optimized signals were sent directly to ProTools, followed by a recording of the drummer's performance of the pre-compiled list of samples and musical phrases (See *Chapter 5*). The recording sessions required proper communication and referencing between the artist and producer. Each recording session was hosted within a separate 24-bit ProTools session, with each audio track sampling an individual microphone channel. A rough time division amounted to the following and consisted of instrument setup, microphone placements, patching and signal gain:

- Floating studio: 6 hours
- Endler Hall: 3 hours
- Fismer Hall: 3 hours

An unplanned second recording event was performed in October 2003, during which all bass drum samples were re-recorded using an AKG D112 dynamic microphone. This was decided upon for two reasons: 1) during the first recording event, the resonant head of the bass drum had no sound hole cut into the skin, as the drum kit was brand new. The result was a dark, indeterminate bass drum sound, especially in the samples recorded in the Fismer and Endler Halls. A sound hole had later been cut into the skin of the resonant head, which allowed for a microphone placement inside the bass drum, 10 cm away from the beater and facing off-centre, giving a much more defined bass drum sound. 2) The recording studios of the Konservatorium also acquired an AKG D112 in the interim period. It was decided to rather make use of this microphone as much commercial recording experience had been gained, using the D112 throughout the past year. During this second recording event, the prospect of sampling a new snare drum and floor tom-tom was also investigated. Although the prospect was beyond the scope of the thesis, several additional snare drum samples were incorporated in the final sample library.

### *4.4.3. Communication and performance*

Good communication was imperative for streamlining the recording process, as each session required specific skills and performance procedures. The drummer performed an array of musical tasks, mostly revolving around playing a pre-compiled list of drum hits (to be sampled). A different set of musical phrases was also sampled in each room, although the focus was more on sampling the individual instrument parts. Most of the recording time was spent in the floating studio – due to the 1) novelty of the sampling process, and 2) the greater amount of samples to be recorded.

## 4.5. Sample editing

The sample-editing phase involved a combination of editing, mixing and effects processing activities, although the physical editing was the most time-consuming task of the entire project. All editing, mixing and signal processing was performed within ProTools. A chronological order of events in the process was as follows:

*Editing*

Firstly, for each sample a start and end time was resolved by trimming away unwanted segments of the raw material. This procedure, referred to as 'top and tail', was performed simultaneously on all audio tracks constituting the mix of an individual sample. For start times, a minimum time gap was allowed; end times were set 'by ear' and varied greatly between samples. These were generally set according to the audible decay in each sound, which in turn was comprised by a combination of room ambience and natural resonance. ProTools has a built-in application for trimming audio (so-called *silence*) below a user-specified threshold. This application, called the *strip silence* function, was applied during the editing of the floating studio samples, proving to be much more time-efficient than editing by hand.

*Mixing and effects processing*

All samples were recorded as a combination of different microphones, each sensing the instrument part from a different perspective. Sample mixing essentially involved setting the levels of the individual audio tracks to shape the desired ambient and/or tonal image,[51] and setting the panning[52] of

[51] Two general types of ambient sound images were finalized: *dry* sound samples included less room ambience; *wet* samples, more.
[52] *Panning* refer to a 'position' anywhere within the 180° range (left through right) of a stereo sound image, e.g. two loudspeakers (White 1991: 236).

each audio channel within the stereo sound image. In general, close-miked channels were centered while the ambient microphone pairs were panned either left or right, depending on the stereo perspective. For the exclusive reason of preserving the samples as raw and as natural as possible, no filtering, equalization or compression was applied whatsoever. Prior to bouncing, all samples recorded in the Fismer and Endler Halls were normalized to –0.1 dB; floating studio samples were normalized during mastering.

*Bouncing to disk*

Samples were bounced in real-time to 24-bit stereo wave files, from within the respective ProTools sessions. File names were structured (see *Chapter 6*) to enable easy sample mapping within GigaStudio. Contrary to the single-sample files produced from the Endler and Fismer Hall sessions, the floating studio samples were bounced as sample groups, without being normalized individually. This allowed for freedom of cutting, labeling and export during mastering.

*Mastering*

The post-production phase primarily entailed 1) audio restoration for the Fismer and Endler Hall samples, and 2) cutting, splicing and normalization of the floating studio samples. This process was introduced for two reasons. Firstly, proper audio restoration – i.e. the extraction and reduction of room noise – was best executed with proper audio restoration software (Sequoia 7.1 – refer to *section 4.3.5.)*. 'Air conditioning noise' itself was sampled. Utilizing an FFT algorithm, this sample was reverse-imposed onto noisy samples, producing clean, 'noise-free' samples without destroying the natural room reverb. Secondly, the vast amount of floating studio samples could more effectively be prepared for GigaStudio, in terms of sample editing, sorting and normalization. The sample library was to be released in both CD audio and Giga formats. The purpose of the mastering stage was therefore twofold: finalizing of the 16-bit CD audio tracks of all samples and sample groups as well as the 16-bit stereo wave files for GigaStudio.

# CHAPTER 5

# THE SAMPLE LIBRARY

## 5.1. The drum samples

This project was primarily steered by a process of creative research. As in any project of this kind, margins had to be set between which the freedom to experiment could be exercised. These margins encompassed the following: 1) the predetermined musical or stylistic content, 2) the amount and type of drum samples from each room, and 3) the expectations and proposed outcome of the sample library as product – in terms of the commercial relevance (usability) and academic viability. These margins varied slightly for each recording venue, as many new variables were introduced in each location. The only true constants were the drum kit, the artist, the microphones and the recording rooms; the rest was variables, driven only by basic recording and artistic principles. This section provides a brief description of the samples produced from each of the three locations.

### *5.1.1. Temporary sample labeling*

The labeling process was important in organizing the bulk of samples produced, as file names were directly employed during the GigaStudio stage. Labeling of the Fismer and Endler Hall samples were much simpler than the floating studio samples. All samples – refer to *Appendix D* for the complete list – were labeled according to the location, instrument part, stroke (or drum hit), type of drumstick (e.g. wooden tip, brush etc.), velocity[53] and ambience. For example, a 'dry' brass snare sample, center-hit at medium velocity (66% intensity), recorded in the floating studio with a wooden tip drumstick would be labeled as follows:

*Floating studio (D) + brass snare (BS) + center hit (C) + wooden tip (WT) + medium velocity (66) + dry ambience (dry) = DBSCWT66dry*

[53] A framework for guiding the velocities of drum hits was wholly determined by the drummer's experience.

### *5.1.2. Qualitative description*

A general, qualitative overview of the sample collections is very difficult to form, as many variables contributed to each sample collection. Due to the proximity effect, close-miked samples contain more bass frequency components whereas the ambient samples are more tone-rich, warm and transparent. The absence of dynamic signal input in these samples contributed greatly to the brighter sample quality. In each sample set, the particular room characteristics contributed significantly to the tonal quality of the samples. For this reason, the floating studio collection – especially the dry samples – is much 'darker' than samples recorded in the two halls. The sample collections are all of excellent quality, and convey a true tonal image of 1) the *drum kit* (as individual parts and as a whole), as well as 2) the *spatial identity* of the three unique recording locations.

### *5.1.3. FFT analysis*

The frequency spectra of a selection of samples are included in this section. These samples represent the greater sample collection as follows (refer to *Chapter 3, section 3.3.2.*):

- A dry sample of each instrument type recorded in the floating studio – *Figures 4, 5 and 7-11.*
- A dry and wet sample of a single snare drum hit, also recorded in the floating studio – *Figures 5 and 6.*
- Two wet samples of a snare drum hit (one sample before and one after mastering) recorded in the Endler Hall, and a sample of the Endler Hall air conditioning noise[54] – *Figures 12-14.*

An FFT sample-size of 1024 was utilized, except where stated differently. Screenshots of the Frequency Analysis window of *Cool Edit 96* [55] were captured and cropped to size. Graphs are logarithmic displays and show the frequency content of a single [left] channel of each sound sample. The dynamic range was set to 160 dB, expressed on the Y-axis as values ranging from –144 to 0 dB. Generally, levels of the frequency components appear low; this is because the frequency spectra are all expressions of the average frequency weightings over the specified sample periods. Graphs should be viewed in unison with the sample descriptions in *Chapter 3, section 3.3.2.*

[54] Refer to Appendix A.
[55] Visit the Syntrillium Software Corporation at http://www.syntrillium.com.

Figure 4 shows the predominantly low-frequency content of the bass drum sample peaking at around 160 Hz. An evenly spaced amount of mid frequencies is present, peaking in the high mids, and dropping steeply above five kHz. Figure 5 shows the bulk frequencies of the stainless steel snare drum to be present above 160 Hz, with frequencies steadily dropping in energy above 1.3 kHz. Figure 6 shows the same snare drum as in Figure 5 with notable variations in the lower frequencies, introduced by room reflections and fair amounts of comb filtering. Refer to *sections 3.4. and 4.2*. Figure 7 shows the predominantly low-frequency content of the 10” tom-tom. The sample-size of 1024 is restricting, as little of the higher frequencies, introduced by the impact of the drumstick, is visible. A higher FFT sample-size, or a shorter sample period, may have indicated more high frequencies.

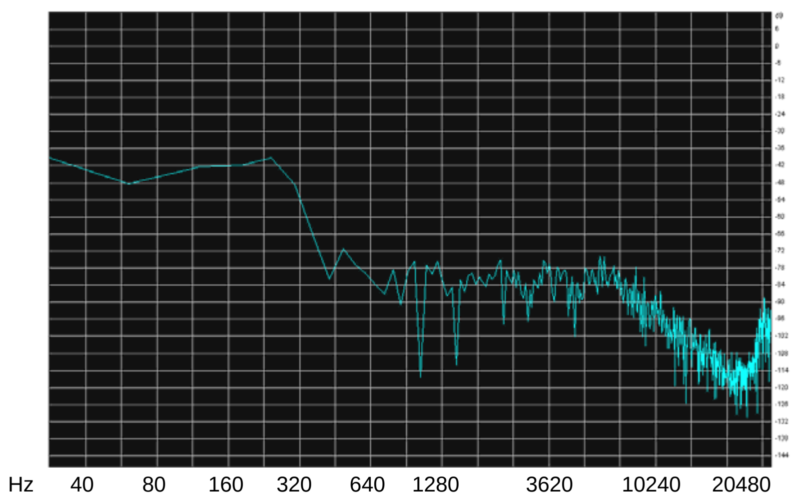



**Figure 4:** Bass drum sample – 0.428 seconds.

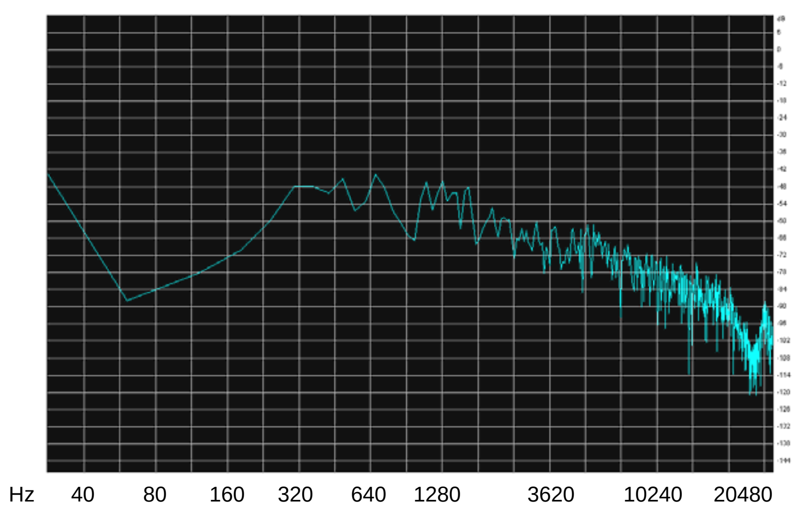



**Figure 5:** *Dry* stainless steel snare sample – 0.412 seconds.

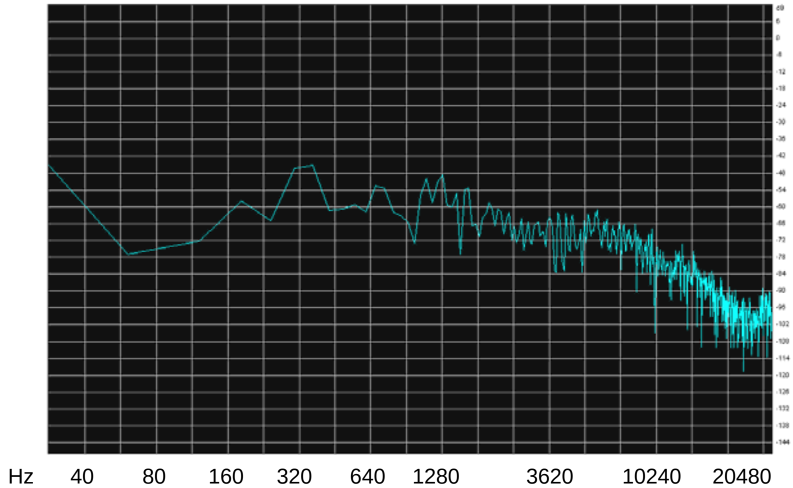



**Figure 6:** *Wet* stainless steel snare sample – 0.599 seconds.

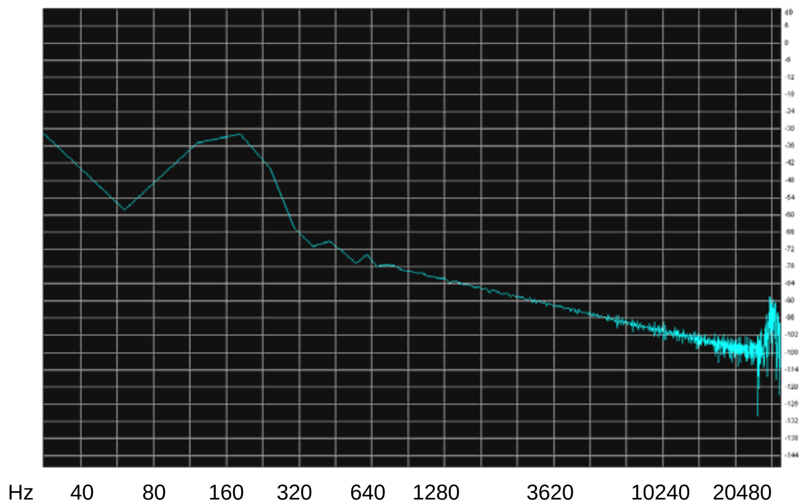



**Figure 7:** 10” tom-tom – 2.269 seconds.

Figures 8 and 9 show subtle differences in the low frequency regions of the 12” and 14” tom-toms. This is due to the differences in fundamentals (tuning) of the respective drums. The same graphical restrictions appear to be present in the lack of visible high-frequency spikes. Higher FFT sample-sizes and/or shorter sample periods might have indicated more of the frequencies introduced by the stick impact.

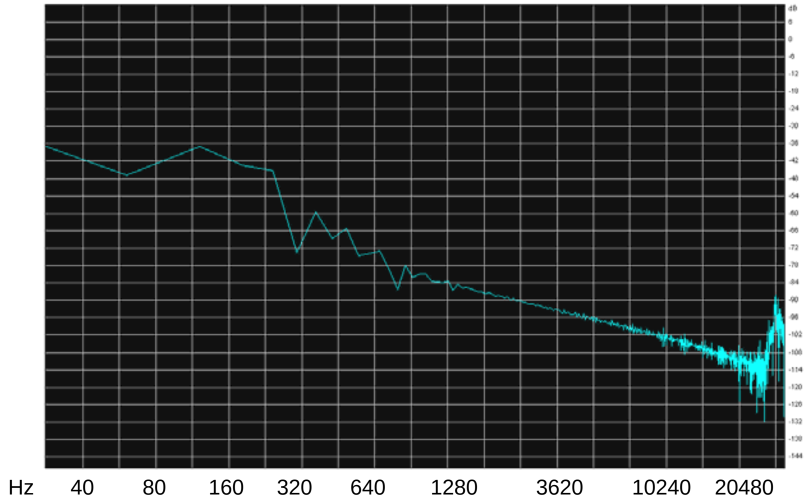



**Figure 8:** 12” tom-tom sample – 1.830 seconds.

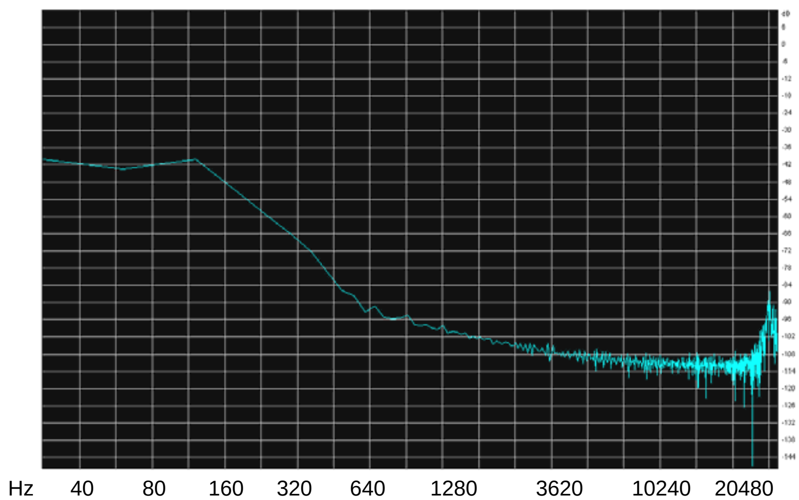



**Figure 9:** 14” tom-tom – 2.307 seconds.

Figures 10 and 11 both indicate great amounts of high frequencies present in the hi-hats and the cymbal samples. The low-frequency spike in the hi-hat sample may be the result of either 1) mechanical noise picked up through the microphone stand, or 2) the stick impact generating much low-frequency energy. The profusion of harmonically isolated high frequencies is evident in both samples. Figure 12 shows the detailed, yet uncorrelated frequency-composition of the noise sample of the Endler Hall air conditioning system. This particular sample was extracted from the Endler Hall recording session and used during mastering (sound restoration) to isolate and remove excess noise from all Endler Hall samples. A larger FFT sample-size (4096 values) was used to compile the noise graph.

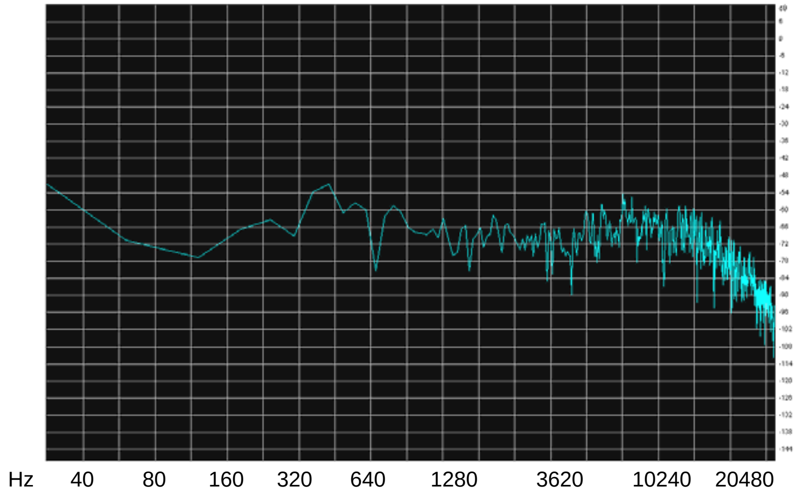



**Figure 10:** Tight hi-hats played with the tip of a stick – 0.246 seconds.

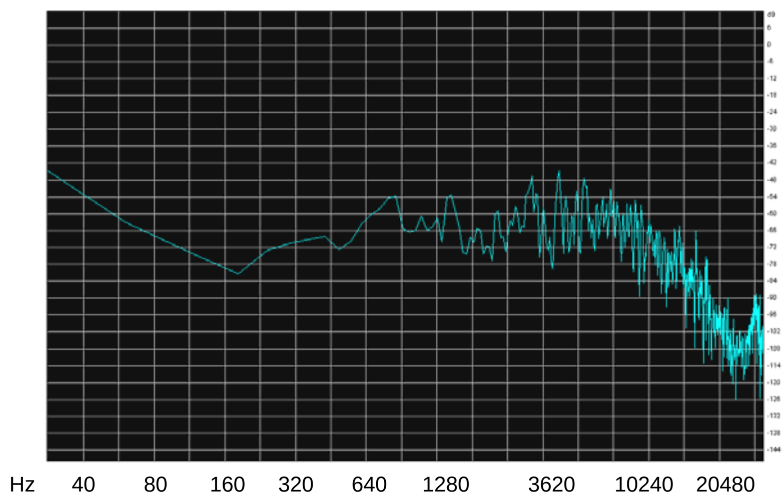



**Figure 11:** 15” crash cymbal – 3.729 seconds.

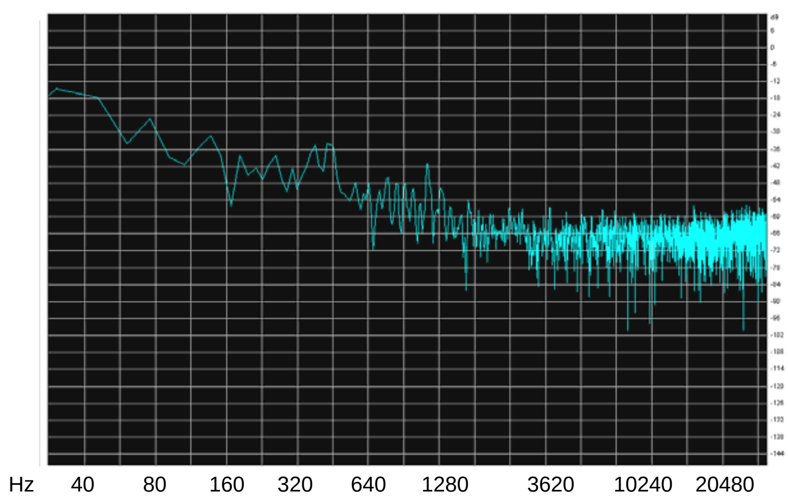



**Figure 12:** Endler Hall air conditioning noise, normalized –
4.934 seconds; FFT size: 4096 samples.

Figures 13 and 14 shows the frequency spectra the same maple snare samples, before and after mastering respectively. Virtually no difference is discernible. Compared to the snare samples of the floating studio (figures 5 and 6), the Endler Hall snare samples contain much more energy. This is a direct result of the hall reverberation adding to the sound energy of the snare sample.

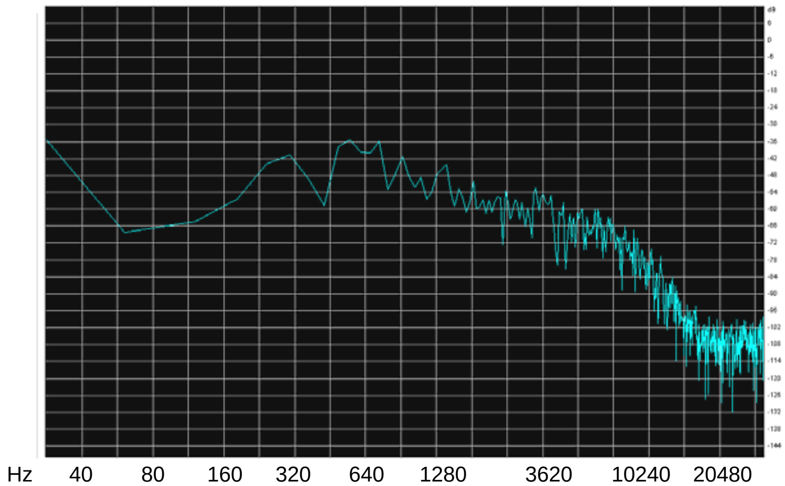



**Figure 13:** *Wet* maple snare sample, Endler Hall before mastering – 1.267 seconds.

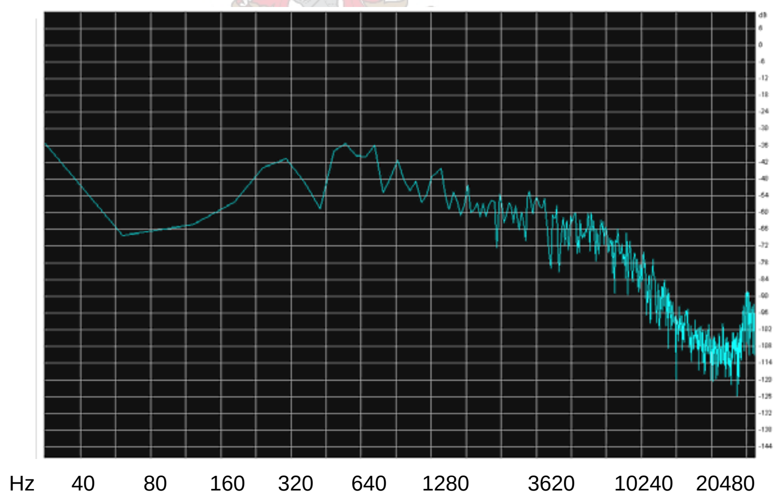



**Figure 14:** *Wet* maple snare sample, Endler Hall after mastering – 1.267 seconds.

### 5.1.4. Sample collections

A different collection of samples was recorded in each room, although the sample collections of the Fismer and Endler Halls overlap.

*Floating studio*

In these samples, the term *dry* refers to either a single close-miked signal, or a combination (mix) of two or three close-miked signals;[56] *wet* refers to the dry signal plus a combination (mix) of the overhead microphone pair and the ambient microphone pair. All the cymbal samples were recorded as a combination signal (mix) of the overhead and ambient microphone pairs. Levels of each channel were set according to the author's preference. The exact number of recorded samples is unsure, as the entire performance was captured, including many 'faulty' samples. The floating studio collection (see *Appendix D*) was compiled as follows:

- <u>Bass drum</u>. The bass drum was sampled at three velocities, with five attempts at each. A dry and wet version was bounced for the best attempt at each velocity.

- <u>Snare drums</u>. Both the brass and maple snare was played with wooden and nylon tip drumsticks, as well as rutes and brushes. For each of these combinations, various drum hits (three hits per velocity) were sampled at three velocities each – soft (33% intensity), medium (66% intensity) and loud (99% intensity). Where applicable, the drum hits included some or all of the following:[57] snare center, snare off-center, rim-tap, rim-shot, flam, flam-on-rim, and double-stroke and military stroke. The 'best' performance at each velocity of each drum hit was selected during the editing stage. For each hit both a dry and wet sample was bounced. A few samples of the newly sampled 14" Gretsch stainless steel snare were included in the final floating studio collection.

- <u>Tom-toms</u>. Each of the three tom-toms was sampled at three velocities while drum hits included tom center and flam. Samples were finalized according to the same procedure as the snare drum samples.

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[56] As in the case of snare samples, recorded with one microphone facing the batter head, another facing the side (body) and a third facing the snare head. Bass drum samples recorded in the floating studio used a microphone on the closed resonant head, and another facing the beater from the front.

[57] Not all drum hits were suitable for every beater, e.g. a snare flam could not be executed properly with brushes. See Appendix D for detail.

- Cymbals. The hi-hats were the only close-miked cymbals. Various hi-hat strokes were sampled, as this was the only instrument part of the drum kit played by a combination of foot-pedal and drumsticks. All cymbals were captured exclusively by an overhead and room microphone combination – therefore only ‘wet’ samples. Three velocities of each cymbal stroke (single attempt each) was sampled and bounced to disk.

*Fismer and Endler Halls*

In these samples, *dry* refers to the overhead microphone pair, and *wet* to a mix between the overhead and the ambient microphone pair. Every drum hit was sampled at the loudest velocity making a single attempt at each, except in the case of a severe mistake being made. Mixing levels were also set according to preference. More or less 36 samples were recorded in each hall. These two sample collections (see *Appendix D*) were compiled as follows:

- Bass drum. A dry and wet version was bounced for a single, loud performance.

- Snare drums. Both the brass and maple snare were sampled with a wooden drumstick only. A smaller variety of drum hits was sampled at a single velocity only. These included some or all of the following: snare center, snare off-center, rim-tap, rim-shot, flam and flam-on-rim. For each hit, both a dry and wet sample was bounced.

- Tom-toms. Each of the three tom-toms was sampled once at a single, loud velocity. Drum hits included tom center and flam. Samples were bounced accordingly.

- Cymbals. A single velocity of each cymbal and hi-hat stroke (single attempt at each) was sampled and bounced to disk. Again, a variety of hi-hat strokes was sampled.

## 5.2. The GigaStudio phase

Employing GigaStudio represented the final academic stage of the project. Sample collections were prepared, in terms of recording, editing/mixing and mastering, with specific focus on mapping and layering the individual samples into the GigaStudio platform. Within the larger context of the project, GigaStudio functioned as the **sampler** into which the recorded samples were loaded. Sample collections were organized into separate *GigaSampler Instruments*, making use of the *GigaSampler Instrument Editor*. The instrument editor features the following: a *wizard tool* to help build complex instruments, *drag and drop mapping*, *layering of samples*, *release triggers* for triggering samples when a key is released, *sub mixing* of sample regions, *resonant filters* with separate settings for each, and *drag tool editing* for enabling quick and intuitive region editing (Nemesys 1998: 66-67).

This final and very brief stage of the study attempted to suggest a possible use of the sample collections within a commercial software sampler. Note that there was no hard and fast way, there were no rules, and very little limitations in terms of the design, layout and settings of GigaSampler Instruments. Therefore, this section does not attempt to provide a user's guide for GigaStudio, but merely present the creative results of this study. GigaSampler Instruments can be fully customized, and therefore any setting can be altered and set to exact preference. This feature demonstrates the power and the versatility of software samplers. Refer to *Chapter 2, section 2.4*, or refer to the GigaSampler User's Guide (1998: Nemesys Music Technology, Incorporated) for comprehensive information on GigaStudio.

### *5.2.1. GigaSampler Instruments*

*Introduction and review*

GigaStudio sample collections are assembled into functional sample 'groups' with the GigaSampler Instrument Editor. Each functional group of samples, including all sample layers, settings and peripherals, is referred to as a GigaSampler Instrument – hence termed *instrument*. An instrument is defined as any number of samples – sample groups are usually organized into separate folders – carefully imported and mapped (assigned) to a set of user-defined sample regions. Each user-defined sample region is linked to either an individual semitone or range of semi-tones of a [MIDI] keyboard. In all instruments created for this study, a single sample region correlates to a single semi-tone, allowing a single note to trigger an individual sample or one or more out of a set (layer) of samples. Each region furthermore allows various velocity splits, sample layers (e.g. panning of left and right mono samples) and an array of user-defined settings. In short, every instrument can be customized as preferred. The instrument editor has a very convenient yet simple-to-use *wizard tool* that allows quick and easy mapping of huge numbers of samples. Compiled instruments contain all imported samples associated with that instrument, whether mapped to a sample region or not. Instruments – saved as *GIG files* – are finally exported directly to the GigaStudio workspace. Refer to the *GigaStudio User's Guide* (Nemesys: 1998) for comprehensive detail on GigaSampler Instruments.

*Instruments created for this study*

In total, five stereo GigaSampler Instruments were carefully compiled. Note that these instruments remain fully user-adjustable; the five created instruments are customized according to the author's preference. The instruments are outlined as follows:

- Endler Hall Collection (EHC): The collection contains all samples as outlined in *section 6.1.* and listed in *Appendix D*. Bass drum samples are mapped towards the lower registers, followed by the brass and maple snares, toms and hi-hats. The range of cymbals is mapped towards the high registers. A dry and wet sample is layered in each region. The modulation wheel is set to toggle between dry and wet sample layers. No velocity splits are used, as Endler Hall drum hits were sampled at a single velocity.

- Fismer Hall Collection (FHC): The same mapping procedures were followed as in the Endler Hall Collection. No velocity splits were used. This collection contains a few additional samples – stainless steel snare and the rerecorded bass drum samples (sampled with the AKG D112). The only audible difference between the two instruments is the tonal differences introduced by the room ambience.

- Floating Studio Pearl Brass Snare Collection (PBSC): This collection contains an endless array of brass snare hits performed with various beaters. Regions are mapped according to the groups of snare hits related to each beater. Each group of regions contains the following general snare hits: snare center, off-center, flam, rim tap, rim shot, rim flam and military roll. Each sample region has a single velocity split (equals two velocities) and a wet and dry layer mapped for each velocity. The modwheel is set to toggle between layers.

- Floating Studio Gretsch Maple Snare Collection (GMSC): The same mapping configuration as the Brass Snare Collection was used. In addition, a single velocity split with a wet/dry layer for each velocity, utilizing the modwheel to toggle between the dry/wet layers.

- Gretsch Floating Studio Collection (GFSC): This collection contains a variety of the best floating studio samples, compiled as a general Gretsch Renown Maple drum sample collection. Regions are mapped similar to the two floating studio snare collections – bass drum samples are mapped towards the lower registers, followed by brass and maple snare samples (wooden stick only, for both snares), the few stainless steel samples, toms, hi-hats and cymbals. All sample regions, except for *bass drum* and *cymbals* with three velocities per region, have a single velocity split (two velocities per region) and a wet and dry layer mapped for each velocity.

### *5.2.2. The GigaStudio workspace*

GigaStudio allows several GigaSampler Instruments to be loaded into the sampler simultaneously. Each instrument is assigned to a MIDI port and MIDI channel. This allows a maximum of 16 channels (instruments) per port – 64 instruments. The workspace employs simple MIDI control and is straightforward to use. Following this, all five Gretsch instruments can be loaded into GigaStudio and triggered via MIDI. Application note: ensure correct MIDI setup prior to use of GigaStudio.

## 5.3. Publishing of the sample library

### *5.3.1. The publishing process*

The information in this section literally deals with the expectation of commercial release of the sample library. The process is slow and meticulous, and for this and other legal reasons, this section actually extends beyond the set scope of the study – should the product not be released, the study shall be regarded as complete.

Publishing is the collective term[58] for the process of preparing a product for commercial release. It is a comprehensive process drawing from the input of various professional resources and individuals. Traditionally, the publishing process is hosted and coordinated by a commercial *publishing house*. Stellenbosch *Merchant Records and Publishing* is the exclusive publisher of the Gretsch drum sample library.

For the discussion that follows, the *artist* refers to both the musical performer and producer of the musical works discussed. This publishing process essentially involves the following, although the particular order is not predetermined (Merchant Records and Publishing 2003):

- <u>Publishing contracts</u>: A *Deed of Assignment* is signed between the artist and the publishing house. This secures and protects the rights of both parties, while involving a royalty scheme set for the specific project. A further contract is signed – as in the particular situation – between the producer of musical works and the publishing house, for the same reasons as the latter. The publishing house coordinates all legal and financial affairs and ensures transparent communication between all parties involved.

- <u>Recording and mastering</u>: In a normal situation, the publishing house coordinates and streamlines communication between the artist, producer and the various internal and external role-players involved in the actual production – studios, recording engineers, mastering facilities etc. The publishing house often employs the exclusive assistance of a *record company* that would take complete control and responsibility of the production. In this specific situation, Merchant Records

[58] According to Allen (2001: 712) this process traditionally refers to the production and commercial release of books, newspapers etc. It may also refer specifically to the actual printing process.

functions as a combined publishing house and record company. This inevitably streamlines the process.

- Licensing and registration: All music registration and licensing (including a commercial barcode for the product) with the necessary external music rights organizations are coordinated, executed and funded by the publishing house. This process ensures that all exclusive rights are assigned to the appropriate individuals and/or organizations. Traditionally, the copyright(s) of recorded and published material is owned and managed by a publishing house, while the phonographic rights (that is the actual audio master disk) are owned by a record company. Merchant Records functions as both.

- Art direction and cover design: This process may include some or all of the following – photography (photo shooting), art direction and coordination, actual design of CD covers, design of packaging etc. The artistic process may be subcontracted to one or more external individuals or companies, and remains the legal responsibility of the publishing house.

- Cover printing and CD replication: These two diverse processes may be under control of either the same governing body, or two totally separate companies. The combined process involves the actual printing of CD covers (inlays and back cards, packaging etc.), the replication of audio and data disks from the master disk and cliché printing on the disks itself. Usually this process also involves the final packaging of the product.

- Marketing and Distribution: The logistic stage of publishing is the actual distribution of the final product. An external *Distribution Company* usually takes charge of this process. In the specific situation, all printing, replication, packaging, warehousing and distribution is coordinated by *Bowline Cape Town* – a private and independent distribution corporation dealing mainly with the distribution of *Microsoft* products in South Africa (Bowline 2001). The services of Bowline also include "product customization, warehousing, inventory risk management, security, order processing and fulfillment, management of receivables, and complex distribution" (Bowline 2001). Merchant Records coordinates and ensures communication between the artist and Bowline, and takes responsibility for the marketing of the product.

For the stated process certain commercial principles applies, assuming royalty divisions for all parties contractually involved. These are 1) the University of Stellenbosch, for the supply of equipment and studio time as well as hosting the study, 2) professional drummer Pierre Tredoux, for investing time and allowing the sampling of his acclaimed Gretsch drum kit, and 3) Merchant Records and Publishing, for coordinating and publishing the sample library (Merchant Records and Publishing 2003).

#### *5.3.2. Product information*

The information about the final product is that which was rendered available by the time of printing. The product will marketed under the commercial title of *Pierre Tredoux Gretsch Drums Volume 1*. An alternative suggestion is *Merchant Records Drum Sample Collection Volume 1 – featuring Pierre Tredoux on Gretsch Drums.*

The product will consist of two data disks, containing all 16-bit stereo wave files as well as the GigaSampler Instrument files, two audio compact discs and a compact user's document, with track listings and information about licensing and copyright protections. Packaging will either be a carton with two double disks with documentation, or a small A5-size package containing the above. The prospect of including 24-bit stereo wave files of all samples is under investigation.

In terms of marketing, the immediate prospect is to announce the sample library on the e-commerce facility of Merchant Records – refer to http://www.merchantrecords.com.

# CHAPTER 6

# CONCLUSION

## 6.1. Summary of results

The outcome of the study includes 1) a successful product, currently in the process of publishing, as well as 2) a thesis documenting the academic and creative scope of the study as set out in *Chapter 1*. It was decided that a discussion of the commercial viability of the sample library remained beyond the current academic discussion, as the complex process of publishing the finalized product may have jeopardized the time frame set for the project. Refer to *section 6.3.*

The set expectations of this study, in terms of the research intent and final product were successfully met. These included the acquisition of practical knowledge on the acoustic qualities of the particular recording rooms, a thorough understanding of the acoustics of a drum kit and associated recording methods, familiarity with the difficulties of recording a complex instrument and setting realistic objectives in terms of the musical content. The thesis therefore provides 1) a practical and coherent plan[59] for producing a sound sample library where one (or more than one) real instrument(s) is/are sampled, and 2) a quality product (prototype) highlighting the different creative and academic aspects of the project. The final product excluded drum loops or any musical content related to a specific music genre. Restricting the product and its documentation to a drum sample collection, to a certain extent secured the scope of the study. The final product therefore consists of a drum sample library hosted on several compact discs, for specific use within the GigaStudio environment, but also conveniently for use with any other digital audio workstation. For this practical solution to be implemented, both audio and data formats of the finalized sample collection are included in the final product. The product was in the final publishing stage at the time of printing of the thesis.

[59] Within context, the term ‘plan’ refers to the specific approach of this study.

## 6.2. Applications of the product

The sample library was originally planned for exclusive application within the GigaStudio environment. GigaStudio however ‘prefers’ specific file formats (16-bit stereo wave files, sampled at 44.1 kHz sampling rate), which may have been restricting to end-users using mainly other audio file formats. For this and other practical and commercial reasons, the sample library additionally includes all samples in audio format (16-bit stereo CD audio).

However, the CD audio format places certain restrictions. Firstly, **audio tracks** from the floating studio collection contain, in several instances, groups of variably spaced[60] samples, as opposed to the dual sample (*wet* and *dry*) audio tracks of the similar Fismer and Endler Hall collections. Audio tracks were normalized as a whole, with the implication that loud samples are strident and quiet samples are very low in sound level. Secondly, note that individual samples will have to be ‘cut’ from the audio tracks for access to the individual samples – and thus for use in other digital audio workstations or environments.

GigaSampler Instruments all utilize **data files** as individual samples. Note that these samples are all normalized for easy mapping within GigaStudio, with the implication that both the *quiet* and *loud* samples are normalized to the same intensity levels. With this in mind, the individual samples can however be used in any other application. Finally, a single velocity split (two velocities) is included per sample, which results in a stronger tonal gradient that places emphasis on the versatility of the velocity splits.

The following application guidelines are suggested:

- The different drum sample collections (Giga instruments) are best triggered via a default MIDI connection[61] between the sampler (GigaStudio) and an external MIDI controller or digital audio workstation, running on the same computer. Each Giga instrument must be loaded into the sampler and assigned to a user-specified MIDI port and channel.

[60] Spacing within tracks depends wholly on sample decay time.
[61] *Default* in this context refers to the specific MIDI setup of the applicable (user’s) GigaStudio environment.

- Drums are best played back (for programming loops etc.) when triggered directly in GigaStudio. Velocity-sensitive triggering allows for natural differences in playback levels and tonal nuances, and thus creates a sense of spatial reality. When programming drums using the individual wave files, care should be taken to realistically[62] tweak the levels of the various individual samples.

- Differences in room ambience can realistically be adjusted using the assigned controllers. The mod-wheel was assigned as default controller for this function.

- All Giga instruments can be fully customized by the user. This inevitably demands a fundamental understanding of the GigaStudio Instrument Editor.

In conclusion, the application of the product is again unbound.

## 6.3. Limitations of the research

Several limitations surfaced during the study. Firstly, a lack of existing academic guidelines introduced escalating numbers of options while the scope of the project was continually interrogated with the inherent risk of digression from the set objectives. This specific limitation only crystallized as the project expanded and required new academic margins to be set on several occasions.

Secondly, the various professional role-players all contributed more than just knowledge and skill. The fact that artistic input at a professional level was difficult to render into commercial value complicated the prospect of commercial exploitation of the product. If, in a study of this kind, the product develops for retail purposes, a completely new set of commercial and moral variables are introduced. In terms of the product, these include issues of ownership, royalty divisions, copyright protection, phonographic rights and more. Investigation of these impediments slowed down the final publishing stage of the project. By the time of printing, the product was still held in care of the publishing company.

Thirdly, the autonomous nature of the study had a restrictive impact specifically on the documentation. Trustworthy guidelines had to be followed in terms of recording and production

[62] These level differences are entirely a matter of imitating a real drummer's technique. Using the scope of drum hits (e.g. center and off-center snare hits) could add to the sense of realism.

techniques, as this enabled accurate academic tracking of the creative process. This restriction however can be seen as a limitation or advantage.

Finally, a major limitation was the lack of surfeit time and financial resources. The recording process is expensive[63] and time-consuming and many contributing factors lay beyond the scope of individual time and financial liability. In this regard, one practical solution was the exclusion of actual drum loops as part of the drum sample library. It was decided against the inclusion of loops, for the simple reason that drum loops could not have been separated from a specific musical style (genre) and influence, and would therefore have extended the academic scope and related impediments even further. An inclusive understanding of various other limitations (of the actual recording equipment etc.) may in future secure realistic expectations of the outcome and usability of digital sound sample libraries.

## 6.4. Areas for future research

In hindsight, this sample library study represents merely one of the almost infinite number of research possibilities in the area of sample library productions. Directly or indirectly related to this study, the following areas for future research are suggested:

- As stated in the previous section, a first and immediate expansion area – a <u>qualitative study</u> – could be the design of a *drum loop library*, or merely the inclusions of drum loops in a similar drum sample library. In such a sample collection, the focus would have to shift from a mainly technical (or engineering) approach to focus on the actual musical content of the library. In addition to the technical and production information, documentation of such a study would have to focus on the rationale behind the music genre and selection of musical phrases/loops within that musical context.

- Secondly, a <u>comparative study</u> could also be performed, focusing mainly and directly on the differences in sample (tonal) quality between the samples recorded in various environments as well as a comparison for the use of different microphones and recording techniques etc. The question arises whether or not such a study would be commercially more viable than the current study.

[63] This implies all costs incurred in recording projects: session musicians, equipment and studio hire, mastering etc.

- A third prospect may be a technical study, sampling more advanced drumming techniques and experimenting with complex sample layering, for increased sample playback realism. A study of this kind would inevitably request detailed research on drumming styles and techniques.

- A final suggestion is a technical analysis focusing on the frequency content of drum samples, experimenting and testing various factors and parameters such as the viability of microphone applications, mastering techniques etc.

At the end of a study that occupied more than just a span of two years of my life, I am conscious of the enormous potential of the work, both from an academic and artistic point of view. Many of the samples produced in this study have been used in commercial productions over past 12 months with very positive feedback. I never expected those samples to go all the way 'into' this final blissful document. With great expectation, I look forward to wherever this is going.

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# APPENDICES

# APPENDIX A

# ROOM NOISE LEVELS AND THE AIR HANDLING UNIT

*Sound levels and weightings*

Irwin and Graf (1979: 47-48) state that *sound levels* are “sound pressure levels that have been weighted according to a particular curve”. These curves – weightings A, B and C – and associated sound levels were developed to better evaluate the impact of noise on the human ear. The *A-scale* – “used almost exclusively in measurements that relate directly to the human response to noise,” (Irwin and Graf 1979: 48) – was developed for levels below 55 dB, the *B-scale* for levels between 55 and 85 dB, and the *C-scale* for levels above 85 dB. A-scale measurements (measured in dBA) are referred to as *sound level measurements*. Table 2 lists the frequency response and decibel conversions, to or from a flat response, for the A-weighting and clearly depicts the differential sensitivity of the human ear for different octave-band sound pressure levels. The total A-weighted sound level can be calculated from a set of octave-band sound pressure levels.

**Table 5:** Sound level conversions chart from flat response A weightings (Irvin and Graf 1979: 49).

| *Frequency (Hz)* | *A weighting (dB)* | *Frequency (Hz)* | *A weighting (dB)* | *Frequency (Hz)* | *A weighting (dB)* |
|---|---|---|---|---|---|
| 10 | -70.4 | 160 | -13.4 | 2500 | 1.3 |
| 12.5 | -63.4 | 200 | -10.9 | 3150 | 1.2 |
| 16 | -56.7 | 250 | -8.6 | 4000 | 1 |
| 20 | -50.5 | 315 | -6.6 | 5000 | -0.1 |
| 25 | -44.7 | 400 | -4.8 | 6300 | -0.5 |
| 31.5 | -39.4 | 500 | -3.2 | 8000 | -1.1 |
| 40 | -34.6 | 630 | -1.9 | 10000 | -2.5 |
| 50 | -30.2 | 800 | -0.8 | 12500 | -4.3 |
| 63 | -26.2 | 1000 | 0 | 16000 | -6.6 |
| 80 | -22.5 | 1250 | 0.6 | 20000 | -9.3 |
| 100 | -19.1 | 1600 | 1 | | |
| 125 | -16.1 | 2000 | 1.2 | | |

*Room noise levels*

Taking in account that total noise (in terms of dBA) is the sum of all the octave bands present, it is difficult to predict whether the noise within an environment might be annoying, or audible at all, if insufficient information about the frequency content is available (Irvin and Graf 1979: 49-50). The human ear distinquishes between sound levels of different frequencies, whereas microphones do not function in this way. Any noise within the frequency and sensitivity range of a microphone will be sensed. The gentle, audible drone of the air conditioning system in both Konservatorium halls, turned out to be the major problem in the samples recorded within these halls. Table 6 provides an indication of the sound levels of the relevant Konservatorium rooms, measured under designated conditions.[64] All sound levels were measured between 10:45 and 11:30 am, using a digital Sound Level Meter with a sensitivity range of 30 – 130 dB.

**Table 6**: Comparison of room sound levels measured under various conditions.

| *Room* | *Condition* | *Sound level (dBA)* |
|---|---|---|
| Endler Hall | lights on | 32 |
| | lights off | 32 |
| Fismer Hall | lights on | 35 |
| | lights off | 35 |
| Floating studio | lights on | 31.4 |
| Control room 1 | lights on, computer off | 31.3 |
| | lights on, computer on | 35.8 |
| Control room 2 | all off | 32.1 |
| | lights on, computer off, air con full | 45.3 |
| | lights on, computer on, air con full | 46 |

[64] Referring to certain controllable variables e.g. lights on or lights off etc.

*Konservatorium Air Handling Unit (AHU)*

The central Air Handling Unit of the Konservatorium building (a Johnson MetaSys air conditioning system) was designed by Arthur Morris Consulting Engineers, and is maintained by Cape Automation Systems. This programmable unit operates on a day and night schedule,[65] regulating the temperature and humidity within the building. The AHU keeps the air in the Endler Hall around 21°C, with a relative humidity of 50%. Conditions in both halls are quite similar (Stellenbosch University Division Physical Infrastructure 2003a). No air conditioning problems were faced in the floating studio. According to the Manager of Electrical and Mechanical Services, three main factors influence the noise levels within a room: mechanical rumble, air movement and structural noise. In both halls, all three factors were detected, although the main concern was the low frequency mechanical rumble of the central AHU. Noise levels were particularly problematic in the decay of the recorded samples.

*Remarks*

Comparing the sound levels in the different rooms, it was interesting to note that a difference of only 0.6 dB between the floating studio (31.4 dB) and the Endler Hall (32 dB) was measured. In terms of audible intensity difference, this should theoretically be omissible. Furthermore, a difference of 3 dB was measured between the Endler Hall (32 dB) and the Fismer Hall (35 dB), although the AHU proved much more problematic in the Endler than in the Fismer Hall. The most probable explanation for the latter phenomenon is the ambient microphone setup in the smaller Fismer Hall, which proved more susceptible to sensing room noise, than in the larger Endler Hall. The enormous difference between room noise in the floating studio and the Endler Hall could also solely be explained by the microphone placements in the respective rooms.

A thorough FFT analysis of the AHU should be launched for comprehensive remarks on sound levels in the respective rooms. All room noise imposed on the recorded samples was effectively removed, or minimized, during the mastering phase.

[65] The day cycle normally terminates after 22:00 hours. The programmable schedule is under direct control and supervision of the Department of Maintenance, Division Physical Infrastructure (Stellenbosch University Division Physical Infrastructure 2003a).

# APPENDIX B

## KONSERVATORIUM SURFACE DIAGRAMS

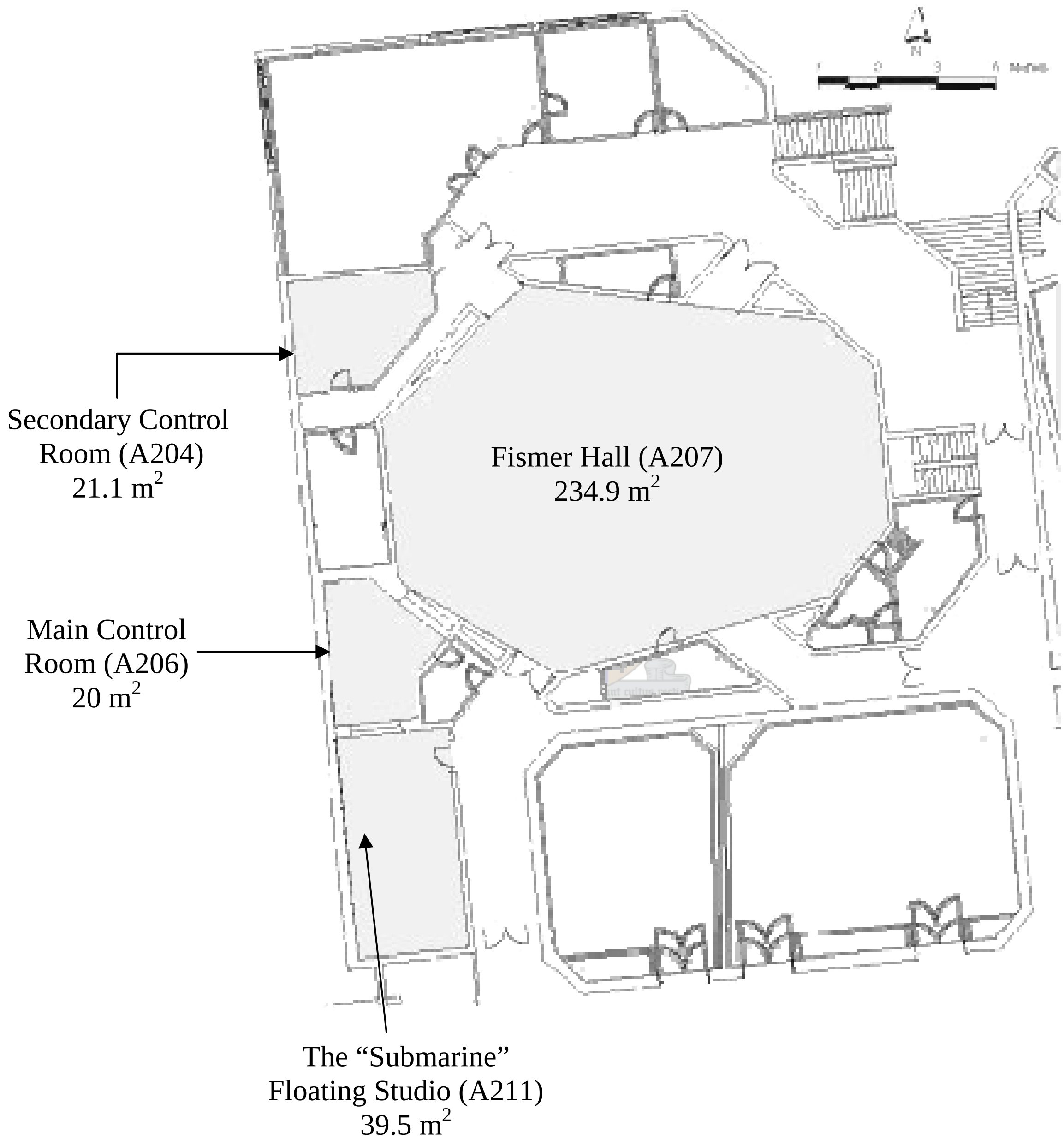


**Figure 15**: Surface areas of Konservatorium rooms A204, A206, A207 and A211 (Stellenbosch University Division Physical Infrastructure 2003)

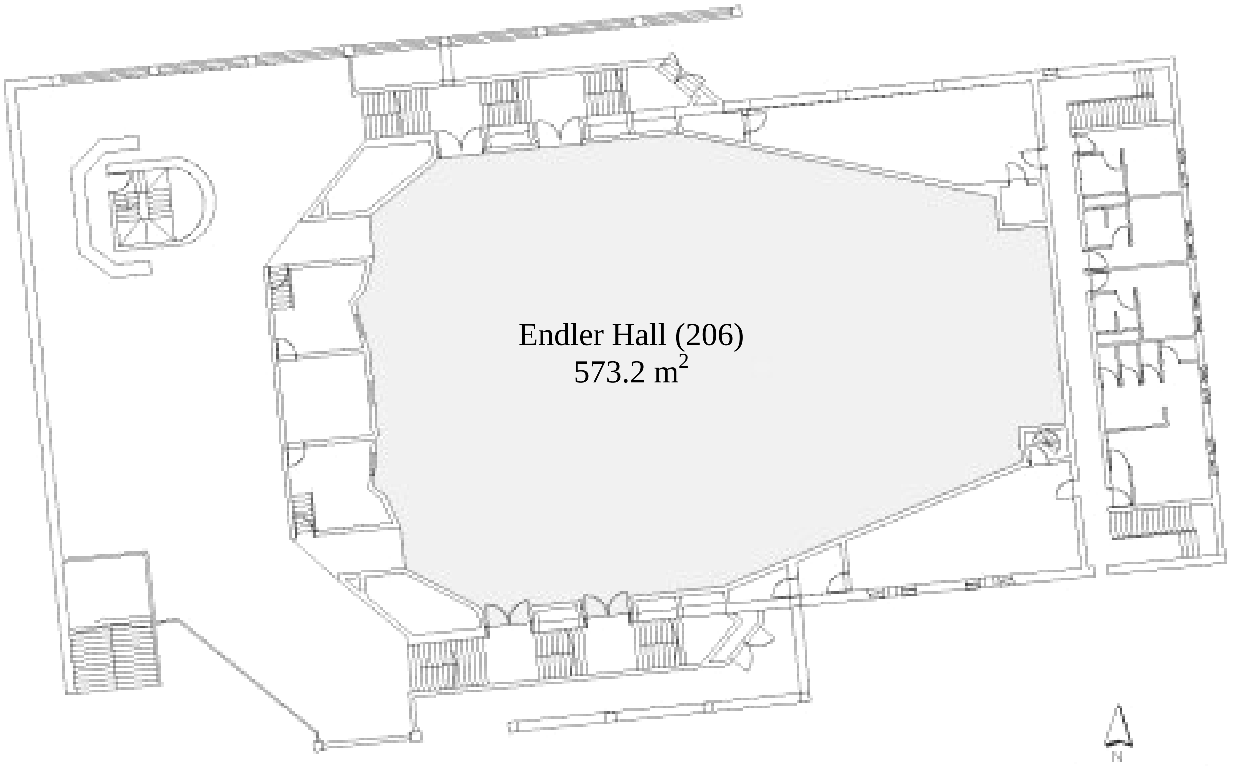


**Figure 16**: Surface area of the Konservatorium Endler Hall (Stellenbosch University Division Physical Infrastructure 2003).

# APPENDIX C

## MICROPHONE RESPONSE CURVES

The following figures depict the frequency response curves of the different microphones used during the sampling project. The diagram for the CK1 cardioid capsule is also included, as the AKG C452 EB was the only microphone utilizing a detachable capsule.

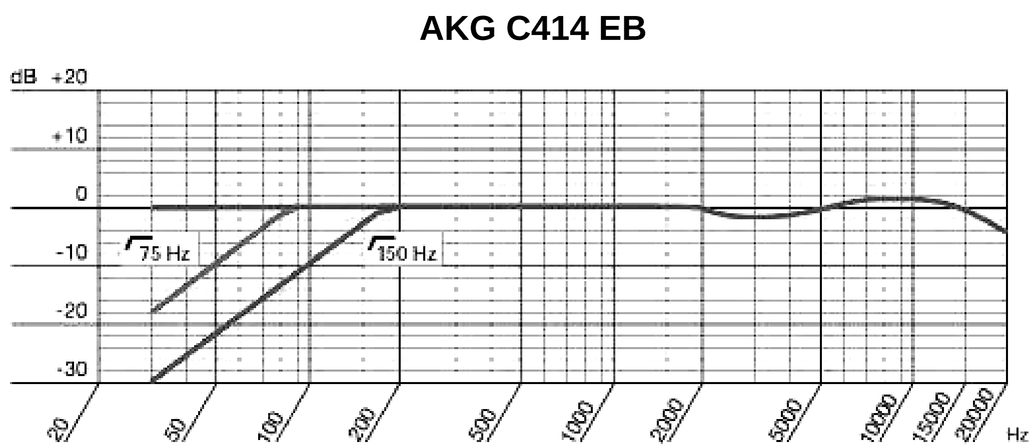


**Figure 17**: The near ‘flat’ response curve of the AKG C414 EB, indicating a 2 dB dip in the 2 – 5 kHz range, and a 2 dB lift in the 6 – 12 kHz range. The filter slopes of both HP filters are also indicated (AKG Acoustics 2003).

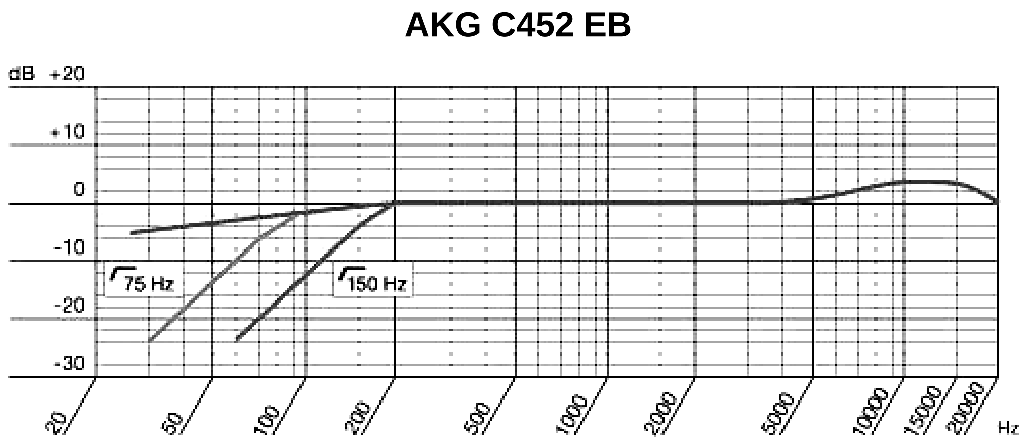


**Figure 18**: Response curve of the AKG C452 EB, indicating a -5 dB slope below 200 Hz, and a 4 dB lift in the 5 – 18 kHz range. Filter slopes of both HP filters are also indicated. An AKG C1 cardioid capsule was used in conjunction with the C452 (AKG Acoustics 2003).

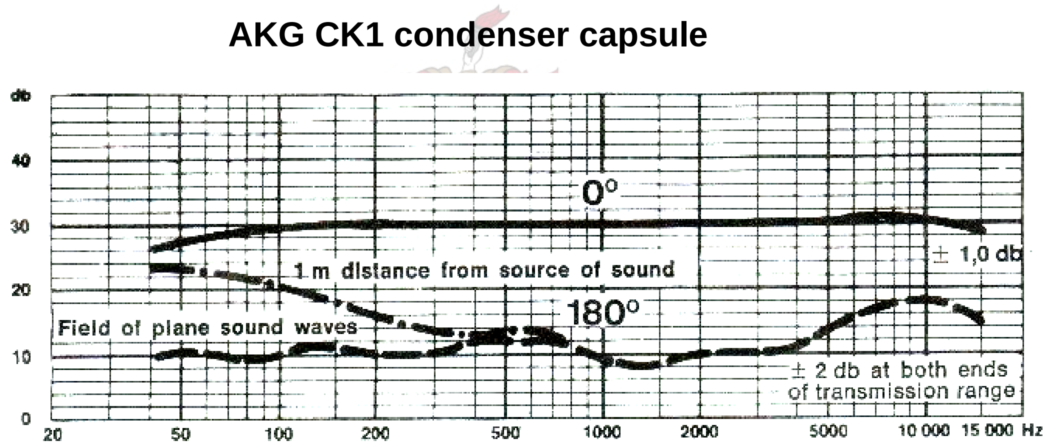


**Figure 19:** The near-flat response curve of the AKG CK1 cardioid condenser capsule, indicating a slight reduction below 100 Hz. This capsule was fitted to the AKG C452 EB (AKG Acoustics 2003).

## AKG D112

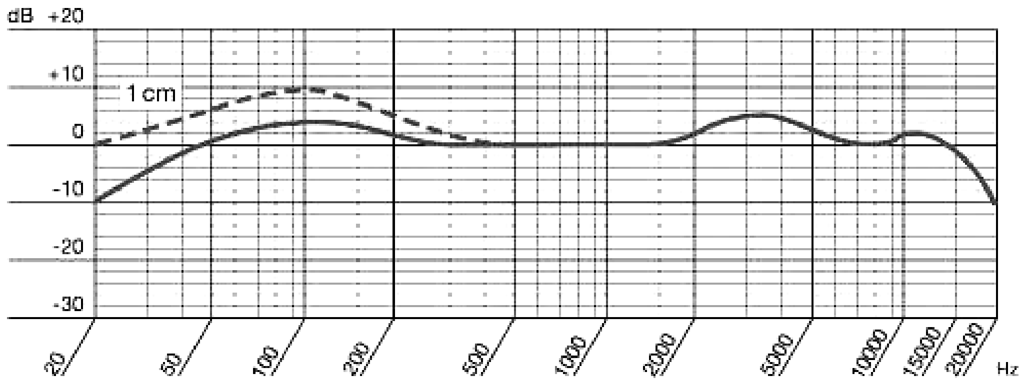


**Figure 20**: Response curve of the AKG D112 cardioid bass drum microphone, indicating a 4 dB rise in the 100 Hz vicinity and a presence rise of 6 dB around 4 kHz. A slight lift occurs between 10 and 14 kHz (AKG Acoustics 2003).

## AKG D224 E

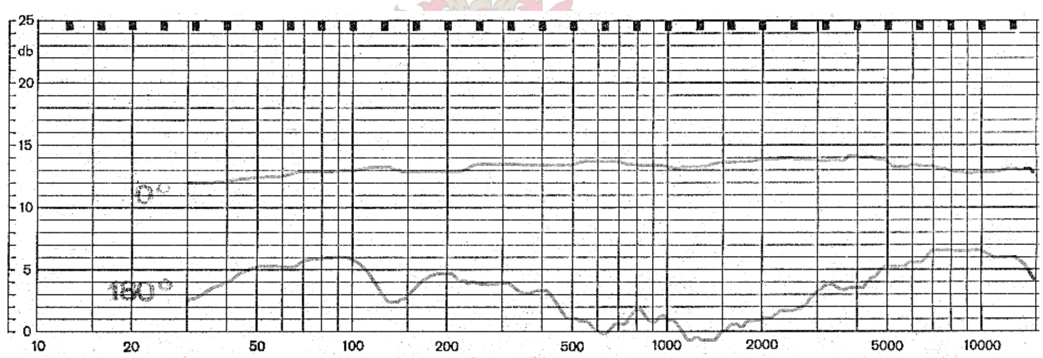


**Figure 21**: Response curve of the AKG D224 E cardioid dynamic microphone, indicating a random response offset over the entire frequency response. A curve slopes downward below 100 Hz and shows the strongest lift just below 5 kHz. The lower graph indicates the rear (180°) response (AKG Acoustics – date unknown).

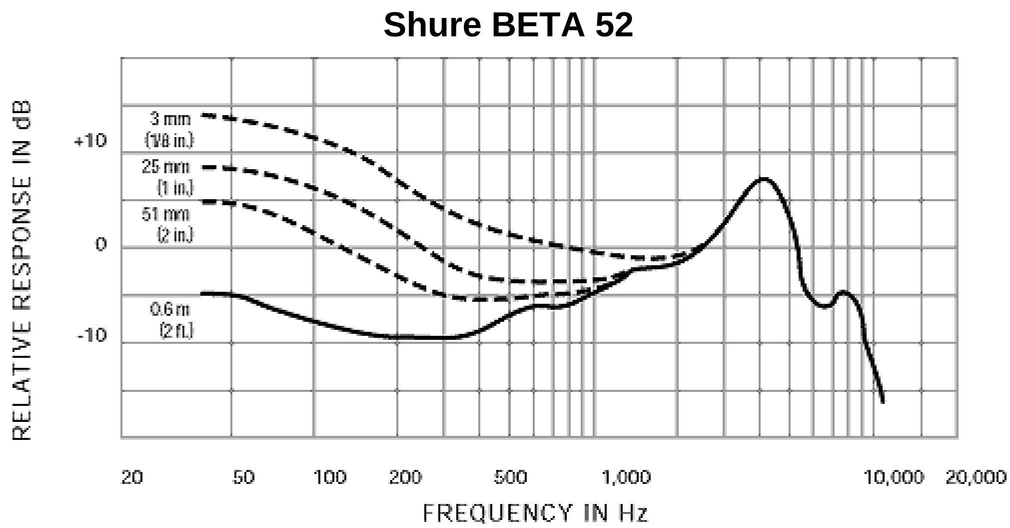


**Figure 22**: The highly tailored response curve of the Shure Beta 52 supercardioid bass drum microphone, indicating a 5 dB dip between 50 and 500 Hz, and a 7 dB lift in the 3 – 5 kHz range. The response pattern for the proximity effect is also indicated with dotted lines (Shure Inc. 2003).

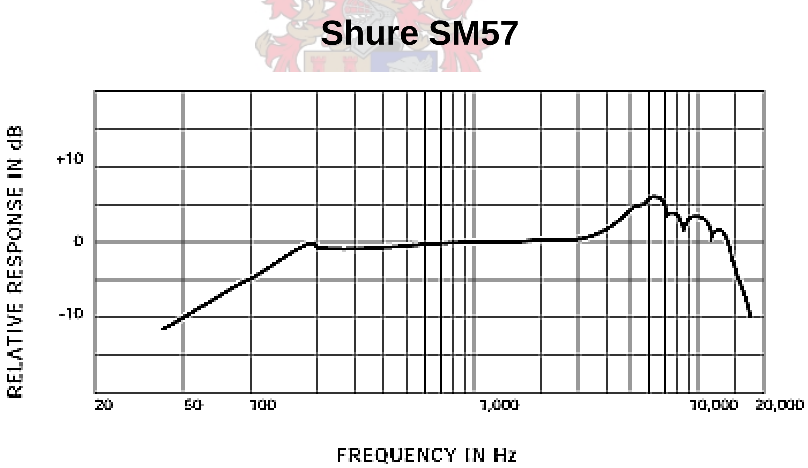


**Figure 23**: The Shure SM57 cardioid instrument microphone has a -2 dB attenuation below 200 Hz, a slight dip between 200, 600 Hz, and a 6-dB composite lift in the 3 – 13 kHz range. A peak lift occurs at 6 – 7 kHz, tailored to add high presence for a variety of applications (Shure Inc. 2003).

# APPENDIX D

# LISTS OF RECORDED SAMPLES

This Appendix lists the sample collections finalized for use in Gigastudio, as well as for release in standard audio CD format. Temporary sample labels were configured in the following order (where the variable was applicable): room, instrument part, specific stroke, drumstick/beater, velocity and ambience. There is a slight difference between the final lists of CD (audio) samples and the GigaStudio Instrument (data) samples. All data samples are 16-bit stereo wave files while audio tracks are inevitably also 16-bit stereo.

<u>Sample Collections</u>:

EHC | Endler Hall Collection

FHC | Fismer Hall Collection

PBSC | Pearl Brass Snare Collection

GFSC | Gretsch Floating Studio Collection

GMSC | Gretsch Maple Snare Collection

## *Floating Studio Data Samples*

**Table 7**: List of 12 bass drum samples – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***20" Gretsch bass (kick) drum*** | |
| DK112_33dry | Kick with AKG D112 quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DK112_33wet | Kick with AKG D112 quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DK112_99dry | Kick with AKG D112 loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DK112_99dry | Kick with AKG D112 loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DK112_57_33dry | Kick with AKG D112 & Shure SM57 quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DK112_57_33wet | Kick with AKG D112 & Shure SM57 quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DK112_57_99dry | Kick with AKG D112 & Shure SM57 loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DK112_57_99wet | Kick with AKG D112 & Shure SM57 loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DK52_57_33dry | Kick with Shure Beta52 & SM57 quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DK52_57_33wet | Kick with Shure Beta52 & SM57 quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DK52_57_99dry | Kick with Shure Beta52 & SM57 loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DK52_57_99wet | Kick with Shure Beta52 & SM57 loud, wet | Gretsch Floating Studio Collection (GFSC) |

**Table 8**: List of 28 brass snare samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Pearl Brass snare \| Wooden tip drum stick*** | |
| DBSCWT_33dry | Brass snare center, wooden tip quiet, dry | PBSC & GFSC |
| DBSCWT_33wet | Brass snare center, wooden tip quiet, wet | PBSC & GFSC |
| DBSCWT_99dry | Brass snare center, wooden tip loud, dry | PBSC & GFSC |
| DBSCWT_99wet | Brass snare center, wooden tip loud, wet | PBSC & GFSC |
| DBSOCWT_33dry | Brass snare off-center, wooden tip quiet, dry | PBSC & GFSC |
| DBSOCWT_33wet | Brass snare off-center, wooden tip quiet, wet | PBSC & GFSC |
| DBSOCWT_99dry | Brass snare off-center, wooden tip loud, dry | PBSC & GFSC |
| DBSOCWT_99wet | Brass snare off-center, wooden tip loud, wet | PBSC & GFSC |
| DBSFWT_33dry | Brass snare flam, wooden tip quiet, dry | PBSC & GFSC |
| DBSFWT_33wet | Brass snare flam, wooden tip quiet, wet | PBSC & GFSC |
| DBSFWT_99dry | Brass snare flam, wooden tip loud, dry | PBSC & GFSC |
| DBSFWT_99wet | Brass snare flam, wooden tip loud, wet | PBSC & GFSC |
| DBSRTWT_33dry | Brass snare rim tap, wooden tip quiet, dry | PBSC & GFSC |
| DBSRTWT_33wet | Brass snare rim tap, wooden tip quiet, wet | PBSC & GFSC |
| DBSRTWT_99dry | Brass snare rim tap, wooden tip loud, dry | PBSC & GFSC |
| DBSRTWT_99wet | Brass snare rim tap, wooden tip loud, wet | PBSC & GFSC |
| DBSRSWT_33dry | Brass snare rim shot, wooden tip quiet, dry | PBSC & GFSC |
| DBSRSWT_33wet | Brass snare rim shot, wooden tip quiet, wet | PBSC & GFSC |
| DBSRSWT_99dry | Brass snare rim shot, wooden tip loud, dry | PBSC & GFSC |
| DBSRSWT_99wet | Brass snare rim shot, wooden tip loud, wet | PBSC & GFSC |
| DBSRFWT_33dry | Brass snare rim flam, wooden tip quiet, dry | PBSC & GFSC |
| DBSRFWT_33wet | Brass snare rim flam, wooden tip quiet, wet | PBSC & GFSC |
| DBSRFWT_99dry | Brass snare rim flam, wooden tip loud, dry | PBSC & GFSC |
| DBSRFWT_99wet | Brass snare rim flam, wooden tip loud, wet | PBSC & GFSC |
| DBSMILWT_33dry | Brass snare military stroke, wooden tip quiet, dry | PBSC & GFSC |
| DBSMILWT_33wet | Brass snare military stroke, wooden tip quiet, wet | PBSC & GFSC |
| DBSMILWT_99dry | Brass snare military stroke, wooden tip loud, dry | PBSC & GFSC |
| DBSMILWT_99wet | Brass snare military stroke, wooden tip loud, wet | PBSC & GFSC |

**Table 9**: List of 28 brass snare samples played with nylon tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
| --- | --- | --- |
| | ***14" Pearl Brass snare \| Nylon tip drum stick*** | |
| DBSCNT_33dry | Brass snare center, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCNT_33wet | Brass snare center, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSCNT_99dry | Brass snare center, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCNT_99wet | Brass snare center, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCNT_33dry | Brass snare off-center, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCNT_33wet | Brass snare off-center, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCNT_99dry | Brass snare off-center, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCNT_99wet | Brass snare off-center, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSFNT_33dry | Brass snare flam, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSFNT_33wet | Brass snare flam, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSFNT_99dry | Brass snare flam, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSFNT_99wet | Brass snare flam, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRTNT_33dry | Brass snare rim tap, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRTNT_33wet | Brass snare rim tap, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRTNT_99dry | Brass snare rim tap, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRTNT_99wet | Brass snare rim tap, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSNT_33dry | Brass snare rim shot, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSNT_33wet | Brass snare rim shot, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSNT_99dry | Brass snare rim shot, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSNT_99wet | Brass snare rim shot, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRFNT_33dry | Brass snare rim flam, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRFNT_33wet | Brass snare rim flam, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRFNT_99dry | Brass snare rim flam, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRFNT_99wet | Brass snare rim flam, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSMILNT_33dry | Brass snare military stroke, nylon tip quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSMILNT_33wet | Brass snare military stroke, nylon tip quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSMILNT_99dry | Brass snare military stroke, nylon tip loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSMILNT_99wet | Brass snare military stroke, nylon tip loud, wet | Pearl Brass Snare Collection (PBSC) |

**Table 10**: List of 24 brass snare samples played with rutes – floating studio.

***14" Pearl Brass snare | Rutes***

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| DBSCR_33dry | Brass snare center, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCR_33wet | Brass snare center, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSCR_99dry | Brass snare center, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCR_99wet | Brass snare center, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCR_33dry | Brass snare off-center, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCR_33wet | Brass snare off-center, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCR_99dry | Brass snare off-center, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCR_99wet | Brass snare off-center, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSFR_33dry | Brass snare flam, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSFR_33wet | Brass snare flam, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSFR_99dry | Brass snare flam, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSFR_99wet | Brass snare flam, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSR_33dry | Brass snare rim shot, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSR_33wet | Brass snare rim shot, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSR_99dry | Brass snare rim shot, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSR_99wet | Brass snare rim shot, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRFR_33dry | Brass snare rim flam, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRFR_33wet | Brass snare rim flam, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRFR_99dry | Brass snare rim flam, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRFR_99wet | Brass snare rim flam, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSMILR_33dry | Brass snare military stroke, rutes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSMILR_33wet | Brass snare military stroke, rutes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSMILR_99dry | Brass snare military stroke, rutes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSMILR_99wet | Brass snare military stroke, rutes loud, wet | Pearl Brass Snare Collection (PBSC) |



**Table 11**: List of 12 brass snare samples played with brushes – floating studio.

***14" Pearl Brass snare | Brushes***

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| DBSCB_33dry | Brass snare center, brushes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCB_33wet | Brass snare center, brushes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSCB_99dry | Brass snare center, brushes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCB_99wet | Brass snare center, brushes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCB_33dry | Brass snare off-center, brushes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCB_33wet | Brass snare off-center, brushes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSOCB_99dry | Brass snare off-center, brushes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSOCB_99wet | Brass snare off-center, brushes loud, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSB_33dry | Brass snare rim shot, brushes quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSB_33wet | Brass snare rim shot, brushes quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSRSB_99dry | Brass snare rim shot, brushes loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSRSB_99wet | Brass snare rim shot, brushes loud, wet | Pearl Brass Snare Collection (PBSC) |

**Table 12**: List of 4 brass snare samples played with mallets – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Pearl Brass snare \| Mallets*** | |
| DBSCM_33dry | Brass snare center, mallets quiet, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCM_33wet | Brass snare center, mallets quiet, wet | Pearl Brass Snare Collection (PBSC) |
| DBSCM_99dry | Brass snare center, mallets loud, dry | Pearl Brass Snare Collection (PBSC) |
| DBSCM_99wet | Brass snare center, mallets loud, wet | Pearl Brass Snare Collection (PBSC) |

**Table 13**: List of 28 maple snare samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Maple snare \| Wooden tip drum stick*** | |
| DMSCWT_33dry | Maple snare center, wooden tip quiet, dry | GMSC & GFSC |
| DMSCWT_33wet | Maple snare center, wooden tip quiet, wet | GMSC & GFSC |
| DMSCWT_99dry | Maple snare center, wooden tip loud, dry | GMSC & GFSC |
| DMSCWT_99wet | Maple snare center, wooden tip loud, wet | GMSC & GFSC |
| DMSOCWT_33dry | Maple snare off-center, wooden tip quiet, dry | GMSC & GFSC |
| DMSOCWT_33wet | Maple snare off-center, wooden tip quiet, wet | GMSC & GFSC |
| DMSOCWT_99dry | Maple snare off-center, wooden tip loud, dry | GMSC & GFSC |
| DMSOCWT_99wet | Maple snare off-center, wooden tip loud, wet | GMSC & GFSC |
| DMSFWT_33dry | Maple snare flam, wooden tip quiet, dry | GMSC & GFSC |
| DMSFWT_33wet | Maple snare flam, wooden tip quiet, wet | GMSC & GFSC |
| DMSFWT_99dry | Maple snare flam, wooden tip loud, dry | GMSC & GFSC |
| DMSFWT_99wet | Maple snare flam, wooden tip loud, wet | GMSC & GFSC |
| DMSRTWT_33dry | Maple snare rim tap, wooden tip quiet, dry | GMSC & GFSC |
| DMSRTWT_33wet | Maple snare rim tap, wooden tip quiet, wet | GMSC & GFSC |
| DMSRTWT_99dry | Maple snare rim tap, wooden tip loud, dry | GMSC & GFSC |
| DMSRTWT_99wet | Maple snare rim tap, wooden tip loud, wet | GMSC & GFSC |
| DMSRSWT_33dry | Maple snare rim shot, wooden tip quiet, dry | GMSC & GFSC |
| DMSRSWT_33wet | Maple snare rim shot, wooden tip quiet, wet | GMSC & GFSC |
| DMSRSWT_99dry | Maple snare rim shot, wooden tip loud, dry | GMSC & GFSC |
| DMSRSWT_99wet | Maple snare rim shot, wooden tip loud, wet | GMSC & GFSC |
| DMSRFWT_33dry | Maple snare rim flam, wooden tip quiet, dry | GMSC & GFSC |
| DMSRFWT_33wet | Maple snare rim flam, wooden tip quiet, wet | GMSC & GFSC |
| DMSRFWT_99dry | Maple snare rim flam, wooden tip loud, dry | GMSC & GFSC |
| DMSRFWT_99wet | Maple snare rim flam, wooden tip loud, wet | GMSC & GFSC |
| DMSMILWT_33dry | Maple snare military stroke, wooden tip quiet, dry | GMSC & GFSC |
| DMSMILWT_33wet | Maple snare military stroke, wooden tip quiet, wet | GMSC & GFSC |
| DMSMILWT_99dry | Maple snare military stroke, wooden tip loud, dry | GMSC & GFSC |
| DMSMILWT_99wet | Maple snare military stroke, wooden tip loud, wet | GMSC & GFSC |

**Table 14:** List of 28 maple snare samples played with nylon tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Maple snare \| Nylon tip drum stick*** | |
| DMSCNT_33dry | Maple snare center, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCNT_33wet | Maple snare center, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSCNT_99dry | Maple snare center, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCNT_99wet | Maple snare center, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCNT_33dry | Maple snare off-center, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCNT_33wet | Maple snare off-center, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCNT_99dry | Maple snare off-center, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCNT_99wet | Maple snare off-center, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSFNT_33dry | Maple snare flam, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSFNT_33wet | Maple snare flam, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSFNT_99dry | Maple snare flam, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSFNT_99wet | Maple snare flam, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRTNT_33dry | Maple snare rim tap, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRTNT_33wet | Maple snare rim tap, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRTNT_99dry | Maple snare rim tap, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRTNT_99wet | Maple snare rim tap, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSNT_33dry | Maple snare rim shot, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSNT_33wet | Maple snare rim shot, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSNT_99dry | Maple snare rim shot, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSNT_99wet | Maple snare rim shot, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRFNT_33dry | Maple snare rim flam, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRFNT_33wet | Maple snare rim flam, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRFNT_99dry | Maple snare rim flam, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRFNT_99wet | Maple snare rim flam, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSMILNT_33dry | Maple snare military stroke, nylon tip quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSMILNT_33wet | Maple snare military stroke, nylon tip quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSMILNT_99dry | Maple snare military stroke, nylon tip loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSMILNT_99wet | Maple snare military stroke, nylon tip loud, wet | Gretsch Maple Snare Collection (GMSC) |

**Table 15:** List of 24 maple snare samples played with rutes – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Maple snare \| Rutes*** | |
| DMSCR_33dry | Maple snare center, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCR_33wet | Maple snare center, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSCR_99dry | Maple snare center, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCR_99wet | Maple snare center, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCR_33dry | Maple snare off-center, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCR_33wet | Maple snare off-center, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCR_99dry | Maple snare off-center, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCR_99wet | Maple snare off-center, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSFR_33dry | Maple snare flam, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSFR_33wet | Maple snare flam, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSFR_99dry | Maple snare flam, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSFR_99wet | Maple snare flam, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSR_33dry | Maple snare rim shot, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSR_33wet | Maple snare rim shot, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSR_99dry | Maple snare rim shot, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSR_99wet | Maple snare rim shot, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRFR_33dry | Maple snare rim flam, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRFR_33wet | Maple snare rim flam, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRFR_99dry | Maple snare rim flam, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRFR_99wet | Maple snare rim flam, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSMILR_33dry | Maple snare military stroke, rutes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSMILR_33wet | Maple snare military stroke, rutes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSMILR_99dry | Maple snare military stroke, rutes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSMILR_99wet | Maple snare military stroke, rutes loud, wet | Gretsch Maple Snare Collection (GMSC) |



**Table 16:** List of 12 maple snare samples played with brushes – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Maple snare \| Brushes*** | |
| DMSCB_33dry | Maple snare center, brushes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCB_33wet | Maple snare center, brushes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSCB_99dry | Maple snare center, brushes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCB_99wet | Maple snare center, brushes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCB_33dry | Maple snare off-center, brushes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCB_33wet | Maple snare off-center, brushes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSOCB_99dry | Maple snare off-center, brushes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSOCB_99wet | Maple snare off-center, brushes loud, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSB_33dry | Maple snare rim shot, brushes quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSB_33wet | Maple snare rim shot, brushes quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSRSB_99dry | Maple snare rim shot, brushes loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSRSB_99wet | Maple snare rim shot, brushes loud, wet | Gretsch Maple Snare Collection (GMSC) |

**Table 17:** List of 4 maple snare samples played with mallets – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Maple snare \| Mallets*** | |
| DMSCM_33dry | Maple snare center, mallets quiet, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCM_33wet | Maple snare center, mallets quiet, wet | Gretsch Maple Snare Collection (GMSC) |
| DMSCM_99dry | Maple snare center, mallets loud, dry | Gretsch Maple Snare Collection (GMSC) |
| DMSCM_99wet | Maple snare center, mallets loud, wet | Gretsch Maple Snare Collection (GMSC) |

**Table 18:** List of 20 stainless steel snare samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Gretsch Stainless Steel snare samples \| Wooden tip*** | |
| DSSCWT_33dry | Steel snare center, wooden tip quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSCWT_33wet | Steel snare center, wooden tip quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSCWT_99dry | Steel snare center, wooden tip loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSCWT_99wet | Steel snare center, wooden tip loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSOCWT_33dry | Steel snare off-center, wooden tip quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSOCWT_33wet | Steel snare off-center, wooden tip quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSOCWT_99dry | Steel snare off-center, wooden tip loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSOCWT_99wet | Steel snare off-center, wooden tip loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSFWT_33dry | Steel snare flam, wooden tip quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSFWT_33wet | Steel snare flam, wooden tip quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSFWT_99dry | Steel snare flam, wooden tip loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSFWT_99wet | Steel snare flam, wooden tip loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSRSWT_33dry | Steel snare rim shot, wooden tip quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSRSWT_33wet | Steel snare rim shot, wooden tip quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSRSWT_99dry | Steel snare rim shot, wooden tip loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSRSWT_99wet | Steel snare rim shot, wooden tip loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSRFWT_33dry | Steel snare rim flam, wooden tip quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSRFWT_33wet | Steel snare rim flam, wooden tip quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DSSRFWT_99dry | Steel snare rim flam, wooden tip loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DSSRFWT_99wet | Steel snare rim flam, wooden tip loud, wet | Gretsch Floating Studio Collection (GFSC) |

**Table 19:** List of 24 tom-tom samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***Gretsch toms \| Wooden tip*** | |
| DT1_33dry | 10" Mounted tom center, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT1_33wet | 10" Mounted tom center, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT1_99dry | 10" Mounted tom center, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT1_99wet | 10" Mounted tom center, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DT1F_33dry | 10" Mounted tom flam, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT1F_33wet | 10" Mounted tom flam, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT1F_99dry | 10" Mounted tom flam, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT1F_99wet | 10" Mounted tom flam, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DT2_33dry | 12" Mounted tom center, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT2_33wet | 12" Mounted tom center, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT2_99dry | 12" Mounted tom center, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT2_99wet | 12" Mounted tom center, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DT2F_33dry | 12" Mounted tom flam, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT2F_33wet | 12" Mounted tom flam, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT2F_99dry | 12" Mounted tom flam, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT2F_99wet | 12" Mounted tom flam, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DT3_33dry | 14" Floor tom center, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT3_33wet | 14" Floor tom center, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT3_99dry | 14" Floor tom center, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT3_99wet | 14" Floor tom center, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DT3F_33dry | 14" Floor tom flam, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT3F_33wet | 14" Floor tom flam, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DT3F_99dry | 14" Floor tom flam, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT3F_99wet | 14" Floor tom flam, loud, wet | Gretsch Floating Studio Collection (GFSC) |

**Table 20**: List of 40 hi-hat samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***13" Zildjian K/Z hi-hats \| Wooden tip*** | |
| DHB_33dry | Hats breathe, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHB_33wet | Hats breathe, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHB_99dry | Hats breathe, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHB_99wet | Hats breathe, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DHP_33dry | Hats pedal, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHP_33wet | Hats pedal, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHP_99dry | Hats pedal, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHP_99wet | Hats pedal, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSCS_33dry | Hats semi-closed stick, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSCS_33wet | Hats semi-closed stick, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSCS_99dry | Hats semi-closed stick, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSCS_99wet | Hats semi-closed stick, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSCT_33dry | Hats semi-closed tip, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSCT_33wet | Hats semi-closed tip, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSCT_99dry | Hats semi-closed tip, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSCT_99wet | Hats semi-closed tip, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DHS_33dry | Hats splash, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHS_33wet | Hats splash, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHS_99dry | Hats splash, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHS_99wet | Hats splash, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSB_33dry | Hats splash-breathe, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSB_33wet | Hats splash-breathe, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DHSB_99dry | Hats splash-breathe, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DHSB_99wet | Hats splash-breathe, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DOHS_33dry | Open hats stick, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DOHS_33wet | Open hats stick, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DOHS_99dry | Open hats stick, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DOHS_99wet | Open hats stick, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DOHT_33dry | Open hats tip, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DOHT_33wet | Open hats tip, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DOHT_99dry | Open hats tip, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DOHT_99wet | Open hats tip, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DTHS_33dry | Tight hats stick, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DTHS_33wet | Tight hats stick, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DTHS_99dry | Tight hats stick, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DTHS_99wet | Tight hats stick, loud, wet | Gretsch Floating Studio Collection (GFSC) |
| DTHT_33dry | Tight hats tip, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DTHT_33wet | Tight hats tip, quiet, wet | Gretsch Floating Studio Collection (GFSC) |
| DTHT_99dry | Tight hats tip, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DTHT_99wet | Tight hats tip, loud, wet | Gretsch Floating Studio Collection (GFSC) |

**Table 21:** List of 14 cymbal samples played with wooden tip sticks – floating studio.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***Zildjian cymbals \| Wooden tip*** | |
| DS1_33d | 10" *A* splash, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DS1_99 | 10" *A* splash, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DC1_33 | 15" *A Custom* crash, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DC1_99 | 15" *A Custom* crash, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DC2_33 | 17" *A Custom* crash, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DC2_99 | 17" *A Custom* crash, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DT_33 | 18" *Oriental China* trash, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DT_99 | 18" *Oriental China* trash, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DRE_33 | 20" *A Ping* ride edge, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DRE_99 | 20" *A Ping* ride edge, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DRB_33 | 20" *A Ping* ride body, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DRB_99 | 20" *A Ping* ride body, loud, dry | Gretsch Floating Studio Collection (GFSC) |
| DB_33 | 20" *A Ping* ride bell, quiet, dry | Gretsch Floating Studio Collection (GFSC) |
| DB_99 | 20" *A Ping* ride bell, loud, dry | Gretsch Floating Studio Collection (GFSC) |

## *Endler Hall Data Samples*

**Table 22:** List of 24 snare samples played with wooden tip sticks – Endler Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***14" Brass and maple snares \| Wooden tip*** | |
| EBSCdry | Brass snare center, dry | Endler Hall Collection (EHC) |
| EBSCwet | Brass snare center, wet | Endler Hall Collection (EHC) |
| EBSOCdry | Brass snare off-center, dry | Endler Hall Collection (EHC) |
| EBSOCwet | Brass snare off-center, wet | Endler Hall Collection (EHC) |
| EBSFdry | Brass snare flam, dry | Endler Hall Collection (EHC) |
| EBSFwet | Brass snare flam, wet | Endler Hall Collection (EHC) |
| EBSRTdry | Brass snare rim tap, dry | Endler Hall Collection (EHC) |
| EBSRTwet | Brass snare rim tap, wet | Endler Hall Collection (EHC) |
| EBSRSdry | Brass snare rim shot, dry | Endler Hall Collection (EHC) |
| EBSRSwet | Brass snare rim shot, wet | Endler Hall Collection (EHC) |
| EBSRFdry | Brass snare rim flam, dry | Endler Hall Collection (EHC) |
| EBSRFwet | Brass snare rim flam, wet | Endler Hall Collection (EHC) |
| EMSCdry | Maple snare center, dry | Endler Hall Collection (EHC) |
| EMSCwet | Maple snare center, wet | Endler Hall Collection (EHC) |
| EMSOCdry | Maple snare off-center, dry | Endler Hall Collection (EHC) |
| EMSOCwet | Maple snare off-center, wet | Endler Hall Collection (EHC) |
| EMSFdry | Maple snare flam, dry | Endler Hall Collection (EHC) |
| EMSFwet | Maple snare flam, wet | Endler Hall Collection (EHC) |
| EMSRTdry | Maple snare rim tap, dry | Endler Hall Collection (EHC) |
| EMSRTwet | Maple snare rim tap, wet | Endler Hall Collection (EHC) |
| EMSRSdry | Maple snare rim shot, dry | Endler Hall Collection (EHC) |
| EMSRSwet | Maple snare rim shot, wet | Endler Hall Collection (EHC) |
| EMSRFdry | Maple snare rim flam, dry | Endler Hall Collection (EHC) |
| EMSRFwet | Maple snare rim flam, wet | Endler Hall Collection (EHC) |

**Table 23:** List of 14 bass drum and tom-tom samples – Endler Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***20" Gretsch bass (kick) drum and toms*** | |
| EKoh | Kick with AKG D112, dry | Endler Hall Collection (EHC) |
| EKwet | Kick with AKG D112, wet | Endler Hall Collection (EHC) |
| ET1dry | 10" Mounted tom center, dry | Endler Hall Collection (EHC) |
| ET1wet | 10" Mounted tom center, wet | Endler Hall Collection (EHC) |
| ET1Fdry | 10" Mounted tom flam, dry | Endler Hall Collection (EHC) |
| ET1Fwet | 10" Mounted tom flam, wet | Endler Hall Collection (EHC) |
| ET2dry | 12" Mounted tom center, dry | Endler Hall Collection (EHC) |
| ET2wet | 12" Mounted tom center, wet | Endler Hall Collection (EHC) |
| ET2Fdry | 12" Mounted tom flam, dry | Endler Hall Collection (EHC) |
| ET2Fwet | 12" Mounted tom flam, wet | Endler Hall Collection (EHC) |
| ET3dry | 14" Floor tom center, dry | Endler Hall Collection (EHC) |
| ET3wet | 14" Floor tom center, wet | Endler Hall Collection (EHC) |
| ET3Fdry | 14" Floor tom flam, dry | Endler Hall Collection (EHC) |
| ET3Fwet | 14" Floor tom flam, wet | Endler Hall Collection (EHC) |

**Table 24:** List of 16 hi-hat samples played with wooden tip sticks – Endler Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***13" Zildjian hi-hats \| Wooden tip*** | |
| EHBdry | Hats breathe, dry | Endler Hall Collection (EHC) |
| EHBwet | Hats breathe, wet | Endler Hall Collection (EHC) |
| EHSCSdry | Hats semi-closed stick, dry | Endler Hall Collection (EHC) |
| EHSCSwet | Hats semi-closed stick, wet | Endler Hall Collection (EHC) |
| EHSCTdry | Hats semi-closed tip, dry | Endler Hall Collection (EHC) |
| EHSCTwet | Hats semi-closed tip, wet | Endler Hall Collection (EHC) |
| EHSdry | Hats splash, dry | Endler Hall Collection (EHC) |
| EHSwet | Hats splash, wet | Endler Hall Collection (EHC) |
| EHOHSdry | Open hats stick, dry | Endler Hall Collection (EHC) |
| EHOHSwet | Open hats stick, wet | Endler Hall Collection (EHC) |
| EHOHTdry | Open hats tip, dry | Endler Hall Collection (EHC) |
| EHOHTwet | Open hats tip, wet | Endler Hall Collection (EHC) |
| ETHSdry | Tight hats stick, dry | Endler Hall Collection (EHC) |
| ETHSwet | Tight hats stick, wet | Endler Hall Collection (EHC) |
| ETHTdry | Tight hats tip, dry | Endler Hall Collection (EHC) |
| ETHTwet | Tight hats tip, wet | Endler Hall Collection (EHC) |

**Table 25:** List of 14 cymbal samples played with wooden tip sticks – Endler Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***Zildjian cymbals \| Wooden tip*** | |
| ES1dry | 10" *A* splash, dry | Endler Hall Collection (EHC) |
| ES1wet | 10" *A* splash, wet | Endler Hall Collection (EHC) |
| EC1dry | 15" *A Custom* crash, dry | Endler Hall Collection (EHC) |
| EC1wet | 15" *A Custom* crash, wet | Endler Hall Collection (EHC) |
| EC2dry | 17" *A Custom* crash, dry | Endler Hall Collection (EHC) |
| EC2wet | 17" *A Custom* crash, wet | Endler Hall Collection (EHC) |
| ETdry | 18" *Oriental China* trash, dry | Endler Hall Collection (EHC) |
| ETwet | 18" *Oriental China* trash, wet | Endler Hall Collection (EHC) |
| EREdry | 20" *A Ping* ride edge, dry | Endler Hall Collection (EHC) |
| EREwet | 20" *A Ping* ride edge, wet | Endler Hall Collection (EHC) |
| ERBdry | 20" *A Ping* ride body, dry | Endler Hall Collection (EHC) |
| ERBwet | 20" *A Ping* ride body, wet | Endler Hall Collection (EHC) |
| E+Bdry | 20" *A Ping* ride bell, dry | Endler Hall Collection (EHC) |
| EBwet | 20" *A Ping* ride bell, wet | Endler Hall Collection (EHC) |

**Table 26:** List of 30 snare samples played with wooden tip sticks – Fismer Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***Brass, maple and steel snare samples \| Wooden tip*** | |
| FBSCdry | Brass snare center, dry | Fismer Hall Collection (FHC) |
| FBSCwet | Brass snare center, wet | Fismer Hall Collection (FHC) |
| FBSOCdry | Brass snare off-center, dry | Fismer Hall Collection (FHC) |
| FBSOCwet | Brass snare off-center, wet | Fismer Hall Collection (FHC) |
| FBSFdry | Brass snare flam, dry | Fismer Hall Collection (FHC) |
| FBSFwet | Brass snare flam, wet | Fismer Hall Collection (FHC) |
| FBSRTdry | Brass snare rim tap, dry | Fismer Hall Collection (FHC) |
| FBSRTwet | Brass snare rim tap, wet | Fismer Hall Collection (FHC) |
| FBSRSdry | Brass snare rim shot, dry | Fismer Hall Collection (FHC) |
| FBSRSwet | Brass snare rim shot, wet | Fismer Hall Collection (FHC) |
| FBSRFdry | Brass snare rim flam, dry | Fismer Hall Collection (FHC) |
| FBSRFwet | Brass snare rim flam, wet | Fismer Hall Collection (FHC) |
| FMSCdry | Maple snare center, dry | Fismer Hall Collection (FHC) |
| FMSCwet | Maple snare center, wet | Fismer Hall Collection (FHC) |
| FMSOCdry | Maple snare off-center, dry | Fismer Hall Collection (FHC) |
| FMSOCwet | Maple snare off-center, wet | Fismer Hall Collection (FHC) |
| FMSFdry | Maple snare flam, dry | Fismer Hall Collection (FHC) |
| FMSFwet | Maple snare flam, wet | Fismer Hall Collection (FHC) |
| FMSRTdry | Maple snare rim tap, dry | Fismer Hall Collection (FHC) |
| FMSRTwet | Maple snare rim tap, wet | Fismer Hall Collection (FHC) |
| FMSRSdry | Maple snare rim shot, dry | Fismer Hall Collection (FHC) |
| FMSRS | Maple snare rim shot, wet | Fismer Hall Collection (FHC) |
| FMSRFdry | Maple snare rim flam, dry | Fismer Hall Collection (FHC) |
| FMSRFwet | Maple snare rim flam, wet | Fismer Hall Collection (FHC) |
| FSSCdry | Steel snare center, dry | Fismer Hall Collection (FHC) |
| FSSOCdry | Steel snare off-center, dry | Fismer Hall Collection (FHC) |
| FSSFdry | Steel snare flam, dry | Fismer Hall Collection (FHC) |
| FSSRTdry | Steel snare rim tap, dry | Fismer Hall Collection (FHC) |
| FSSRSdry | Steel snare rim shot, dry | Fismer Hall Collection (FHC) |
| FSSRFdry | Steel snare rim flam, dry | Fismer Hall Collection (FHC) |

**Table 27:** List of 15 bass drum and tom-tom samples – Fismer Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***20" Gretsch bass (kick) drum and toms*** | |
| FK112_57_33 | Kick with AKG D112 and Shure SM57, quiet | Fismer Hall Collection (FHC) |
| FK112_57_66 | Kick with AKG D112 and Shure SM57, medium | Fismer Hall Collection (FHC) |
| FK112_57_99 | Kick with AKG D112 and Shure SM57, loud | Fismer Hall Collection (FHC) |
| FT1dry | 10" Mounted tom center, dry | Fismer Hall Collection (FHC) |
| FT1wet | 10" Mounted tom center, wet | Fismer Hall Collection (FHC) |
| FT1Fdry | 10" Mounted tom flam, dry | Fismer Hall Collection (FHC) |
| FT1Fwet | 10" Mounted tom flam, wet | Fismer Hall Collection (FHC) |
| FT2dry | 12" Mounted tom center, dry | Fismer Hall Collection (FHC) |
| FT2wet | 12" Mounted tom center, wet | Fismer Hall Collection (FHC) |
| FT2Fdry | 12" Mounted tom flam, dry | Fismer Hall Collection (FHC) |
| FT2Fwet | 12" Mounted tom flam, wet | Fismer Hall Collection (FHC) |
| FT3dry | 14" Floor tom center, dry | Fismer Hall Collection (FHC) |
| FT3wet | 14" Floor tom center, wet | Fismer Hall Collection (FHC) |
| FT3Fdry | 14" Floor tom flam, dry | Fismer Hall Collection (FHC) |
| FT3Fwet | 14" Floor tom flam, wet | Fismer Hall Collection (FHC) |

**Table 28:** List of 18 hi-hat samples played with wooden tip sticks – Fismer Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***13" Zildjian hi-hats \| Wooden tip*** | |
| FHBdry | Hats breathe, dry | Fismer Hall Collection (FHC) |
| FHBwet | Hats breathe, wet | Fismer Hall Collection (FHC) |
| FHPdry | Hats pedal, dry | Fismer Hall Collection (FHC) |
| FHPwet | Hats pedal, wet | Fismer Hall Collection (FHC) |
| FHSCSdry | Hats semi-closed stick, dry | Fismer Hall Collection (FHC) |
| FHSCSwet | Hats semi-closed stick, wet | Fismer Hall Collection (FHC) |
| FHSCTdry | Hats semi-closed tip, dry | Fismer Hall Collection (FHC) |
| FHSCTwet | Hats semi-closed tip, wet | Fismer Hall Collection (FHC) |
| FHSdry | Hats splash, dry | Fismer Hall Collection (FHC) |
| FHSwet | Hats splash, wet | Fismer Hall Collection (FHC) |
| FHOHSdry | Open hats stick, dry | Fismer Hall Collection (FHC) |
| FHOHSwet | Open hats stick, wet | Fismer Hall Collection (FHC) |
| FHOHTdry | Open hats tip, dry | Fismer Hall Collection (FHC) |
| FHOHTwet | Open hats tip, wet | Fismer Hall Collection (FHC) |
| FTHSdry | Tight hats stick, dry | Fismer Hall Collection (FHC) |
| FTHSwet | Tight hats stick, wet | Fismer Hall Collection (FHC) |
| FTHTdry | Tight hats tip, dry | Fismer Hall Collection (FHC) |
| FTHTwet | Tight hats tip, wet | Fismer Hall Collection (FHC) |

**Table 29:** List of 20 cymbal samples played with wooden tip sticks – Fismer Hall.

| Temporary label | Description | GigaStudio Instrument |
|---|---|---|
| | ***Zildjian cymbals \| Wooden tip*** | |
| FS1dry | 10" *A* splash, dry | Fismer Hall Collection (FHC) |
| FS1wet | 10" *A* splash, wet | Fismer Hall Collection (FHC) |
| FC1dry | 15" *A Custom* crash, dry | Fismer Hall Collection (FHC) |
| FC1wet | 15" *A Custom* crash, wet | Fismer Hall Collection (FHC) |
| FC1Sdry | 15" *A Custom* crash swell, dry | Fismer Hall Collection (FHC) |
| FC1Swet | 15" *A Custom* crash swell, wet | Fismer Hall Collection (FHC) |
| FC2dry | 17" *A Custom* crash, dry | Fismer Hall Collection (FHC) |
| FC2wet | 17" *A Custom* crash, wet | Fismer Hall Collection (FHC) |
| FC2Sdry | 17" *A Custom* crash swell, dry | Fismer Hall Collection (FHC) |
| FC2Swet | 17" *A Custom* crash swell, wet | Fismer Hall Collection (FHC) |
| FTdry | 18" *Oriental China* trash, dry | Fismer Hall Collection (FHC) |
| FTwet | 18" *Oriental China* trash, wet | Fismer Hall Collection (FHC) |
| FTSdry | 18" *Oriental China* trash swell, dry | Fismer Hall Collection (FHC) |
| FTSwet | 18" *Oriental China* trash swell, wet | Fismer Hall Collection (FHC) |
| FREdry | 20" *A Ping* ride edge, dry | Fismer Hall Collection (FHC) |
| FREwet | 20" *A Ping* ride edge, wet | Fismer Hall Collection (FHC) |
| FRBdry | 20" *A Ping* ride body, dry | Fismer Hall Collection (FHC) |
| FRBwet | 20" *A Ping* ride body, wet | Fismer Hall Collection (FHC) |
| FBdry | 20" *A Ping* ride bell, dry | Fismer Hall Collection (FHC) |
| FBwet | 20" *A Ping* ride bell, wet | Fismer Hall Collection (FHC) |

## *Audio Disk 1*

## TRACKLISTING

**Table 30:** Audio disk 1 track listing – Endler Hall samples (35 tracks)

| Track # | Track name | Sample(s) |
|---|---|---|
| | ***Endler Hall Samples*** | |
| 1 | Brass snare center | dry; wet |
| 2 | Brass snare off-center | dry; wet |
| 3 | Brass snare flam | dry; wet |
| 4 | Brass snare rim tap | dry; wet |
| 5 | Brass snare rim shot | dry; wet |
| 6 | Brass snare rim flam | dry; wet |
| 7 | Maple snare center | dry; wet |
| 8 | Maple snare off-center | dry; wet |
| 9 | Maple snare flam | dry; wet |
| 10 | Maple snare rim tap | dry; wet |
| 11 | Maple snare rim shot | dry; wet |
| 12 | Maple snare rim flam | dry; wet |
| 13 | Kick plus overheads | dry |
| 14 | Kick plus room | wet |
| 15 | 10" Tom | dry; wet |
| 16 | 10" Tom flam | dry; wet |
| 17 | 12" Tom | dry; wet |
| 18 | 12" Tom flam | dry; wet |
| 19 | 14" Floor tom | dry; wet |
| 20 | 14" Floor tom flam | dry; wet |
| 21 | Tight hi-hats with stick body | dry; wet |
| 22 | Tight hi-hats with stick tip | dry; wet |
| 23 | Semi-closed hats with stick body | dry; wet |
| 24 | Semi-closed hats with stick tip | dry; wet |
| 25 | Open hi-hats with stick body | dry; wet |
| 26 | Open hi-hats with stick tip | dry; wet |
| 27 | Hi-hats breathe | dry; wet |
| 28 | Hi-hats splash | dry; wet |
| 29 | 15" Crash | dry; wet |
| 30 | 17" Crash | dry; wet |
| 31 | 10" Splash | dry; wet |
| 32 | 18" China | dry; wet |
| 33 | 20" Ride edge | dry; wet |
| 34 | 20" Ride body | dry; wet |
| 35 | 20" Ride bell | dry; wet |

**Table 31:** Audio disk 1 track listing – Fismer Hall samples (42 tracks)

| Track # | Track name | Sample(s) |
|---|---|---|
| | ***Fismer Hall Samples*** | |
| 36 | Brass snare center | dry; wet |
| 37 | Brass snare off-center | dry; wet |
| 38 | Brass snare flam | dry; wet |
| 39 | Brass snare rim tap | dry; wet |
| 40 | Brass snare rim shot | dry; wet |
| 41 | Brass snare rim flam | dry; wet |
| 42 | Maple snare center | dry; wet |
| 43 | Maple snare off-center | dry; wet |
| 44 | Maple snare flam | dry; wet |
| 45 | Maple snare rim tap | dry; wet |
| 46 | Maple snare rim shot | dry; wet |
| 47 | Stainless steel snare center | dry |
| 48 | Stainless steel snare off-center | dry |
| 49 | Stainless steel snare flam | dry |
| 50 | Stainless steel snare rim tap | dry |
| 51 | Stainless steel snare rim shot | dry |
| 52 | Stainless steel snare rim flam | dry |
| 53 | 10" Tom | dry; wet |
| 54 | 10" Tom flam | dry; wet |
| 55 | 12" Tom | dry; wet |
| 56 | 12" Tom flam | dry; wet |
| 57 | 14" Floor tom | dry; wet |
| 58 | 14" Floor tom flam | dry; wet |
| 59 | Tight hi-hats with stick body | dry; wet |
| 60 | Tight hi-hats with stick tip | dry; wet |
| 61 | Semi-closed hats with stick body | dry; wet |
| 62 | Semi-closed hats with stick tip | dry; wet |
| 63 | Open hi-hats with stick body | dry; wet |
| 64 | Open hi-hats with stick tip | dry; wet |
| 65 | Hi-hats pedal | dry; wet |
| 66 | Hi-hats breathe | dry; wet |
| 67 | Hi-hats splash | dry; wet |
| 68 | 15" Crash | dry; wet |
| 69 | 17" Crash | dry; wet |
| 70 | 15" Crash swell | dry; wet |
| 71 | 17" Crash swell | dry; wet |
| 72 | 10" Splash | dry; wet |
| 73 | 18" China | dry; wet |
| 74 | 18" China swell | dry; wet |
| 75 | 20" Ride edge | dry; wet |
| 76 | 20" Ride body | dry; wet |
| 77 | 20" Ride bell | dry; wet |

## *Audio Disk 2*

## TRACKLISTING

**Table 32:** Audio disk 2 track listing – floating studio samples (37 tracks)

| Track # | Track name | Sample details |
|---|---|---|
| | ***Floating Studio Samples*** | |
| 1 | Brass snare wooden tip, dry | |
| 2 | Brass snare wooden tip, wet | |
| 3 | Brass snare nylon tip, dry | |
| 4 | Brass snare nylon tip, wet | |
| 5 | Brass snare rutes, dry | |
| 6 | Brass snare rutes, wet | *Tracks 1 - 22:* |
| 7 | Brass snare brushes, dry | (3 velocities per hit) |
| 8 | Brass snare nylon tip, wet | |
| 9 | Brass snare mallets, dry | center |
| 10 | Brass snare mallets, wet | off-center |
| 11 | Maple snare wooden tip, dry | rim shot |
| 12 | Maple snare wooden tip, wet | rim tap |
| 13 | Maple snare nylon tip, dry | military stroke |
| 14 | Maple snare nylon tip, wet | double stroke |
| 15 | Maple snare rutes, dry | rim tap flam |
| 16 | Maple snare rutes, wet | snare flam |
| 17 | Maple snare brushes, dry | rim shot flam |
| 18 | Maple snare nylon tip, wet | |
| 19 | Maple snare mallets, dry | |
| 20 | Maple snare mallets, wet | |
| 21 | Steel snare wooden tip, dry | |
| 22 | Steel snare wooden tip, wet | |
| 23 | Kick with D112, dry | |
| 24 | Kick with D112, wet | *Tracks 23-28:* |
| 25 | Kick with D112 and SM57, dry | |
| 26 | Kick with D112 and SM57, wet | 3 velocities each |
| 27 | Kick with Beta52 and SM57, dry | |
| 28 | Kick with Beta52 and SM57, wet | |
| 29 | 10" Tom, dry | |
| 30 | 10" Tom, wet | *Tracks 29-34:* |
| 31 | 12" Tom, dry | (3 velocities each) |
| 32 | 12"Tom, wet | center |
| 33 | 14" Tom, dry | flam |
| 34 | 14" Tom, wet | |
| 35 | 13" Hi-hats, dry * | |
| 36 | 13" Hi-hats, wet * | *see below* |
| 37 | Cymbal collection, wet ** | |

* Hi-hat samples include the following strokes (3 velocities each): tight hats [tip and stick body], semi-closed hats [tip and stick body], hi-hats breathe [tip and stick body], hi-hats open [tip and stick body], hi-hats pedal, hi-hats splash and hi-hats splash-breathe.

** Cymbal samples include (at 3 velocities each): 15” and 17”crash, 18” china, 10” splash, 20” Ride body, edge and bell.

# APPENDIX E

## BIOGRAPHICAL INFORMATION

### *Professional Drummer Pierre Tredoux*

Final-year medical student and professional drummer, *Pierre Tredoux (1979)*, was the sole musical performer in the production of the Gretsch drum sample library. Pierre's drumming career was launched during his five-year period as sidedrummer for the South African Nr 3 Cadet Band of Vredendal High School. Since 1998, Pierre has been performing live and as session drummer for numerous South African bands and artists. Full-time drummer for Stellenbosch rock band *Merchant Seal* (1998-2002), Pierre has also performed with South-African artists *Louis Brittz*, *Leon Ferreira*, *Reana Nel*, *Idols*-winner *Heinz Winckler*, the group *Prophet* and many more. Pierre has also played on several album releases and demo recordings and has presented a number of drumming workshops in and around Stellenbosch. Pierre plays a Gretsch Renown Maple drumkit with Zildjian cymbal range and Vic Firth drumsticks. Currently he is working as session drummer with Stellenbosch Merchant Records (http://www.merchantrecords.com) and Sunset Recording Studios (http://ww.sunsetrecording.com). He shall be appearing soon on his debut Gretsch drum sample library (© 2004 Merchant Records).



### *Mastering Engineer Tim Lengfeld*

German-born Tim Lengfeld, proprietor and mastering expert of Tim Lengfeld Mastering Stellenbosch, was the mastering engineer in the production of the Gretsch drum sample library. Tim has worked in close collaboration with some of the most renowned record labels and publishing companies in South Africa. With his mastering suite situated on the farm Wechmars Hof in the Banhoek Valley outside Stellenbosch, Tim has performed some of the finest mastering work for artists from the farthest corners of the country. Visit the website of Tim Lengfeld Mastering at http://www.tl-mastering.com for more information on the mastering process, as well as the artist and album credits associated with Tim Lengfeld Mastering.

# APPENDIX F

# GLOSSARY

Where not described in the text or annotations, this chapter defines terms of relevance, and provides a source of reference for abbreviations and terms used throughout Chapters Two to Six. Glossary entries and their definitions appear in alphabetical order. Refer also to *The Penguin Dictionary of Electronics 3rd Edition* by Valerie Illingworth (1998: London, Penguin Books).

**Acoustics**

The science of sound (Allen 2002: 7). See also *Chapter 3.*

**ADC, A/D converter**

Analog-to-Digital Converter. "Changes continuous values into discrete digital samples." (Russ 1996: 350)

**ADSR**

Abbreviation for Attack, Decay, Sustain and Release. The ADSR model describes the four stages composing a basic envelope type (Sams 1999: 75). See *Envelope*.

**Aftertouch**

Additional key pressure used as a controller. Also termed *touch* (Russ 1996: 391).

**Ambience, ambient**

In this study, *ambience* exclusively refers to the acoustical quality or content of samples or recording rooms. In terms of the samples, *wet* or 'more ambient' refers to a sound containing more room reflections than a *dry* or 'less ambient' sample. Ambience also generally refers to the acoustics of an enclosed environment – i.e. a concert hall; small room etc. 'More ambient' would define a room or hall with more reverberations than a smaller, dry room with fewer reverberations.

**Amplitude [filter]**

Amplitude refers strictly to the peak value of an alternating wave, in the positive or negative direction (Illingworth 1998: 13). An amplitude filter describes the varying gain levels of a sound over time (Sams 1999: 75).

**Analog [signal, delay line]**

A signal that varies continuously over time and in amplitude (Illingworth 1998: 15).

**Attack**

The initial segment of an envelope, usually followed by a rapid rise to the maximum velocity (Russ 1996: 351).

**Attenuation**

Reduction in signal level (amplitude), usually measured in *decibels* (White 1991: 23).

**Bandwidth**

The total range of unattenuated frequencies (from lowest to highest) that can pass through a filter, or any other audio device (Sams 1999: 22).

**Bit, bit-depth**

Acronym from *bi*nary digi*t*, representing the basic unit of information (One of the digits 0 or 1) in a computer processing system (Illingworth 1998: 44). In digital audio recording, the *bit-depth* refers to audio resolution – the number of bits per digital sample. The use of a greater number of bits permits registering more levels in the amplitude scale (Sams 1999: 25).

**Bitstream**

A playback system of compact discs that performs 256 times oversampling (256 times the normal 44.1 kHz, using 1-bit words). The bitstream system is "more linear than conventional digital-to-analog conversion," especially at low signal levels. Noise plus distortion is at least 106 dB below the maximum signal level (White 1991: 41).

**Bouncing**

The act of compiling a mono or stereo digital audio track (file), from all parameters contributing to the final mix. These parameters may include any or all of the following, depending on the digital audio workstation: mixing levels, panning, editing, processing and automation. Bouncing may be a real-time or off-line process.

**Cardioid**

Literally meaning 'heart-shaped'. A unidirectional microphone response pattern, most sensitive to sounds arriving from the front, or on-axis, and least sensitive for sounds coming directly from behind (White 1991: 51). See *On Axis.*

**Center frequency ($f_c$)**

In spectrum analysis, the frequency that corresponds to the middle of a frequency span. Also, the midpoint of a frequency range in a frequency-dependant electronic (analogue) circuit (Illingworth 1998: 65-66).

**Condenser, capacitor [microphone]**

A very sensitive microphone type utilizing a simple electrical capacitor system. An external voltage source supplies the capacitor with an electric charge (White 1991: 72).

**Control voltage**

Signals used to vary parameters (Russ 1996: 355).

**Cross fade**

Overlapping volume fades between two adjacent audio regions or segments. A cross fade is a gradual mix from one sound source or group of sources to another (Nisbett 1995: 346) and is executed according to a selected fade type/shape (Sams 1999: 43). Also termed *X-fade*.

**DAC, D/A converter**

Digital-to-Analog Converter. A device that converts a stream of digital audio data, by means of clocking and filtering (Newell 2000: 263), into an analog signal, comprised of voltages varying over time. DAC's form part of the output stage of all digital recorders and samplers etc. (Sams 1999: 47)

**DAW, Digital Audio Workstation**

Digital Audio Workstation. "A hard-disk based audio production system used for a variety of applications including recording, mixing and/or mastering" (Digidesign 1999a: 30).

**Decibel, dB [scale]**

Literally, one tenth of a bel – a unit for expressing the intensity of a sound and/or the power of an electric or acoustic signal (Allen 2002: 220). The *decibel* is defined as "the common logarithm of the ratio of two powers" and is a "pure number with no dimensions" (White 1991: 87). See White (1991: 87) for a comprehensive explanation on the *decibel [scale]*.

**Direct-to-disk recording**

Recording directly to "a storage device for digital information which uses a rigid rotating disk coated with magnetic material." (Russ 1996: 362) Direct-to-disk technology is no longer inhibited by RAM restrictions. The hard disk recorder stores data on concentric tracks, which it accesses by moving the head radially (Watkinson 1994: 19). Alternatively termed hard disk recording.

**Digital [circuit]**

A [circuit] responding to discrete values of input voltage, and producing discrete values of output values. Usually two voltage levels only are recognized (Illingworth 1998: 129). See *Analog circuit.*



**DJ**

Disc Jockey. According to the Penguin English Dictionary (Allen 2002: 243), it is "a person who plays and introduces recorded music on a radio program or at a nightclub or party."

**Drumbeat, drum hit**

"Stroke on a drum or its sound." (Allen 2002: 265).

**DSP**

Digital Signal Processing (Allen 2002: 266). Data processing in signal processing applications, using microprocessors (Illingworth 1998: 134).

**Dynamic [range]**

Dynamics refer to the "gradations of volume" (Kennedy 1996: 217), or "changes in loudness" (White 1991: 108) in music. Measured in *decibels*, the *dynamic range* of a sound is the ratio of the strongest (loudest) part to the weakest (softest) part.

**Dynamic microphone**

A simple microphone type consisting of a diaphragm with a coil of wire attached to it, moving in a magnetic field supplied by a permanent magnet (White 1991: 109).

**Electronic musical instrument**

A device that uses electronic circuits as the source for creating musical sounds, e.g. synthesizers and samplers (Sams 1999: 74). Electronic musical instruments would be classified as *electrophones*. See also *Chapter 2, section 2.2.*

**Envelope**

The shape of the change of volume or level of an audio signal (Russ 1996: 358). Also, the contour of a sound, "reflecting changes in amplitude, pitch, or timbral characteristics over time." (Sams 1999: 75) See *ADSR, Amplitude envelope, Envelope generator* and *Filter envelope*.

**EG, envelope generator**

Envelope generator. A circuit producing a sequence of segments representing the stages of an envelope. It is used as a control voltage source (Russ 1996: 358). See *Envelope.*

**EQ, equalization, equalizer**

Equalization, equalizer. An equalizer, consisting of various filters, distorts (boost or attenuate) the relative strengths of certain frequency ranges of an audio signal (White 1991: 120).

**FFT**

Fast Fourier Transform. A high-speed mathematical method of "analyzing discrete or sampled data signals to determine the frequency spectrum." (Illingworth 1998: 143-144)

**Filter envelope**

A filter envelope describes the change in spectral content of sound over time (Sams 1999: 75).

**Flash EPROM**

Erasable Programmable ROM, behaving like non-volatile RAM (Russ 1996: 393). Flash EPROM allows long-term storage in memory chips, which do not require a backup battery (Russ 1996: 210). Also called *flash, flash chips* or *flash memory*.

**Fundamental**

The lowest frequency component of a complex tone (White 1991: 146). See *Partial.*

**Hard disk recording**

See *direct-to-disk recording*.

**IEEE**

Institute of Electrical and Electronics Engineers (Pittsburgh Supercomputing Center 1999).

**Interface**

The electronic circuitry for connecting two or more devices, "usually required to compensate for differences in speed, signal levels and/or codes" between these devices. These devices are generally computer components or systems (Illingworth 1998: 288).



**I/O [port]**

Input/Output. The passing of information into and out of the processing units of computers (Illingworth 1998: 283) and digital audio systems. I/O refers to the port and/or connectors of a unit, "sending or receiving data, audio, synchronization, AC current etc." (Sams 1999: 99)

**Kb, kilobyte**

Computing term - a unit of measure for digital data. 1,024 bytes (Sams 1999: 109).

**LAN**

Local Area Network.  A high-speed data communications network, linking computers together for sharing files, printers and electronic mail. It usually "provides services to directly connected computers of a single organization" (Illingworth 1998: 232).

**LFO**

Low Frequency Oscillator. Commonly used to regulate vibrato modulation effects (Sams 1999: 112). Termed by *Korg* as a *modulation generator* (Russ 1996: 368).

**LED**

Light-Emitting Diode. Used to display characters on the front panels of many electronic devices (Sams 1999: 112).

**Master [disc], mastering**

Originally, the process of mastering was the first step in manufacturing phonograph records from tapes (White 1991: 198). The term is now commonly used to describe the final process of producing a record master or master disc – the original recording from which copies can be made (Allen 2002: 543). Mastering also refers to “the art of making an audio program sound consistent” (Digidesign 1999a).

**MIDI [command, data, note, port, specification]**

Acronym for Musical Instrument Digital Interface – a digital communications protocol which, according to Rumsey (1994: 1), is a digital control interface that transmits and receives serial commands for remote control of musical instruments and other equipment. MIDI is furthermore “an agreement among manufacturers of music equipment, computers, and software” (Rothstein 1995: 1). Rothstein (1995: xi) states: “The MIDI Manufacturers Association has responded to the needs and dreams of MIDI hardware and software developers, who in turn have responded to developments in the MIDI specification.” Utilizing I/O ports, MIDI-controlled equipment is normally based on microprocessor control (Rumsey 1994: 34). For advanced and comprehensive information on MIDI commands and specifications, refer to *Advanced MIDI User’s Guide 2nd Edition* by R.A. Penfold (1995: Glasgow, PC Publishing).

**Modulation**

Changing or varying a parameter. Inclusively used to mean cyclic variation (Russ 1996: 368).

**Mono**

Single channel of audio. This is defined by the form of recording or transmission, and not by the number of loudspeakers (Nisbett 1995: 358). See *Stereo*.

**Monophonic**

Technical term for the capacity to play only one note at once. Also, "a sound system with only one channel" (Illingworth 1998: 363).

**Musical quotation, quote**

A musical 'quotation' is the analog corollary to digital sampling (Weitz 2002). A musical 'quote' is the taking of a distinctive and recognizable portion – relatively brief, according to Burkholder (2001: 689) – of another era's or composer's music and using it in a new context. See *Sample posing*.

**Near field**

The sound field extremely close to a source of sound – at least one wavelength at the frequency of interest (White 1991: 218).

**Note [on, off]**

See *MIDI*.

**On Axis**

In the direction of maximum sensitivity of a microphone (White 1991: 228).

**Pan, panning**

Any 'position' within the 180° range (left through right) of a stereo sound image (White 1991: 236).

**Partial**

Any frequency component of a complex tone, whether in tune with the fundamental, or not (White 1991: 328). See *Fundamental*.

**PCMCIA**

A specific type of memory card and interface (Russ 1996: 391) standardized for many types of devices. Utilizing different PCMCIA slots, the three types of PCMCIA cards vary in width and are primarily used as additional computer ROM or RAM, modem and fax modem cards, and portable disk drives (Webopedia 2003).

**Platform**

A collective term for a recording application with its associated hardware and software peripherals.

**Polyphony**

Technical term for the capacity to play a number of simultaneous notes at once. An instrument with this capacity is termed *polyphonic* (Russ 1996: 372).

**Pop [music]**

Abbreviation for *popular* – earlier, "concerts appealing to a wide audience" (Kennedy 1996: 571). Also, modern commercially promoted *popular music*, usually simplistic in form and with a strong beat (Allen 2002: 684). See *Popular music.*

**Popular music**

Music genre. A widely used term in everyday discourse, though difficult to define. According to Middleton (2001: 128), it generally refers to "types of music that are considered to be of lower value and complexity than art music", and which is "readily accessible to large numbers of musically uneducated listeners rather than to an elite." Popular music is characteristic of 'modern' and 'modernizing' societies – Europe and North America – from about 1800, and even more from about 1900. See *Rock*, *Pop* and *R&B.*

**Q [factor]**

Quality factor – associated with a resonant circuit and describes the capacity of the circuit to produce a large output at the resonant frequency (also *center frequency*), as well as the selectivity of the circuit. The quality factor is expressed as: $Q = f_o / BW$, where $f_o$ = resonant frequency (or center frequency), and BW = band width (Illingworth 1998: 459). See *Center frequency.*

**RAM, dynamic RAM, static RAM**

Random Access Memory: Unlike magnetic tape storage, where a given piece of data may physically be 'further away' and therefore take longer to retrieve, access times to all memory locations are equal. Also termed *bit line*, RAM is usually volatile, meaning it depends on a supply of electrical power to hold data (Russ 1996: 393). RAM can be either static or dynamic: static RAM chips hold its contents for as long as they are powered up. Dynamic RAM chips must be continuously refreshed by the host microprocessor chip in order to 'remember' its content. See Chapter 2 in *The Art of Digital Recording 2nd Edition* by Watkinson, J. (1994: Oxford, Focal Press) for extensive reference to RAM.

**R&B, ‘rhythm and blues’**

*Popular music* “with elements of blues and jazz” (Allen 2002: 760), describing “music marketed primarily to African-Americans” since 1949. *Rhythm and blues* was supplanted by *Soul* in 1969 (Howard 2001: 309), although the term *R&B* continues to be widely used. See *Popular music*.

**Real-time**

Occurring at the same rate as normal time, but implies a short, almost instantaneous time delay (Russ 1996: 375).

**Rock, rock ‘n roll [music]**

A music species (sub-genre) of *popular music*, which originated in the United States in the early 1950’s as *Rock ‘n Roll*. Usually associated with groups performing with [electronically amplified] guitars and drums. Sub-species include folk rock, jazz and punk rock (Kennedy 1996: 612). *Rock ‘n Roll*, according to Walser (2001b: 486), “…is sometimes used broadly to refer to the popular music of the second half of the 20th century.” *Rock* denotes a particular category of *pop* and is a contraction of *Rock ‘n Roll*. *Rock* itself only first appeared in the 1960’s, and was used to describe certain new pop styles developing after about 1965, in Britain and the States (Walser 2001a: 485). See *Popular music*.

**ROM**

Read-only Memory, using permanent solid-state data chips (Russ 1996: 391). The user can read from, but not write to ROM.

**Sample posing**

The style of composing using prerecorded samples in a new, creative arrangement (Sams 1999: 173). See *Musical quotation.*

**Sampling frequency, sampling rate**

The frequency or rate at which some portions of an electrical signal are measured and used to produce a set of discreet values, representing the information contained in the whole (Illingworth 1998: 496).

**Sampling period**

The reciprocal of the sampling rate (Illingworth 1998: 496). See *Sampling frequency*.

**SCSI**

Small Computer Systems Interface: “A high-speed communications protocol that allows computers, samplers, and hard disks to communicate with one another.” (Vail 2000: 329) Pronounced “skuzzy”.

**Steady state**

The part of a musical note “when the tone has stabilized and the amplitude is constant.” (Campbell and Greated 1987: 12). See *Transient*.

**Stereo**

Two channels of audio (left and right). Stereo provides an illusion of a complete [true] sound stage (Russ 1996: 380). See *Mono.*

**Synthesis, synthesizer**

Signal production through manipulation of the time and/or frequency domain. Synthesis types include additive, subtractive and FM synthesis (Illingworth 1998: 552). A synthesizer is an *electronic musical instrument* usually operated by a keyboard, in which sounds are produced by different *synthesis* or *sampling* methods, or by other modeling techniques (Illingworth 1998: 553). See *Electronic Musical Instrument*.



**Timbre**

The unique, characteristic quality of an instrument (Campbell and Greated 1987: 141-142). Also: Tone quality, determined by the distribution of frequencies and intensities in a sound (Nisbett 1995: 370). See *Partial*, *Fundamental* and *Chapter 3, section 3.3.*

**Transient [peak]**

When the amplitude is changing (Campbell and Greated 1987: 12). A transient peak refers to the loudest piece in the attack or onset transient (Campbell and Greated 1987: 157). See *Steady state.*

**Transpose, transposition**

The term for altering both pitch and timing characteristics of a sample (Russ 1996: 207). Also see C*hapter 2, section 2.2.*

**Velocity [-sensitive, switching, zone]**

A MIDI parameter of each *Note On* event, indicating the speed at which the key was pressed. A receiving module may be programmed to respond in a variety of ways to velocity information. This facility is known as *velocity-sensitivity*. *Velocity switching* permits the ability to trigger different samples, according to the velocity at which a key is stroked; the *velocity zone* describes the mapping of sampled sounds (e.g. on a keyboard), according to the *velocity switching* technique (Sams 1999: 216).

**VCA**

Voltage Controlled Amplifier. Amplifier in which the gain is controlled by a control voltage (Russ 1996: 383).