Sound Bites

Materialising the immaterial: Sound and memory as intimate personal experience

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Colophon

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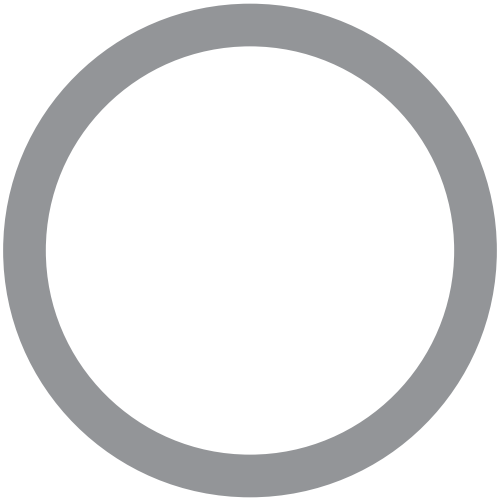
For Aukje.

Forever.



The tree that sheds the twin leaves that fall from "outside" into our stream can also be considered an integral part of the dynamical system called the stream. Moreover, within the stream itself, all the elements—from the sharpest bend to the smallest leaf and pebble—constantly interact with each other. In other words, dynamical systems imply a holism in which everything influences, or potentially influences, everything else because everything is in some sense constantly interacting with everything else. (Briggs, 1992)

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of a university or other institution of higher learning, except where due acknowledgements is made in the acknowledgements.

Gerbrand van Melle Date

Abstract

In the project that forms the site of this creative, practice-led thesis, personal audio recordings are translated into intimate physical experiences. In so doing, the potential of visual music[1] and second order cybernetics[2] are used to develop a new experience that synthesises sound and visual components into material form. In this "aesthetically potent environment" (Pask, 1971, p. 76), the research engages with sound visualisation, sampling methods, and generative design practice.

The idea explored in the thesis is that objects are continuously changing processes in time. Through parallel iterations of sound recordings, sound spectrum analysis, generative model making, and materialising methods, temporarily intimate representations of the world around me surface and are re-composed.

Emerging design work implies a semiotic polyvalence that is realised through a process of techno-transformative and generative methods. As such, new arrangements are created, comprising single parts that are restructured into rhythmic patterns. The individual samples do not act as quotes; instead they operate as generative material for systemic combination.

This design acts as a provocation; its purpose is to trigger an audience to consider the potentials of personally significant sound as a form of unique, material user experience.

1. Visual music is a means of converting music to images using a system or set of rules that can be implemented as a machine or computer code (Friedlander, 1998, para. 8).

2. Second Order Cybernetics refers to the cybernetics of observing systems (Foerster, 1975). In this paradigm there is no longer a separation of the goal and system from the observer (Glanville, 2004).

Figure 1. Hans van Melle (1904 - 1994).

Forerunners

Hans gave me my first turntable.
Hans gave me my first tape deck.
Hans gave me my first camera.
Hans gave me my first computer.
Hans gave me a book by Itten.

Hans (Figure 1) was a librarian, a photographer and a sound engineer. Foremost Hans was my grandfather who, since I was a kid, enabled me to play with sound and image. This thesis has made me realise his influence on my professional life, in industry and in the academy.

My design career began in the early nineties. With friends from design school I started a cooperative group of creative talents called *AAP*, (Monkey in Dutch). Together with a partner, I was responsible for the growth of this agency into a medium-sized design studio specialising in graphic and typographic design. In addition to applied work, time was always found for noncommercial projects, like experimental movies and games.

As a student in the late eighties I started designing gig posters for the Utrecht venue *Tivoli*. This is now a leading Dutch club that organises cultural events with a primary focus on pop music.[3] After 1989 I became the art director for this organisation, responsible for the execution of corporate identity and the implementation of print and web strategies. *Tivoli* offered a playground to experiment with typography, visual language and emerging print technologies. Design work surfacing from this relationship can be viewed in my book *18+*, which I edited, designed and published in 2007 (Figures 2,3 and 4).

3. 315,000 people visit *Tivoli* annually.

Figure 2. Front Cover for *18+*.

Figure 3. Double page spread for *18+*.

Figure 4. Double page spread for *18+*.

In the 1990s, practising visual design for the music and entertainment industries was consolidated through a professional relationship between my design studio and *PIAS Benelux*. This resulted in numerous sleeve designs and advertising campaigns for record labels. In a period where electronic dance music grew exponentially, work varied from visual experiments for Dutch techno acts to more applied communication strategies for the *PIAS Benelux* distribution network (Figures 5 and 6).

In 1999 in collaboration with contemporary musical composer Ivo van Emmerik, I began work on the media design of an interactive music installation called *Foucault*. The system contained a typo- and photographic landscape in which ambient soundscapes and spoken words were randomly activated through mouse movement (Figure 7). The work was performed live during a national tour that included the Stedelijk Museum in Amsterdam. The main feature of this piece was its nonlinear structure. As such, no outcome could be repeated and no predictable configuration could be assured. This was the first time I toured as a graphic designer, playing a synaesthetic digital instrument.

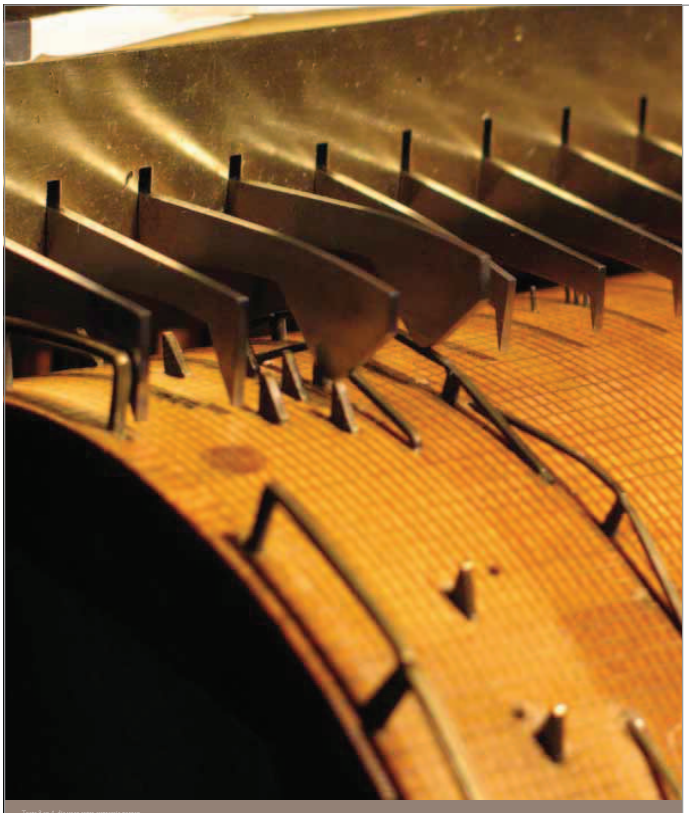
Between 1999 and 2008, I worked as an art director for the *Nationaal Museum van Speelkok tot Pierement* (*National Museum from Musical Clock to Street Organ*).[4] This institute houses one of the world's foremost collections of automatic musical instruments. Here, I was able to learn at close hand about unique analogue music players. I frequented the museum's chambers, marveling at refined hydraulic fingers playing violins and incredible, complicated clockworks. A highlight of this period was the opportunity to design the bookwork *Mozart Mechanisch / Mechanical Mozart* (Koopman & Van Wely & Lefeber-Morsman, 2007) (Figure 8). Often the visual delight of these instruments was more important than experiencing their audible content. In retrospect I can see how this heightened my interest in the physicality of sound.

4. 97,000 people visit the *National Museum from Musical Clock to Street Organ* annually.

Figure 5. 12" Sleeve designs for *Deviate Records* and *Prime Records*.

Figure 6. Magazine advertisement for *PIAS Benelux*.

Figure 7. Still from the interactive installation *Foucault*.



Toets 3 en 4, die voor extra expressie zorgen
Key 3 and 4, used for greater expressiveness
Taste 3 und 4, die für mehr Ausdruck sorgen

Een tweede onduidelijkheid was de functie van de twee wat dikkere toetsen (3 en 4) aan de linker zijde van het klavier. Deze toetsen worden over bruggen geleid die van laag naar hoog en weer van hoog naar laag gaan. Aan deze toetsen is een heel ingenieus mechaniek verbonden dat zich vlak boven de magazijnbalg bevindt. Voordat alle onderdelen werden losgemaakt om ze schoon te maken is heel goed naar de functie van deze mechanieken gekeken. Het vermoeden ontstond dat in ieder geval één van deze mechanieken de druk op de balg verhoogt en daardoor voor meer volume zorgt. Dit zou namelijk alleen bij de doorslaande tongwerken kunnen functioneren, omdat deze niet vals worden als je de druk verandert.
Uiteindelijk bleek dat deze twee toetsen samen voor extra expressie in de muziek zorgen. Dit houdt in dat deze toetsen de winddruk verhogen of verlagen, waardoor de tongwerken harder of zachter gaan klinken. Later bleek dat alleen de tongwerken spelen.

De toets die de tongwerken harder laat klinken laat boven het magazijn een veerconstructie over een beweegbare 'drukverhoger' rollen. Deze duwt tijdens het pompen van de schepbalgen vanuit een vaste positie gelijkmatig het magazijn steeds verder naar beneden, waardoor de druk wordt verhoogd en de tongwerken harder gaan klinken.

A second uncertainty concerned the function of the two slightly fatter keys (3 and 4) on the left side of the keyframe. These keys are operated by bridges of increasing/decreasing hight. Attached to these keys is a very clever mechanism, just above the storage bellows. Before we disassembled all the parts to clean them, we took a very good look at the function of these mechanisms. We suspected that in any case one of them increased the pressure on the storage bellows and thereby increased the volume. This would only work in the case of the free reeds because they do not get out of tune when you increase the pressure.
Eventually it became clear that these two keys together add extra expressiveness to the music. It means that the keys increase or decrease the wind pressure so that the free reeds sound louder or softer. We later found that it did indeed only apply to the reeds.

The key that makes the reeds sound louder causes a spring construction to roll across a moveable 'pressure increaser' just above the storage bellows. From a fixed position and while the feeder bellows are pumping, it pushes the storage bellows further down so that the pressure is increased and the reeds sound louder.

Weiterhin war unklar, was die Funktion der beiden dicken Tasten (3 und 4) an der linken Seite des Klaviers war. Diese Tasten werden über Brücken geleitet, die von tief bis hoch und wieder von hoch bis tief gehen. Diese Tasten sind mit einer genialen Mechanik verbunden, die sich direkt über dem Magazinbalg befindet. Bevor alle Teile entfernt wurden um sie zu säubern, wurde genau auf die Funktion diese Mechaniken geachtet. Die Vermutung lag nahe, dass zumindest eine dieser Mechaniken den Druck auf den Balg erhöhen und damit auch das Volumen verstärken würde. Dies würde nämlich nur bei den durchschlagenden Zungenwerken funktionieren können, da diese nicht falsch klingen, wenn man den Druck verändert.
Schließlich wurde klar, dass diese Tasten zusammen für mehr Ausdruck in der Musik sorgen. Das heißt, dass diese Tasten den Winddruck erhöhen oder verringern, wodurch die Zungenwerke lauter oder leiser klingen. Später wurde deutlich, dass nur die Zungenwerke spielen.

Die Taste, die das Zungenwerk lauter klingen lässt, lässt über dem Magazin eine Federkonstruktion über einen beweglichen ‚Druckverstärker' rollen. Diese drückt während des Pumpens der Schöpfbälge von einer festen Position aus das Magazin gleichmäßig immer weiter nach unten, wodurch der Druck erhöht wird und die Zungenwerke lauter klingen.

Figure 8. Double page spread for *Mozart Mechanisch / Mechanical Mozart*.

Sound and the transmodular

Looking back across almost a quarter of a century of graphic design work I realise I am interested in sound as an ingredient in a transmodular[5] creative process. In a digital environment I have begun to ask how time based sound output might be converted to input, and through this process how might space-based objects be generated? To a visual designer this means a significant shift in design approach. The designer generates a system; a matrix with parameters in which numbers read and written numbers correlate. Not being able to determine final solutions allows the designs to emerge from a converging relationship instead of from the designer's aesthetic choices.

Our sound recordings are precious. Users of online music services create and share libraries and playlists of music tracks. As such these media might be defined as avatars of personal identity.[6] Sharing personal belongings can be an intimate matter. Whether it be rare vinyl music recordings or sound tracks of personal video documents, these sound symbols are techno transformative and process-oriented documents.[7] By using them generatively, new structures can be created that enable users to experience sound in space, in close proximity to their physical being.

Within my current research domain, artists, designers and engineers are looking for distinctive ways to transform sound into form.

5. Transmodulation calculates the translation from one frequency into another. It defines the relationship between different wavelengths. A common example of a transmodular method is the translation from the television signal UHF to PAL.

6. According to McLuhan (1964), media is anything we invent and each invention is an extension of some part of ourselves.

7. By this I mean they are not used as quotes, but as basic material that breaks the linearity of the transformation.

In so doing, they challenge conventions relating to how sound is perceived and how sound files can generate visual and physical experiences. In positioning this project it is useful to note the work of four contemporary practitioners:

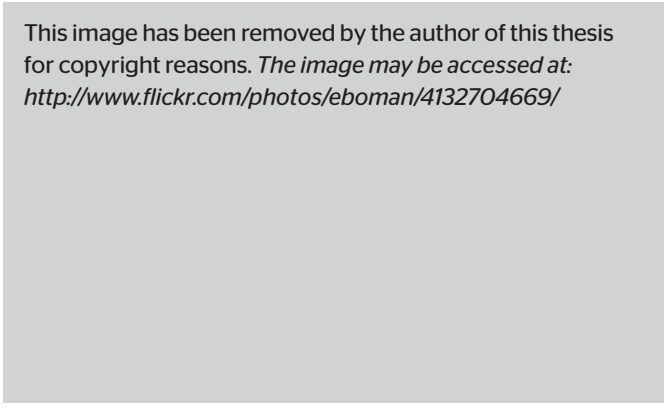


Figure 9. Live performance by Eboman.

Dutch video artist and musician *Eboman* specialises in the production of audiovisual sample compositions, and the development of audiovisual sampling software and hardware. His DVJ performances combine sounds that define visuals and vice versa in continuous loops. Pivotal to sample culture, his experimental approach to interaction design explores new inner logics (Bidner & Feuerstein, 2004) based on audience participation (Figure 9).

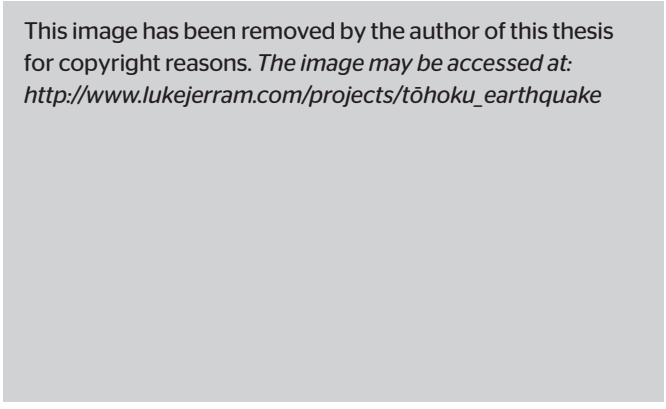


Figure 10. *Instrument for The Sonification of Everyday Things.*

Dennis P. Paul intercepts his visible world in a different way with his *Instrument For The Sonification Of Everyday Things*. His spinning structure operates a laser that reads 3D objects and shoots the 3D data through a sound processor. The Rotations Per Minute (RPM) are synchronised with the Beat Per Minute (BPM) of a beat track. This in effect, turns his installation into potential musical instruments (Figure 10).

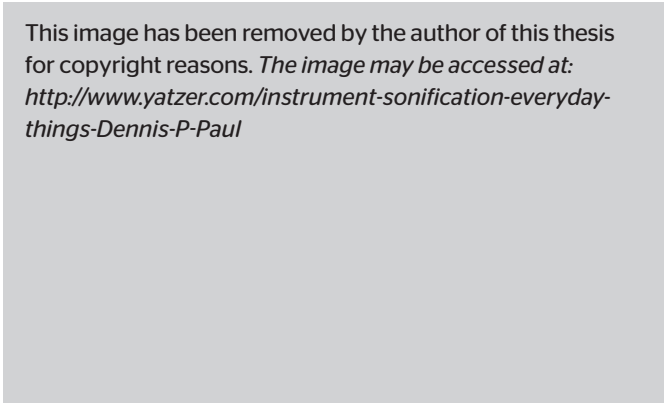


Figure 11. *Tōhoku Japanese Earthquake Sculpture.*

With his *Tōhoku Japanese Earthquake Sculpture*, Luke Jerram designed an artwork to contemplate the 2011 Tōhoku earthquake. The sculpture was created by translating the seismogram into a stylised 3D printed shape. Although the transformed work is very close to the original seismogram's waveform, within it is evidenced the idea of captured, fossilised vibrations (Figure 11).

Figure 12. *Listening to the Ocean on a Shore of Gypsum Sand.*

Finally, Gene Kogan, Phillip Stearns, and Dan Tesene's work *Listening to the Ocean on a Shore of Gypsum Sand* is a collaborative project. Their final 3D printed shape is composed of algorithms created for the purpose of listening to the ocean. However the data stream that defines the shape is not taken from the ocean, it is chosen for a specific aesthetic outcome, the shell (Figure 12).

Research question

Broadly this thesis asks:

To what extent can a transmodular design process intercept personally significant sound and decipher this data to distribute a unique physical user experience?

In asking such a question, the thesis acts as an agent provocateur. Its purpose is to trigger people to consider new meaning for the intimate sounds of their lives. In the case of this project, I use as examples sound bites of everyday living, and fragments of a personally significant music collection.

Current discourse surrounding the exegesis

The exegesis, as a communicative design object, has become the subject of considerable discussion. Visual designers in the academy require stronger consistencies between their practice and its contextualisation. Their professional interest in clarity and expression means that traditions of the thesis document are being challenged. An exegesis that is type set in double line spaced[8] twelve point Times Roman type on one side of a prescriptively margined, white, portrait, A4 page is often too limited to represent the subtle nuances of the designer's voice .

Hamilton (2011) believes that the exegesis depends on harmony between "the disinterested perspective and academic objectivity of an observer/ethnographer/ analyst/theorist [and] the invested perspective of the practitioner/producer" (para. 2).

In 2004, Milech and Schilo distinguished two models of a doctorate exegesis. The first they called the "context model"; this conveys an objective academic voice and provides a theoretical or historical context for the practice. The second form was identified as the"commentary model". It offered a firstperson reflection on practice.

However, in 2010, a third model was proposed by Hamilton and Jaaniste. This "connective exegesis" assumed "a dual orientation-looking outwards to the established field of research, exemplars and theories, and inwards to the methodologies, processes and outcomes of the practice" (Hamilton, 2011, para. 1). In this model Hamilton and Jaaniste noted the author

8. An inheritance from Microsoft Word to indicate the leading of a text.

assumes multiple perspectives (Hamilton & Jaaniste, 2010). This model was a hybrid version of Milech and Schilo's research and it is best characterised by multiple perspectives of the author. Here the researcher uses the tools of writing and visual design to synthesise both formal analysis and subjective reflections. This difference in voice, Hamilton suggests, is not a contradiction; instead the writing "assumes a dual orientation-looking outwards to the established field of research, exemplars and theories, and inwards to the methodologies, processes and outcomes of the practice" (2011, para. 1).

For a visual designer whose practice traverses the self and enquires into new knowledge, it is important to allow for a circular, systemic structure of appropriate voices for different purposes in the text. These voices are polyvocal and surface from the diverse nature of a practice-led creative enquiry.

This polyvocality relates to Burdick's (1992) proposal that designers should consider themselves authors, instead of facilitators. This idea was topical when I graduated from design school in 1992 and defined early decisions to start my own design studio. The necessity for a visual designer to 'author' his text in an authentic manner and to design his voice as both professionally and socially embodied, has been noted by a range of authors including Rock (1996), Scrivener (2000) and Scrivener & Ings (2009).

Within practice-led research it is necessary to find appropriate voices for distinctly different modes of telling. As such Scrivener and Ings (2009, p. 3) describe an exegesis as potentially a "carefully constructed kind of storytelling with a particular audience in mind." They suggest that these academic documents may be ... "not just written, [but] also designed and directed" (ibid, p. 2).[9] They say that this might relate "to a choral work that while understood as a single unit, orchestrates a concordance of voices" (ibid, p. 3).

Ings concludes his position on exegesis design in creative practices by stating, "These texts do not forsake the rigour and integrity of scholarship, but lift it closer to the ethos of the exegesis ... towards its etymological origin. These works interpret, guide and lead" (Ings, 2013).

When I use a diversity of voices I tell a story through more than just text. Image, rhythm, order and tactility become vehicles for communicating the subtlety and complexity of thought. These dimensions are used in ordinary, everyday communications. From the images and video files that are shared in daily social media streams to the animated diagrams in online scientific journals, communication is more than the written word.

9. In describing the exegesis as a form of storytelling the authors extend the concept beyond descriptive narration. The exegesis 'story' is also critical, reflective and contextual.

How to read this exegesis

There are three conceptual frameworks around which *Sound Bites* has been constructed. Each offers a way of understanding ideas relating to the thesis. They are Sampling, Second Order Cybernetics and Transmodular design. The appendix to the exegesis offers a chronological image-led documentation of the research process and a visual consideration of place.

The appendix uses an image-led system of documentation. As such its chronology records both the process and the context in which it occurred. In the body of the exegesis I use scale and placement to differentiate between my own research images and those of others. My images appear at the end of each section. This creates a rhythm in the document and separates my voice from the work of other researchers appearing in the text. Because image and text are interdependent, the exegesis was written in Adobe InDesign. Designing and writing took place simultaneously.[10]

Sound Bites is based on a single page lay out, as I assume the work will be primarily accessed via online media and read on laptops or tablets. As such the scrolling of single pages is a logical format. The spreads that arise in the bound version are specifically redesigned for print.

Instead of a cover, the booklet is contained in a box that is related to the materialisation of the project.

10. The systematic approach of writing text in a word processor and importing the content into a design tool is different to the systemic approach of working as in a single design-oriented environment. An example of this is the image-led appendix, that could only be facilitated inside the architecture of software like Indesign.

The practice-led design thesis

Paradigmatically this research may be understood as a practice-led project (Scrivener, 2000) that employs a process of reflective/ reflexive inquiry (Schön 1983, Gray, 1996). This leads to the development of a system for the creative synthesis of visual and audio material.

According to Scrivener (2000) design research can be divided into two categories: problem solving research projects and creative-production projects. Both forms of research allow for the generation of artifacts, but they differ significantly in their nature and in design development.

Problem solving research projects he suggests, are generally concerned with the development of new or improved artifacts.[11]

In creative-production projects however, Scrivener argues that the artifact may be more important than any 'knowledge' represented in it. The knowledge he suggests "is a by-product of the process rather than its primary objective" (2000, p. 3). In this kind of research the artifact may not be generated in response to a known problem and as such may not demonstrate a solution to a problem. My thesis project is located in this domain.

Schön (1983) argues that when a designer makes sense of a situation that he perceives to be unique, he sees it as part of an established repertoire of examples, understandings, images, and actions. As such this allows

11. Generally the artifact is a solution to a known problem and demonstrates a useful solution to the problem. The problem that is solved is normally acknowledged by others and the knowledge represented within the artifact can be described, transferred and applied. This knowledge he argues is generally more important than the artifact.

designers to generate creative work, by drawing on past experiences in their approach to novel and emerging challenges.

All work generated within this research project is treated as a potential ingredient for generating new processes from which new ingredients may emerge. In this comparatively open framework, design iterations allow for a multi-layered generation of experiments. The design research is generated out of a response, not to one, stable question or the pursuit of an anchored 'truth', but to a set of continually changing ideas and outcomes.

Sound Bites is positioned inside Visual Communication Design, but it also explores disciplinary and ideological parameters. Accordingly its methodological framework differs to many purely user-centred approaches.

Frascara (1997) suggests that the purpose of methodologies is the creation of frames, or paradigms within which design decisions take place. These provide designers with guidance using a broad range of influences (Wallick, 2012, p.20).

In Visual Communication Design, one encounters a significant number of audience-centred or task-oriented methodologies (Bennett 2006). However, these often omit consideration of the *thinking processes* used by designers.

Because the practice-led thesis is not only about the generation of artefacts but also about a process of designing, methodologically one sees surfacing within it the idea of cocreation (VanPatter, 2009; Sanders & Simons, 2009),[12] of looping, thinking and experiments that act as transformative agents.

12. Sanders and Simons (2009) suggest "cocreation [is] any act of collective creativity that is experienced jointly by two or more people". According to them it is different to collaboration, because it refers to "a special case of collaboration where the intent is to create something that is not known in advance" (p. 2).

Framing and re-framing

In a thesis like *Sound Bites*, process is more than a chronology; it is integral to a wider consideration of cocreation and 'sensemaking' (VanPatter, 2007). Here the designer/ researcher is concerned with mastering unframed challenges (Eikeland (2006), and opening spaces for both questions and re-framings to develop. In this regard, my approach to methodology is conceptually aligned with some tenets of design thinking. Design thinking describes the ideas and cognitive resources designers bring to the problem-solving process (Zimmerman, Forlizzi, & Evenson, 2007, p. 494).

It appears in diverse fields of design research where efforts are made to integrate innovation and creativity (Lockwood, 2010). Design thinking emphasises the significant empathy for the context of a problem, creative approaches to generating insights and solutions, and concerns with the 'fit' of solutions to the given context. At the core of its approach is a belief in *knowing about* the process and the methods that are used to ideate, and approach problems. Thus, it elevates 'self-consciousness' and context to high levels of relevance.

Schön (1983) describes the design thinking process as a reflective conversation between the designer and the situation. Here the emphasis is on developing new ideas, re-framings and appreciations of what emerges through practice. In this case the problem need not be highly defined at the outset. It may rather be considered as a space that allows for transformations (Thomas & Carroll, 1979) where designers can exercise intuition and creativity. By focusing on the present and the future, the designer explores the parameters of a situation and the resolutions, simultaneously.

I have found it useful in this thesis project to employ a framework proposed by Frayling (1993) because "the end product is an artefact—where the thinking is, so to speak, embodied in the artefact, where the goal is not primarily communicable knowledge in the sense of verbal communication, but in the sense of visual or iconic or imagistic communication" (1993, p.4).

Frayling's framework may be divided into three actions: research into, research through, and research for design:

— Research into design: The outcome of the investigation leads to a system for the synthesis of vision and sound, that requires research into sound systems and materiality.

— Research through design engages with an understanding of the value of developmental enquiry as a valid research strategy. Throughout the course of my research, findings apply to design experimentation at each stage. This trajectory involves a full synthesis of both analysis and application of understandings. This process leads to design iterations.

— Research for design: Here, the designer/user, considers design related issues such as culturally defined epistimologies. This is partly because the creative enquiry is rooted in the histories of sample culture.

Much of the *Sound Bites* research took place within Frayling's second construct, research through design. The open and experimental iterations led to new found areas of design, not driven by a strong will to choose direction, yet directed by continually paying attention to the moment. Looping back these actions to the original, yet ever changing question, resulted in an open systemic set of design iterations.

Because the enquiry was iterative, from the outset, I used literature sparingly. The research called theory and technical knowledge into itself as required (rather than used them as substrates from which to build thinking).[13] This approach was necessary because the project employed an inductive process where questions were treated as mutable, responsive, and discovery-orientated. A deeper use of precedent analysis and contextual literature took place towards the end of the project where I sought to compare findings to wider discovery and practice in the area.

13. I sought the solution, led by the question at hand. For example, I did not learn about moulding and decide to cast chocolate. I needed to develop a printable and castable consumable material/process that might suggest intimacy and simultaneously capture the subtle forms of a three-dimensional sound. In a similar way the design of the design tools for analysing and visualising the audio content was created.

Semiotic polyvalence

The thesis employs four directions of working sound files based on Von Foerster's division of sound into signals, symbols, spoken language and noise (2004, p. 82).

— He defines a sound as something that is interpreted as a signal which hints at an associated source.
— A signal is a result of diversified inferences that he classifies as a symbol.
— A sound generated by speaking not only reveals the speaker but is also a vehicle for the transference of ideas.
— If sounds are not interpretable, they are defined as noise.

All sounds in this thesis project were found in close proximity to my physical self. They may be considered as personal and exist in one's memory until reproduced or recorded.[14] As soon as one records sound, one samples an element of a continuously changing world. A sample is part of a pattern, but it is also a pattern in its own right.

This project may be understood as a form of sampling and regeneration of existing parts into new looped realities. Bidner and Feuerstein suggest that sampling has diverse functions, forms, or facets. They say,

> *Sampling implies semiotic polyvalence, chronological simultaneity, and spatial parallelism, the result being mixtures, new structures and new contexts subjecting the order of things and the self as well as the relationships and communication between humans to a universal re-editing.* (2004, p. 12)

14. These include sounds from tracks in my music collection to the background noise while driving in my car.

Inner logic

Bidner and Feuerstein (2004) argue that work consisting of foreign quotes or found footage is not yet a product of sampling. They believe one can only speak of sampling when the single parts, in their combinatory logic, are transformed, made rhythmic, and structured in such a way that the individual samples no longer function as quotes. Instead these parts become generative basic material for an inner logic that goes beyond the parts. As such, sampling may be seen as a techno-transformative, process oriented, and generative method. Sampling does not quote. Instead it creates a new structure that breaks with the linearity of the transfer and addresses discontinuities. This idea is central to the way *Sound Bites* pursues the visualisation of sound.

Making samples rhythmic involves a system of organisation that can be found throughout design. The same principle may be applied to a typographical grid for a website or a layout for an interior design. Rhythmic patterns are found throughout the natural world, from spiral and zigzag patterns evident in plant growth, to the way that ocean waves are generated. It is this inner logic, this apparent stand alone rhythm that identifies objects, a leaf, a wave, a visual design. This inner logic is only temporary. It is only a visible intersection of a dynamic process.

People connect through complicated ever growing archives of sample collections. Cognitively these samples are processed into patterns: patterns one understands; patterns that cater for search criteria and enable people to feed back into existing knowledge. They act as pathways that prevent users from getting lost.

According to Godin (2009) information finding through a social, tribal context is the most important user activity. As such 'contemporary society' is in a process of becoming a nonlinear 'network society'[15] (Toffler, 1980). Weinberger suggests that knowledge is shared. "It emerges from public and social thought and it stays there, because social knowing, like the global conversations that give rise to it, is never finished" (2007, p. 147).

These dynamic patterns continue to link memories to one another. To this extent sampling is learning. It is how we know and as such it is closely related to epistemology. The sense of pattern recognition carries out confirmation of, or extensions to, mental samples. As a precise way of segmentation and restructuring, sampling exists parallel to analogue and digital segmentation and standardisation of the world.

In a dynamic world of circular patterns the intersections can become temporary moments in time that allow for stillness, perhaps a frozen inner reflection that is not driven by perpetually changing events.

15. Castells (1996) and Van Dijk (1999) claim that networks, and in particular social networks, shape the prime mode of organisation in modern society.

Regeneration

Working with sampling techniques within this thesis opened up the potential of looped realities. The strength of making samples goes beyond the original sound files and their original meaning. Instead their strength is established by the combination of the head and the tail of the sample and a new that is formed through connection. Its link becomes as important as its emphasis.

Samples from my record collection normally had a minimum of two bars and a maximum of eight bars of music. Less than two bars made the samples sound like the needle was stuck in the groove. More than eight bars made the sound in the middle more important than the newly arisen relationship between the head and the tail of the sample.

When appropriating familiar sound files one has expectations. When one recognises a particular sample it provokes memory; it carries a momentary association. One's memory is provoked, but when the file loops, old continuities are broken and new relationships are developed. Patterns, repetitions and regeneration of intimate moments become reconstituted into a new reality.

Designing these new patterns is an exercise based on visual and audio decisions. Here one reads and listens simultaneously in a flow of circularity.

Although I looped samples of my music collection, daily walks on Piha beach made me realise that landscapes might also be considered as something more than objects. They continuously change. Ocean and weather shape the land. The waves are energy being transported through water. On the beach this energy is released as sound and movement. The transformation of sound is hard to follow, but it temporarily leaves marks of energy patterns on the black sand.

When I walk along the coastline, I am part of something. The patterns those rhythms make, move through cycles of time; day and night, phases of the moon, aeons that break down and rebuild geologies of the land. This caused me to consider my physical environment as a cycle, of which I am part.

> *There is a level of reality, where there is no time and there is no space, there is just energy and we have contact with that through the intermediate waves. So if the right channels, if the right connections are established I don't see why a piece of matter, a piece of broken glass or an old record can't make contact through this very high level of reality that has access to everything, the past and the future.* (Moog in Fjellestad, 2004, 01:04:11-01:04:44)

This observation prompted me to think of a creative response where ideas like cocreation and the experience of art might be treated cyclically. One might experience environments where life contributes to a rhythm, where the sounds one makes becomes part of greater wholes, where one integrates with and consumes sound materially in a cyclic process of generation and regeneration.

In this project I was trying to create new relationships between memories from the past, and future expectations. I explored how these experiences collide in the present through audio content. I have investigated a process in which these audio samples play a part. As such I have considered the sample as a process, not as a discrete thing. I am interested in what it does, not what it is (Ashby, 1958).

This is a common concept in Second Order Cybernetics.

Observing systems

In this thesis project I looked for a theoretical framework in which these dynamically controlled cyclic processes of generation and regeneration were evident. Second Order Cybernetics and its concept of looping gave me insight into the role of the design researcher working inside a cyclic system. It seemed that every element is looped, my search for sound files, the sound files themselves, my own design iterations as well as the preferred design outcomes. On a spiritual level Second Order Cybernetics provided a way of understanding the complex entanglements of everyday life.

The original name *Cybernetics, or the Control and Communication in the Animal and the Machine*, was coined in 1948 by the mathematician Norbert Wiener. The term surfaced in a multidisciplinary study into the flow of information around a system, and the way in which this information is used by the system as a means of controlling itself (Beer, 1959).[16]

Second Order Cybernetics is the cybernetics of observing systems with an active role of the observer within the system (Von Foerster, 1975). Cybernetics is in essence about circularity (Glanville, 2004), a state of being in which the observer observes what is happening in a specific system and acts on that system.

Within *Sound Bites* systemic circular processes occur and these may be likened to those mentioned by cyberneticians. The ideas behind the thesis are not of a linear nature, instead they overlap with cybernetic systems in which control is always circular and realised

16. When a system is being observed by an outside observer, this is understood this as First Order Cybernetics.

through feedback mechanisms. Second Order Cybernetics informed my enquiry into sound, colour and spatial systems. It was used as a way to understand these systems in a manner that emphasised the dynamic connectedness of any part of the system to the dynamic totality of the whole system (Maturana, 1970).

In such approaches to an enquiry Maturana (1970) says that the presence of the researcher is admitted rather than disguised. He describes the observer as the person who guides the ship, the skipper, who acts both on practical know-how and intuition. In this regard, the skipper acts both as a scientist and an artist.

Aesthetically potent environments

Cybernetician Gordon Pask distinguishes two orders of analysis. The first is characterised by the observer entering the system by conditioning the purpose of the system. In a second order stipulation, the observer enters the system by conditioning his own purpose (Pask, 1969). Pask believes that linear control is a specially limited version of circular control and as such linear communication—coding—is also a specially limited version of circular communication.

Pask and McKinnon-Wood presented the first of their *Musicolour* machines at the Soviet Exhibition in London in 1961 (Figure 13). The device controlled lights that reacted to live music. It picked out patterns in the music and responded to these. If musicians did not provide enough variety, MusiColour would provide speculative change of its own accord, working itself up into a frenzy until the musicians changed how they were playing. This truly interactive program operates as an agent provocateur: "its purpose [was] to interfere with the musicians" (Glanville, 1996, para. 9). Pask describes this circular process of control a conversation (Pask, 1975).

This image has been removed by the author of this thesis for copyright reasons. *The image may be accessed at: http://we-makemoney-not-art.com/archives/2008/02/molly-wright-steenson-is-a.php.*

Figure 13. Gordon Pask and his *Musicolour* (1961).

Within the construct of Second Order Cybernetics, Pask (1971) describes aesthetically potent environments. These are "... environments designed to encourage or foster the type of interaction which is (by hypothesis) pleasurable" (p. 76).

According to his research these environments must:

—Provide sufficient variety to provide novelty.

— Provide forms that can be interpreted at various levels of abstraction.

— Provide cues to guide learning.

— Be responsive and engage the player in discourse.

In summary, Pask (1971) suggests that,

> *in each case, the external aesthetically potent environment gives rise, bit by bit, to an internal representation and the reciprocal representation is internalised as a discourse between the internal representation and our immediate selves.* (p. 89)

These four conditions of aesthetically potent environments are woven into the tapestry of my design research. They are related to the idea of the magic circle of play. Huizinga (1949) defines this circle as "...stepping out of 'real' life into a temporary sphere of activity" (Huizinga, 1949).

Playing with the audio loops as well as their visual representation takes place outside of 'real' life. The loops are representations of the common world. The alterations do not effect the original context and as such this work flow might be characterised as,

> *a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner.* (Huizinga, 1949)

Circular control or continuous discourse is the fundamental idea behind a state of flow.

Flow

Maturana (1997) notes that living things are open to the flow of matter and energy. The observer is an intrinsic part of a cyclic process. This ties in with Mihály Csíkszentmihályi (1990), who considers three conditions that have to be achieved to establish a state of flow:

— Firstly one must be involved in an activity with a clear set of intentions and progressions. This adds direction and structure to the task at hand.

— Secondly, the task at hand must provide clear and immediate feedback. This helps the researcher mediate any changing demands and allows one to adjust one's performance to continue the state of flow.

— Thirdly, one must maintain a good balance between the perceived challenges of the task and one's perceived skills. One must have assurance that one is capable to undertake the task at hand.

One might ask, how can these conditions be applied to a sequence of systems that interact with each other in which the users' goals are only being defined though the immediate feedback?

A state of flow distinguishes in a systematic way clear goals at every step of the process. The user has a clear purpose and a good understanding of the steps involved. A challenge that is too demanding compared to the user's skill level will frustrate the user. If the challenge is too light, the user can get bored. In a flow experience, a well balanced match between the user's abilities and the demands of the situation engages the user without producing an overwhelming effect.

Csíkszentmihályi's (1997) graph (Figure 14) represents the perceived challenges of a task and one's perceived skills and their mutual relationship. The state of flow is reached when the user's activity is of a high challenge (above the centre point) and the user has above-average skills (to the right of the centre point).

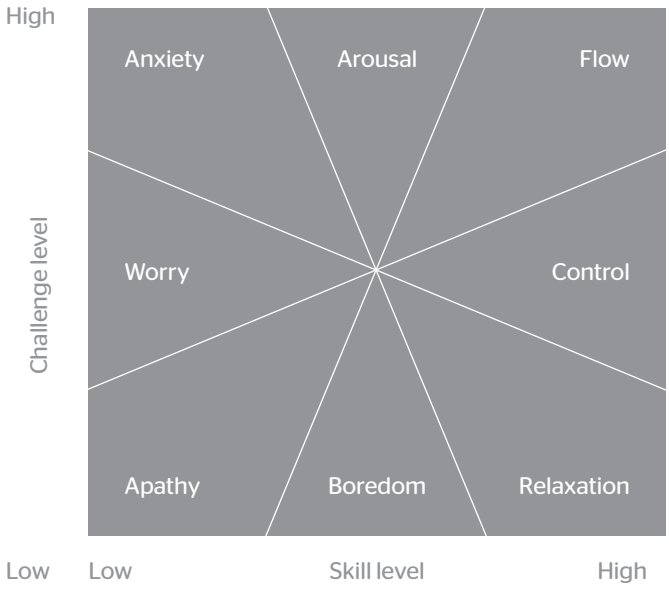


Figure 14. Mental state presented in terms of challenge level and skill level (Csikszentmihalyi's flow model, 1997).

There is an obvious link between Pask's aesthetically potent environment and Csíkszentmihályi's state of flow. In both systems the internal representation and the mutual representation merge in cycles of interaction until these cycles become one's immediate self. These cycles defined my design approach on a micro and macro level. On a micro level I was involved in wrapping loops of sound on to loops of time. On a macro level I attempted to make the original intercepted audio continuously loop from one state into another; from airwaves to digital data to visual pixels to tangible molecules to a final merge with the user.

Action and awareness blend. In flow one is concentrated on what one is doing in the moment. The user being at one with things[17]. The sense of time becomes distorted. The activity becomes 'autotelic'; an end in itself.

The input and output model that is fundamental to the concept of transforming media within *Sound Bites* relates to "the concept of moving within a desired and continuous stream without disruption that might implicate disconnection of this stream, though it might be interrupted by the rhythm of the stream or the [chosen] pathway of the stream" (Thomassen, 2003).

According to this, the maker/user will participate in the flow of matter and energy within the system to establish an equilibrium. This enables flow and brings balance to the system and its parts, and becomes inclusive of all actors engaged in the input-output cycle.

17. This is a key aspect of Japanese Zen Buddhism.

Transmodular design

Collecting

Transmodular design[18] has its origin in science. Transmodulation calculates the translation from one frequency into another. It defines the relationship between different wavelengths. This includes the range of subsonic frequencies to cosmic rays (Figure 15). Common examples of transmodular methods include the translation from a television signal UHF to PAL, or how VU-led meters indicate the volume of sound input or output on an audio device.

In this thesis the mathematical side of transmodulation was utilised to find new pathways of creation. This process is not a scientific model. Instead it is a creative one that taps into existing models, making new connections between different worlds. Transmodular design involved a process of collecting, selecting, analysing, visualising, materialising and exhibiting. It enabled me to enquire into the relationship between time-based entities and space-based objects. The mathematical side of *Sound Bites* occurred in the three phases, analysing, visualising and materialising. In these, code was created to make audio frequencies related to pixels, that then related to molecules.

I am a big vinyl collector of extended versions of disco tracks. Not only are these mixes rich in sound, they also have different intros, breaks and are usually twice as long as the original radio cuts. However, it is the breaks that interest me the most. This is where the artist usually mixes one track into the other, hooking and looping the beats. These parts are quite plain:

18. This term was developed for this thesis. Colab acts as a platform to experiment with Transmodular design practice. It is very different from Transmedia design that involves story telling with a mass audience through multiple platforms, to broaden and lengthen the story.

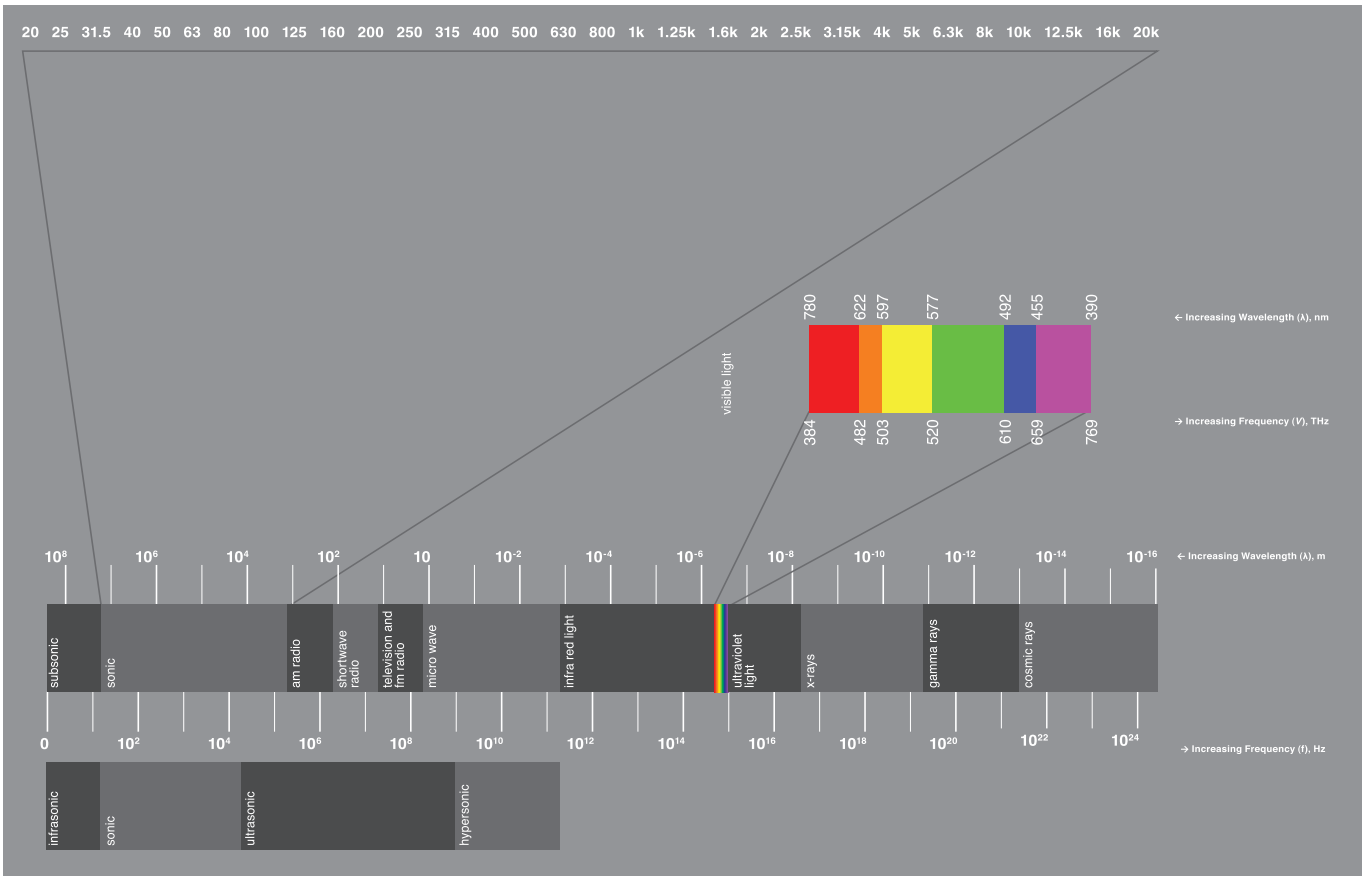


Figure 15. Order of increasing frequencies, or decreasing wavelengths, based on Usbyte table.

kick, clap, snare, closed/open hi-hat, bass-line (basically the rhythm device). Tuning an adjoining tracks is easier without the melody lines of the current one playing. The mixer can avoid conflicting pitches, and there are no song lines to get tangled in the transition. In these breaks there is something familiar but not explicit. The samples that work best are those that suggest something recognisable but never state the obvious.[19]

I know my record collection by heart, so it's easy to find the breaks. Waveform visuals show them in the track time line. Looping these breaks is easily achieved using software like *Ableton Live*.

The mix produces new beats. This is not a novel thing to do; Hiphop is built on this principle.

These breaks often fill my head space. The humming bass lines, tapping beats, and repetitive sound loops seamlessly coexist with the sounds that surround my daily life. They circulate together, blending as a composite.

19. This may be likened to a hot rod car that still reveals something of its original line in its customised state.

Before I began sampling my record collection (Figure 16) I experimented with drum machines so I could gain a deeper appreciation of beat patterns and layered sound compositions.[20] Before looping mixes from my vinyl collection, I began recording everyday sounds in my life. These sounds were not deliberately selected. Instead they were the ambient sounds that constituted a sonic, real time recording of sixteen hours of ordinary living. To collect the data I used my iPhone (Figure 17) and recorded continuously the sounds of my life, day and night, in twelve-hour sequences.[21]

This approach to gathering data did not interfere with my daily actions as I always carry my iPhone in close proximity. The only difference was that I had to carry it upside down in a pouch connected to my belt so I could more effectively expose the instrument's microphone. At night it lay next to me on my bedside table, and when taking a shower I placed it next to the cabinet to prevent it from getting wet. On all other occasions ambient sounds were recorded from a position on my right hip.

I began recording at 8.00pm at night, saved the file, and started a new one at 8.00am. Less than a minute of time was lost during these changeovers. (Figure 18 shows a visual overview of eight, twelve-hour continuous recordings). I planned to record four days and four nights as the number four occurred in previous stages of the trajectory. I worked with four times four bars of music, I created samples that were approximately four seconds long and simultaneously I made a library of four different sound recordings. A multiple of fours seemed sensible because they would seamlessly loop back into the structure of the existing material.

In addition to recording the sounds of my lived life, I also compiled a library from which I sampled other material. While the internal and external recordings may seem conceptually dissonant, in the thesis I was pursuing the idea of intimate sound. The ambient recordings and those of my heartbeat were intrinsic to the rhythm of my daily life. The sound loops were pieces of music that over the years had gathered personal significance. In other words, their intimacy was associated with personally accrued exposure to significant music. These were the soundtracks of my life so to speak. In tandem, the music samples and the sounds of my body both represented forms of intimacy.

20. *Rebirth* the techno micro composer produced by *Propellerhead* proved to be a helpful tool because it combines an emulated *Roland 808* and *909* drum machine with two *303* bass synthesizers.

21. The twelve-hour steps were a matter of necessity, because the app *Voice Recorder HD* has a limit of sixteen hours of continuous recording.

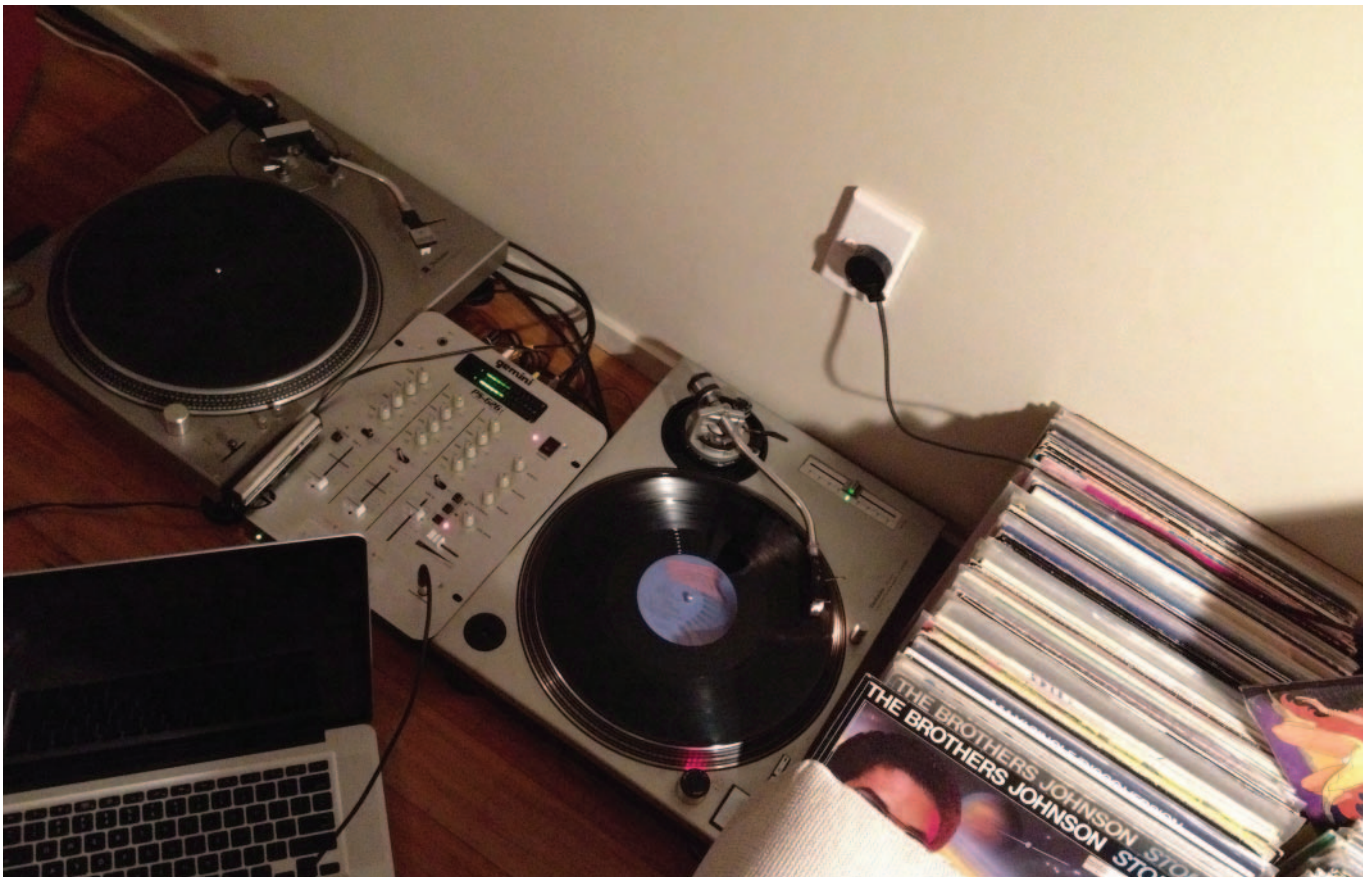


Figure 16. Digitalising of vinyl selections.

Figure 17. iPhone as a recording device for ambient sounds.

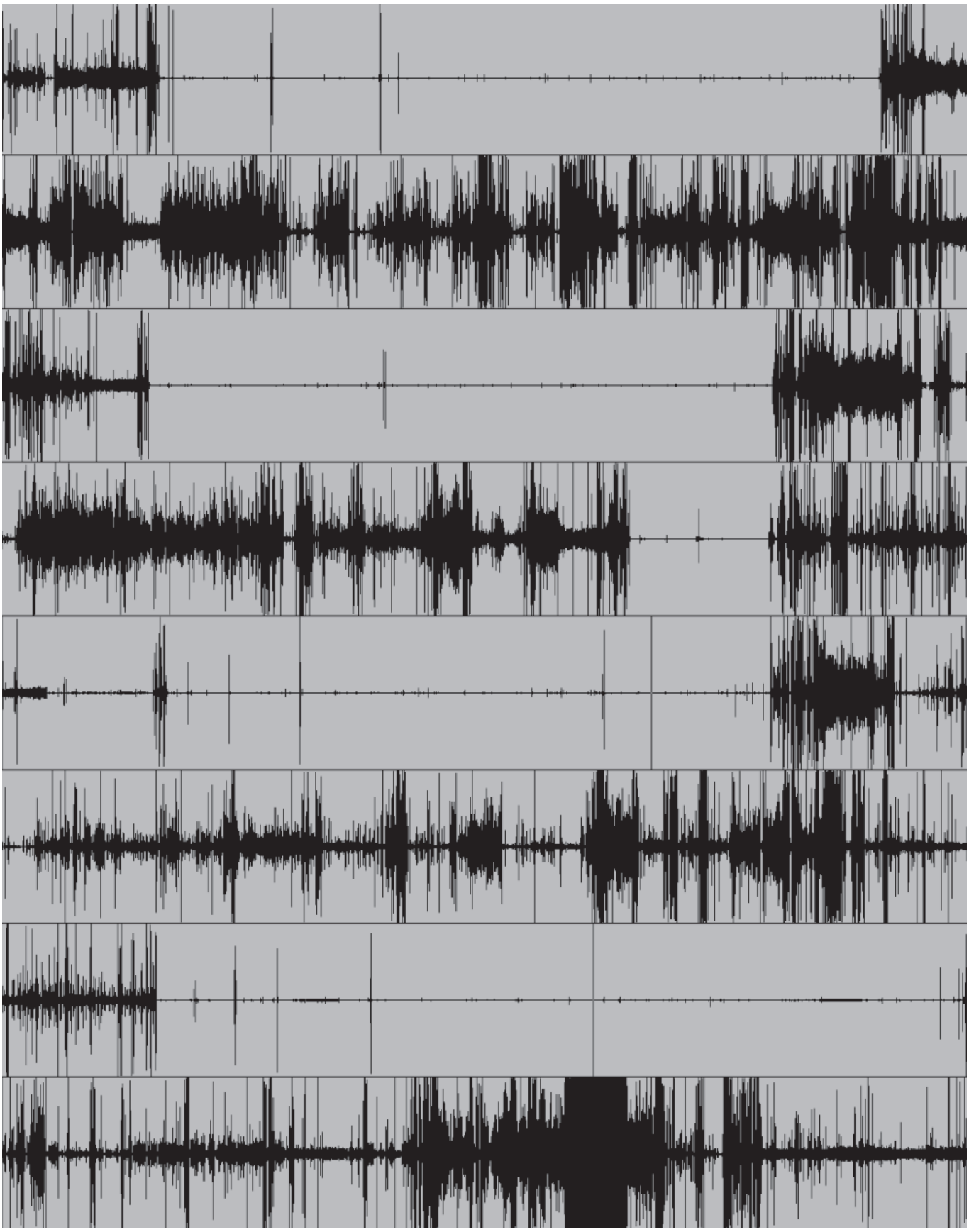


Figure 18. Ambient sound recordings across four nights and four days.

As expected, daytime was noisier than night. The moment during the day that there was quiet (row four in Figure 18), I was wearing a headset (listening to music). The noisiest part of my day was when I visited the beach, (this episode is visible in the last row of Figure 18).

Selecting

In gathering data I sampled an existing world, the world of my twelve inch record collection. The path of creating a vinyl record collection is characterised by circularity of visual and audio feedback loops. I browsed through piles of records making decisions based on visual information connected to my musical memory. Sometimes I received audio feedback by playing the record in store. Sometimes this was not possible and in addition to the printed information design, I look for visual clues in the groove of the actual vinyl disc. Data from the vinyl collection has accumulated over more than two decades and I selected material from this corpus using an intuitive process (Maturana, 1970).

In this intuitive selection process, I browsed through my collection of mixes. By repeated playing and being attentive to the physicality (rhythm) of the recordings I began to match specific selections from my musical memory with visual clues I could see in the record's groove. While mixing two records at the same time, the playback of the song became a search for matching breaks and starts. I was connecting my consciousness to what I heard and saw with my associations with the music.[22] This flow was not centred on one of the media streams, it was a circular movement of continuous change, where my "dynamic connectedness of any part of the system (became simultaneously connected) to the dynamic totality" (Maturana, 1970).

22. I am not only talking here about *how* I remember the music but also *what* I remember in association with it. In this regard I am reminded of Warhol's observation that "Every song has a memory; every song has the ability to make or break your heart, shut down the heart, and open the eyes" (date not established).

I also searched for this dynamic connectedness in the digitised versions of my samples, simultaneously looking at the waveform and listening to the sound. I made choices for loops based on audible information but I fine-tuned these choices by examining information on the Graphical User Interface. Disco tempo is around 120 Beats Per Minute (BPM). Most sampled tracks were four bars long, making each disco sample approximately four seconds in duration. By making them exactly four seconds each, elements that arose, suggesting new beats were easily mixed and matched. What one balances in this process is the fine line between looping and repetition, between a new inner logic (Bidner & Feuerstein, 2004) and monotonous noise.

The rich and complex anatomy of disco music forced the project into a steep learning curve. However, when I began sampling ambient sound recordings from my lived experience the selection process was very different. Even though audio software like *Audacity* (Figures 19 and 20) enables the user to turn an eight-hour ambient recording into a four second sequence, I was curious about what sounds would pop up if I took four seconds every forty-five minutes, leaving me with sixteen intersections of my life.

The consistent heartbeat recordings were not used because they did not significantly change while generating flowing mixes. Against expectations, my heartbeat did not change much at all,[23] so the focus was redirected to a consideration of the ambient recordings. In the end, this personal audio data formed the substrate from which I developed the visualisation and materialisation of the loops.

This resulted in the following selection that covered Von Foerster's sound division (see Table 1 for a detailed overview):

— Disco loops, a selection of four bar sound loops from my personal vinyl collection.

— Ambient recordings, twelve hours' recording of personal ambient sounds.

— Disco loop mix, a recording of mixed disco loops, using four virtual turntables.

— Heartbeat recording, recorded heartbeat during the making of Disco loop mix.

	Control	No control	Symbol	Signal	Speak	Noise
Disco loop	1	0	1	0	0	0
Ambient recording	1	1	1	1	1	1
Disco loop mix	1	1	1	0	0	0
Heartbeat recording	0	1	0	1	0	0

Table 1. Recording overview based on Von Foerster's division (2004).

23. In fact the recording maintained a level BPM throughout the sampled period.

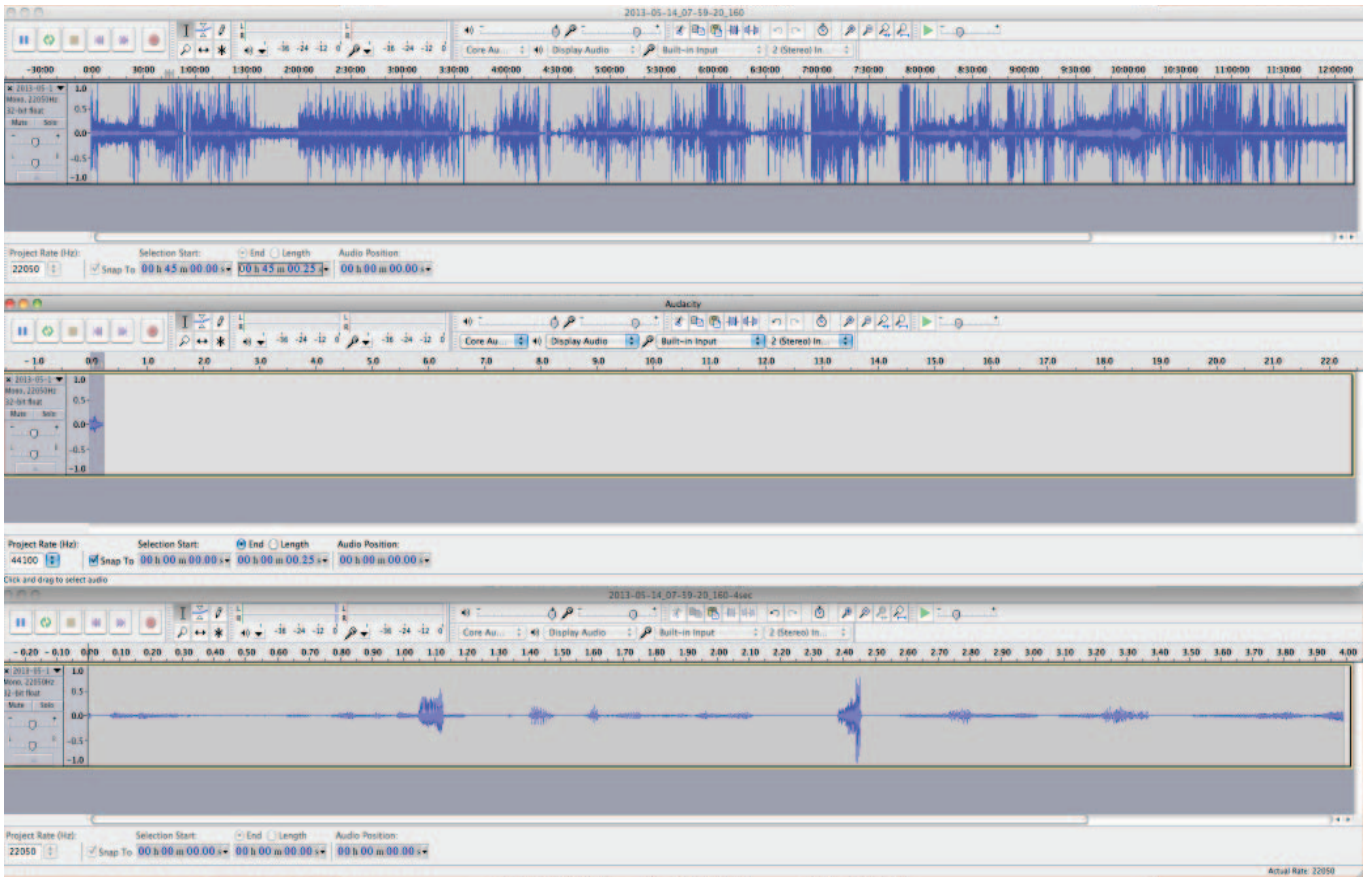


Figure 19. Ambient recording in *Audacity 2.0.3*.

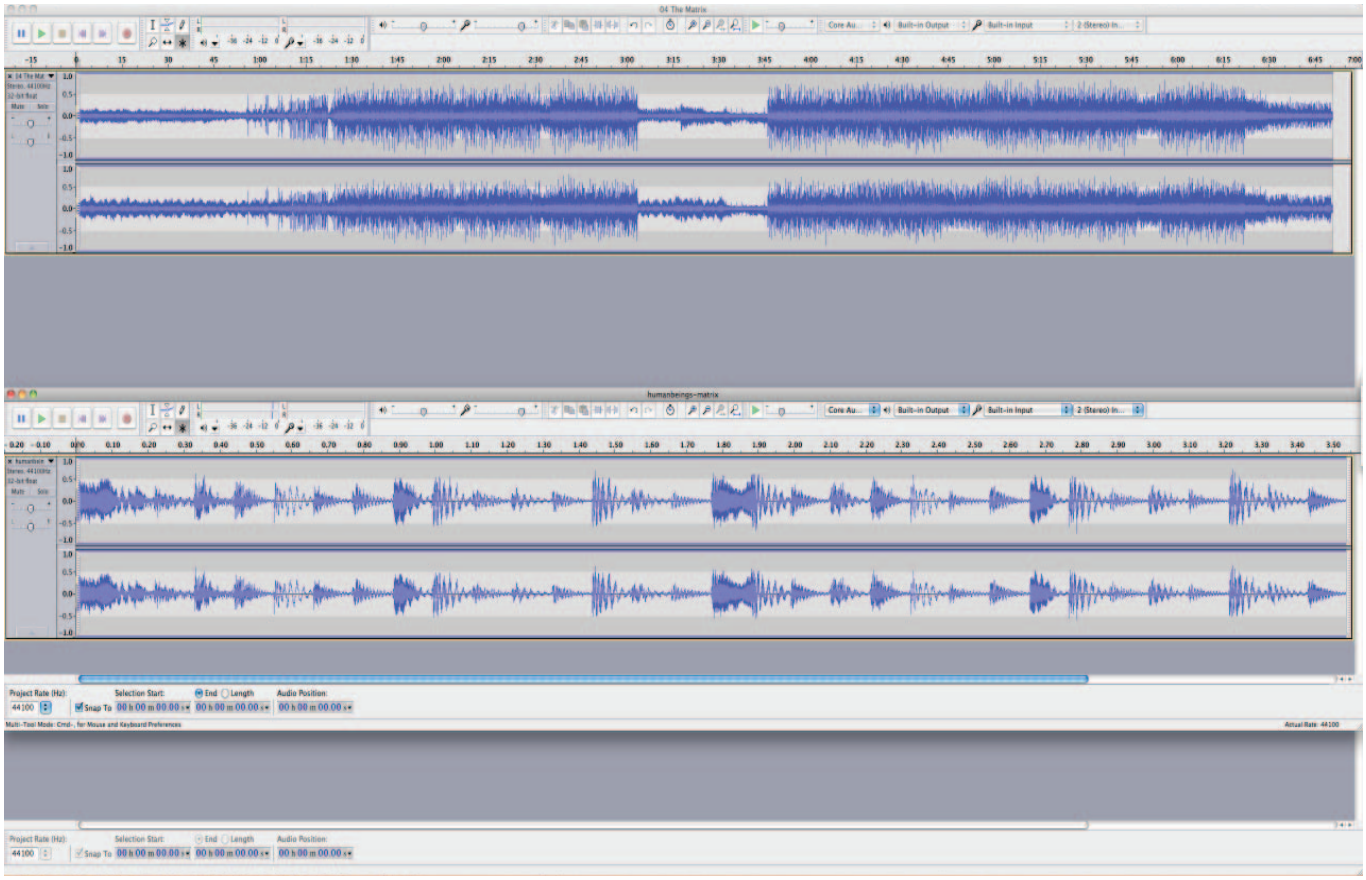


Figure 20. Disco loop *The Matrix*, in *Audacity 2.0.3*.

Analysing

To be able to analyse the digital audio files I had to investigate possible software that could simultaneously play and analyse these. A digital audio file is information, just like any other file found online or on the hard drive of a computer. My aim was to have this information surfaced in such a way that it could be used as input into another information system. No standard commercial applications can operate these functions, and as such I looked into open source object-oriented programming software.

The first steps into analysing and visualising my sound selection were made with the object-oriented programming tools *Max MSP* (Figure 21), and 3D software *Rhino* and *Grasshopper* (Figure 22).

The patch that was made in *Max MSP* opened and played an AIFF audio file. It directly analysed the playing audio file, reading its sound spectrum and processing this information in real time. This information stream was 'printed' to one of the computer ports and read by the *Grasshopper* software.

The object-oriented programming kit *Grasshopper* is an extension of the 3D software *Rhino*. It allows the user to process strings of data to generate points in a virtual 3D *Rhino* environment. This means that an intercepted data stream that is being ported from *Max* can be deciphered in *Grasshopper* which distributes this information as visible points in a 3D environment.

In order to make this visible, I needed to create static fundamentals so I could see the variables change. This was not done by drawing shapes, but by using mathematical descriptors that defined the place of the static points. Other

mathematical objects defined the behavioural change of these points. This was driven by the audio data from *Max MSP*.

In real time this meant that I could see a solid ring change into a dancing 'blob'. This made my first attempt a successful one. However due to technical setbacks and problems that arose while making STL[24] files (that were supposed to be a read by the 3D printer), the software *Max, Rhino and Grasshopper* combination was abandoned. As a consequence an alternative way of analysing and visualising was chosen.

To set up a design process for change and to work within a transmodular framework, I needed to define effective parameters. It was not about drawing, but about actions that defined the drawing process. This was a new way for me of approaching a design project.[25]

On contemporary devices users are accustomed to tapping or clicking a [play] icon and a sound will start to play. However constructing functionality in the patch from scratch, (although based on open source software) made me realise that the systematic approach that is needed to handle a seemingly simple task like 'play a sound' is a very complex one.[26] My object-oriented coding skills were comparatively poor and I relied on my secondary supervisor James Charlton, to help me to build these environments.

In this first trajectory we cocreated a complete dynamic system in which parameters defined all sculpting properties. This redefined a conventional design approach in which processes and intersections drove the final outcome. This suggested a very different role for the designer. Here the designer became more of an orchestrator who was part of a dynamic system. The activities were driven by knowledge and intuition (Maturana, 1970). The design iterations were loops that flowed in continuous circular play between the makers, variables within the analysed data, and the parameters that defined the visualisation of the invisible.

24. Standard Tessellation Language

25. It sometimes seemed more like leading groups of designers than creating shapes and making informed aesthetical choices. As Masten and Reed (2002) note, such approaches position the designer closer to organisational change management, positive coping and adaptation. Here, the designer is engaged in bounce back mechanisms and he thrives on positive adjustment to change (pp. 74–88).

26. One has to address all actions in the correct order and, by dragging and dropping prefabricated code objects (arguments, messages, attributes and variables) one creates working relationships between the elements. This makes one realise that behind a systemic user flow, complex systematic activities operate.

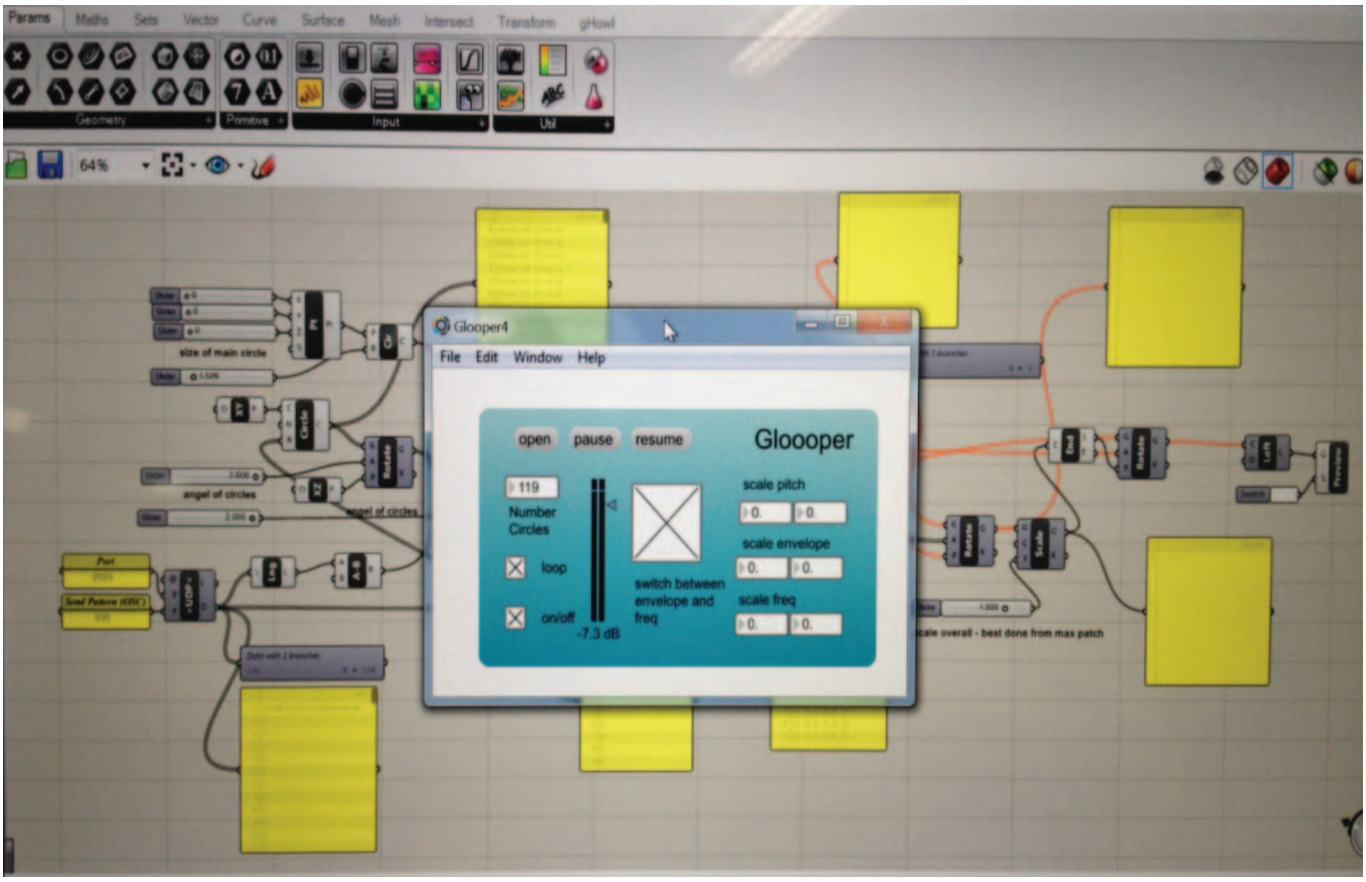


Figure 21. *Max MSP* and *Grasshopper* environment.

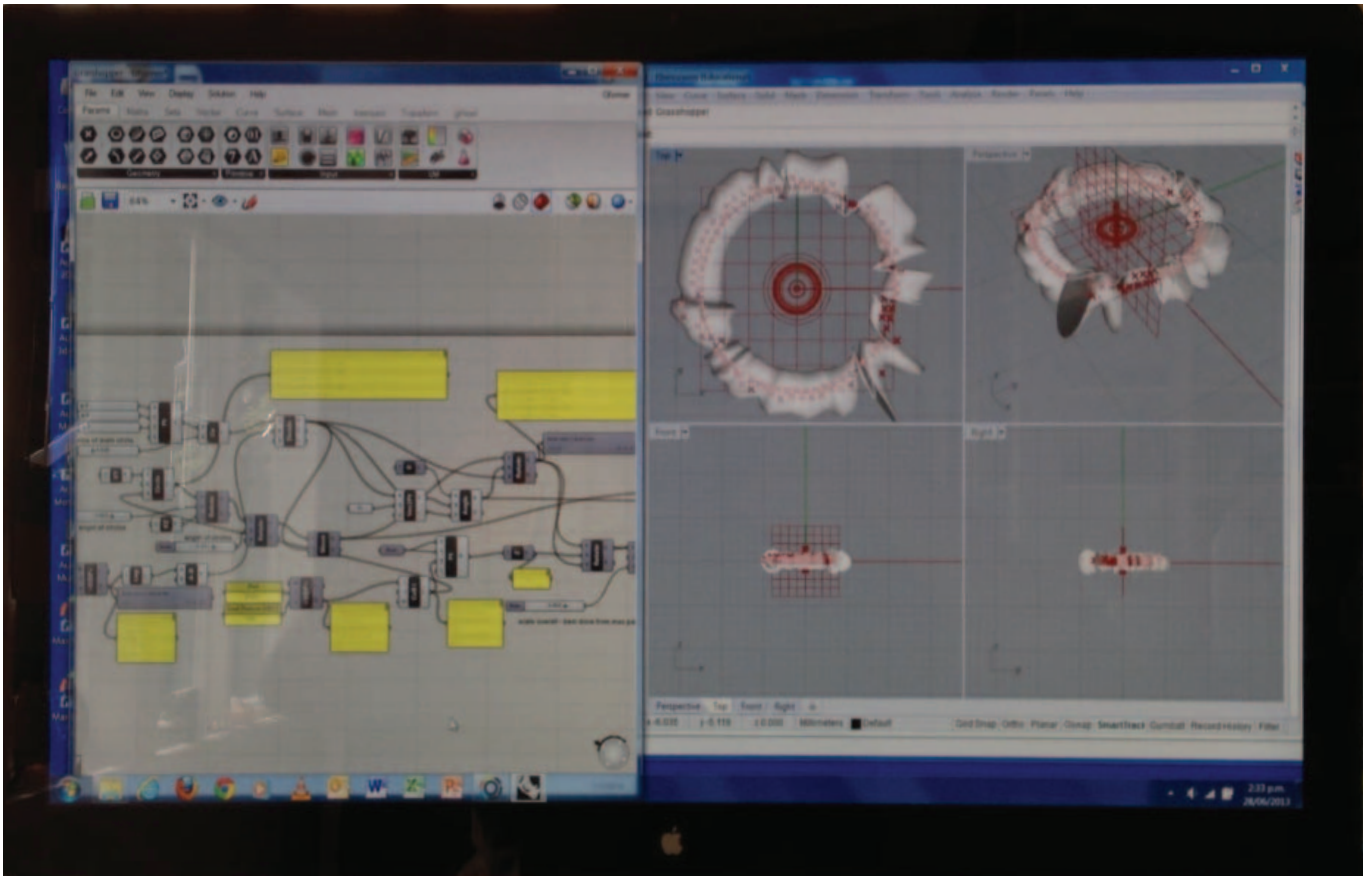


Figure 22. *Grasshopper* and *Rhino* environment.

In collaboration with Stefan Marks a new approach to analysing and visualising of audio was developed. This time the analysing software was written especially for this research in *Processing*. *Processing* is an open source programming tool based on the *Java* programming language. Knowledge of the previous analysing trajectory informed this new development. The tasks of the application were systematically ordered: record audio, than analyse the audio spectrum (Figures 23 and 24) and finally print a data sheet of the spectrum analysis (Figure 25).

While playing an audio file in *Smart Beat Detector* the application actually records the audio file. It records the amplitude over time in decibels per second. Simultaneously it transforms the amplitude into the amplitude of a certain frequency using Fast Fourier Transform[27]. It cuts the spectrum into equally distant pieces, logarithmically averaging the information to prevent a gliding scale.[28]

With the audio signal being captured at 44100 kHz, a FFT frequency analysis ranging from 20kHz down to 20Hz requires a window[29] size of 2048 samples, resulting in a maximum analysis rate of 20Hz. To achieve a higher analysis rate of 200Hz, a sliding buffer window technique was implemented. Within each buffer iteration (smaller than 0.05 second) the audio was filtered through the so called Hamming Window. This resulted in more definition to prevent 'leakage' from the sinusoide, while being transformed from one continuous line into its spectrum pieces.[30] It articulates the sound experience. It smoothes the truncated auto-covariance function in the time domain. This is also known as an apodisation, 'removing the foot'. In other words, it smoothes discontinuities at the beginning and end of the sampled signal or tapering function.

From a non-looped sound recording the final feature of *Smart Beat Detector* saves the string of the syntax, the whole spectrum analysis, into a Comma-Separated Values (CSV) file. This dump has a time stamp and a list of 64 frequencies intensities for that time (see Figure 25).

Smart Beat Detector has seen many versions during my time of working with the software. In the second version the loop function was added, which made it an effective playback tool for the disco loops (because there is no hearable 'gap' between head and tail of any sample). The visual feedback of the sinusoide, and the separated spectrum elements makes it into an aesthetically potent environment (Pask, 1971).

This novel audio-visual music experience not only created data for further implementation, the activity also transformed into a autotelic (Csíkszentmihályi, 1997).

27. The Discrete Fourier Transform (DFT) transforms a finite string of equally spaced samples of a function into a string of coefficients of a finite combination of sinusoids, in order of their frequencies from the same sample values. A Fast Fourier Transform (FFT) is an algorithm that promptly calculates these DFT conversions (Strang, 1994).

28. This is what causes equal spaces (see Figures 23 and 24).

29. This is not a GUI window or a metaphorical window. In signal processing, a window function is a mathematical function that is zero-valued outside a defined interval. (Weisstein, 2003)

30. In Photoshop terms it works like 'unsharp mask'.

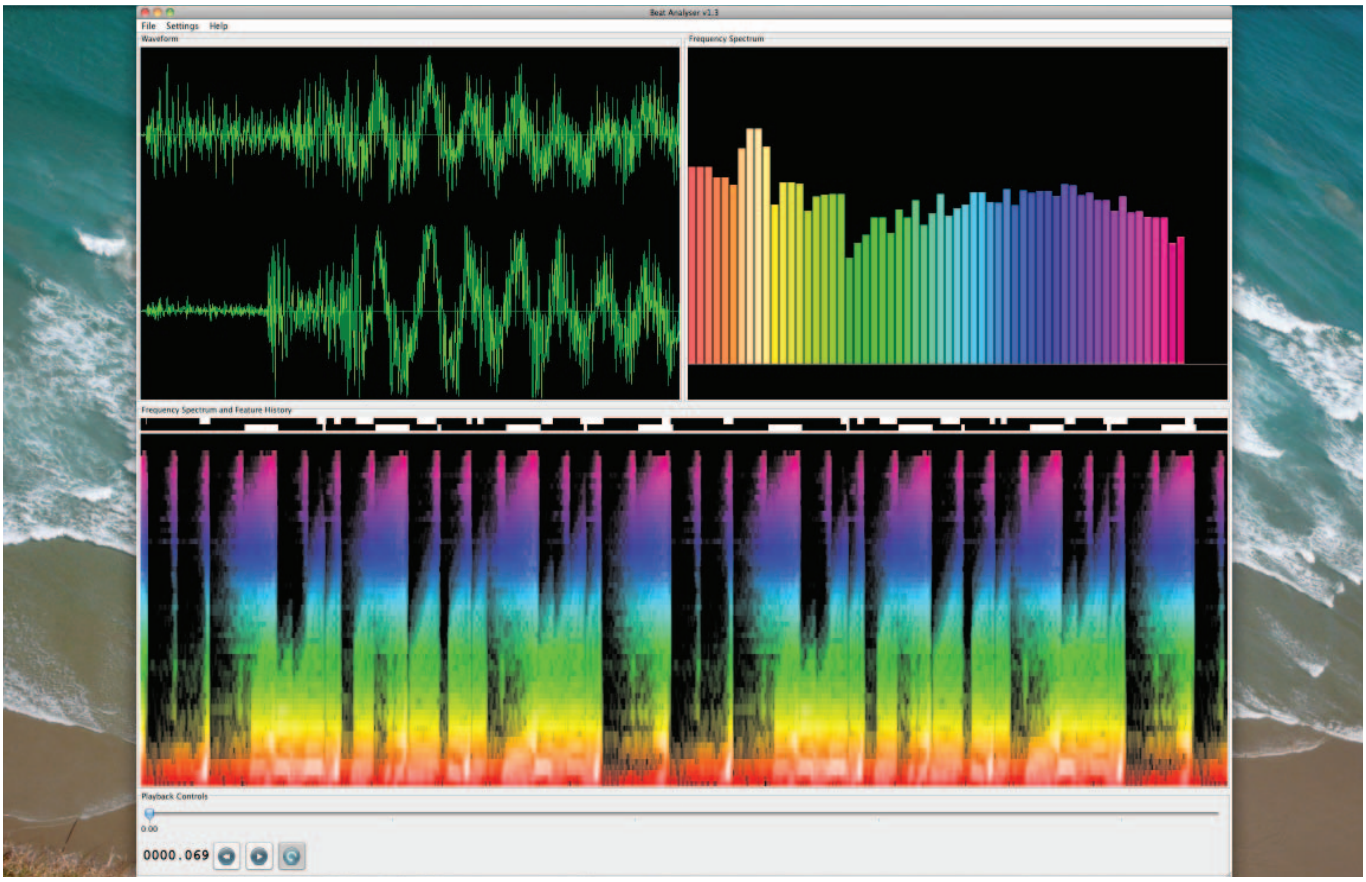


Figure 23. *Smart Beat Detector* GUI processing disco loop.

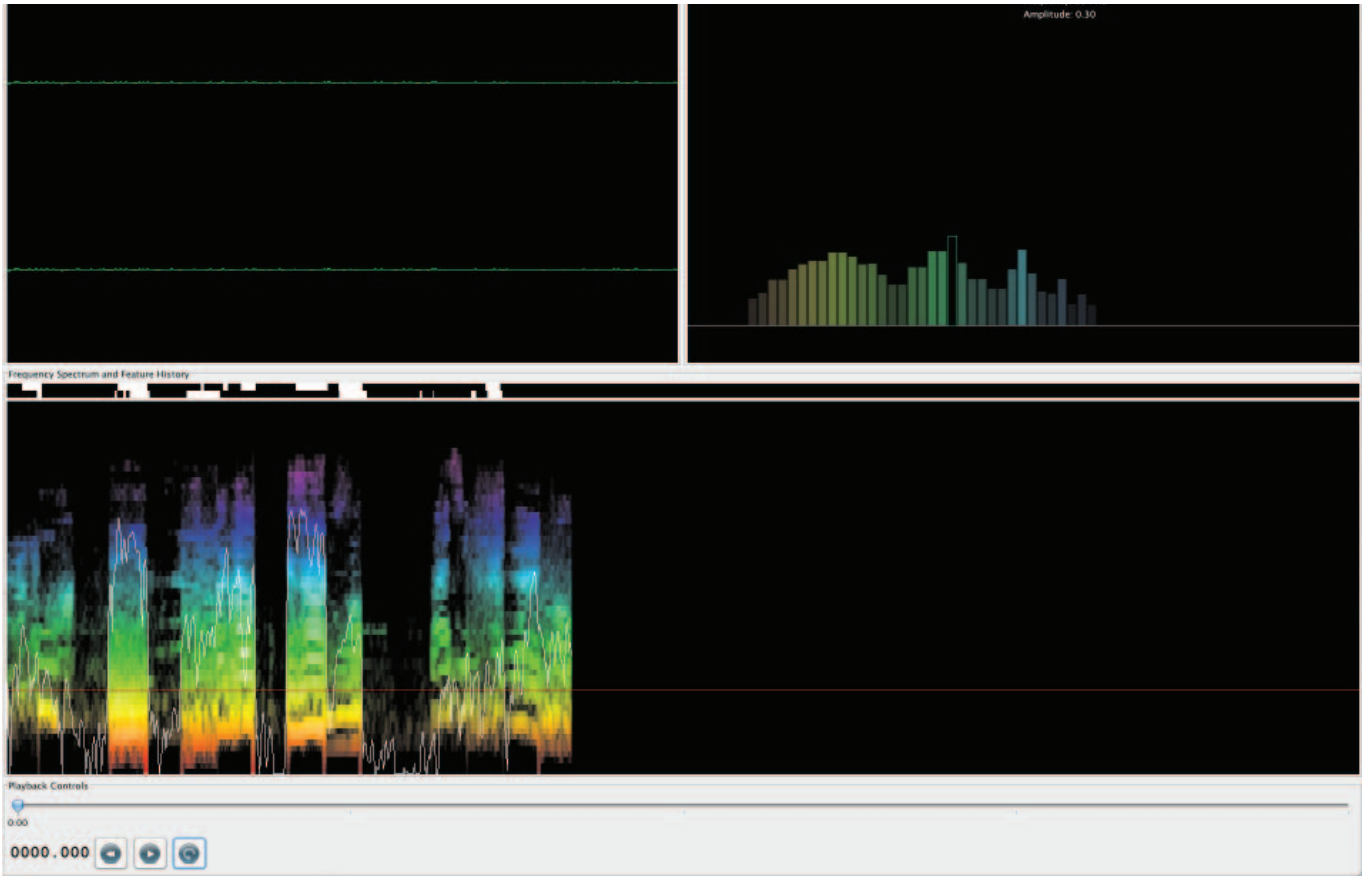


Figure 24. *Smart Beat Detector* GUI processing ambient sound.

time	11Hz	32Hz	54Hz	75Hz	97Hz	118Hz	140Hz	161Hz	183Hz	205Hz	226Hz	248Hz
0.000	0.551	0.575	0.575	0.637	0.642	0.642	0.513	0.573	0.600	0.600	0.517	0.502
0.005	0.516	0.571	0.571	0.616	0.616	0.615	0.440	0.573	0.595	0.595	0.514	0.514
0.010	0.461	0.566	0.566	0.597	0.597	0.591	0.469	0.561	0.575	0.575	0.491	0.514
0.015	0.415	0.552	0.552	0.572	0.580	0.580	0.445	0.547	0.547	0.535	0.452	0.504
0.020	0.417	0.549	0.549	0.539	0.569	0.569	0.477	0.518	0.518	0.482	0.366	0.487
0.025	0.446	0.557	0.557	0.519	0.552	0.552	0.493	0.497	0.497	0.382	0.375	0.480
0.030	0.474	0.560	0.560	0.486	0.527	0.527	0.462	0.497	0.497	0.373	0.419	0.491
0.035	0.478	0.559	0.559	0.468	0.497	0.497	0.474	0.510	0.510	0.438	0.426	0.498
0.040	0.466	0.560	0.560	0.468	0.490	0.490	0.421	0.529	0.529	0.512	0.466	0.503
0.045	0.456	0.562	0.562	0.499	0.509	0.509	0.412	0.542	0.547	0.547	0.478	0.501
0.050	0.457	0.558	0.558	0.527	0.532	0.532	0.459	0.552	0.559	0.559	0.458	0.501
0.055	0.460	0.555	0.555	0.537	0.544	0.544	0.461	0.560	0.560	0.549	0.420	0.495
0.060	0.456	0.559	0.559	0.546	0.546	0.535	0.459	0.556	0.556	0.535	0.370	0.489
0.065	0.458	0.560	0.560	0.554	0.554	0.517	0.395	0.548	0.548	0.522	0.254	0.483
0.070	0.456	0.565	0.565	0.555	0.555	0.523	0.410	0.536	0.536	0.509	0.384	0.483
0.075	0.471	0.581	0.581	0.555	0.560	0.560	0.463	0.522	0.522	0.477	0.416	0.483
0.080	0.473	0.612	0.612	0.576	0.588	0.588	0.490	0.521	0.521	0.442	0.442	0.477
0.085	0.527	0.646	0.646	0.604	0.604	0.587	0.517	0.524	0.524	0.475	0.475	0.486
0.090	0.568	0.680	0.680	0.663	0.602	0.567	0.522	0.526	0.526	0.506	0.497	0.508
0.095	0.605	0.709	0.709	0.699	0.563	0.544	0.507	0.529	0.536	0.536	0.502	0.534
0.100	0.627	0.730	0.730	0.713	0.535	0.521	0.493	0.531	0.533	0.533	0.508	0.550
0.105	0.639	0.740	0.740	0.710	0.567	0.516	0.457	0.531	0.531	0.503	0.477	0.550
0.110	0.638	0.741	0.741	0.697	0.558	0.545	0.395	0.535	0.535	0.445	0.430	0.522
0.115	0.625	0.733	0.733	0.684	0.569	0.569	0.474	0.546	0.546	0.434	0.404	0.468
0.119	0.604	0.720	0.720	0.678	0.578	0.578	0.503	0.558	0.558	0.493	0.412	0.408
0.124	0.582	0.704	0.704	0.669	0.569	0.569	0.508	0.564	0.564	0.536	0.440	0.372
0.129	0.563	0.690	0.690	0.643	0.577	0.558	0.478	0.555	0.570	0.570	0.450	0.422
0.134	0.552	0.676	0.676	0.612	0.553	0.553	0.395	0.551	0.578	0.578	0.490	0.474
0.139	0.548	0.660	0.660	0.612	0.550	0.550	0.456	0.553	0.566	0.566	0.508	0.511
0.144	0.529	0.642	0.642	0.620	0.568	0.548	0.506	0.554	0.554	0.526	0.500	0.528
0.149	0.510	0.622	0.622	0.600	0.568	0.534	0.509	0.543	0.543	0.471	0.471	0.532
0.154	0.484	0.603	0.603	0.543	0.543	0.495	0.475	0.528	0.528	0.437	0.437	0.520
0.159	0.471	0.578	0.578	0.511	0.511	0.451	0.451	0.521	0.521	0.466	0.395	0.498
0.165	0.443	0.548	0.548	0.524	0.511	0.452	0.413	0.525	0.525	0.508	0.380	0.483
0.170	0.422	0.511	0.536	0.536	0.524	0.477	0.450	0.539	0.539	0.521	0.359	0.473
0.175	0.378	0.471	0.506	0.526	0.526	0.462	0.435	0.549	0.549	0.529	0.274	0.465
0.180	0.373	0.404	0.426	0.518	0.518	0.419	0.418	0.554	0.554	0.520	0.404	0.466
0.185	0.365	0.365	0.387	0.522	0.522	0.500	0.504	0.545	0.545	0.481	0.471	0.464
0.190	0.379	0.424	0.465	0.553	0.581	0.581	0.562	0.556	0.514	0.495	0.508	0.508
0.195	0.418	0.482	0.507	0.569	0.624	0.624	0.620	0.560	0.469	0.502	0.541	0.541
0.200	0.439	0.518	0.522	0.551	0.642	0.656	0.656	0.560	0.488	0.488	0.543	0.543
0.205	0.452	0.535	0.535	0.509	0.641	0.669	0.669	0.593	0.531	0.531	0.526	0.570
0.209	0.445	0.542	0.542	0.466	0.624	0.663	0.663	0.612	0.566	0.547	0.496	0.572
0.214	0.430	0.543	0.543	0.445	0.595	0.643	0.643	0.598	0.581	0.560	0.438	0.560
0.219	0.402	0.547	0.547	0.494	0.546	0.612	0.612	0.575	0.575	0.572	0.453	0.536
0.224	0.408	0.554	0.554	0.533	0.519	0.588	0.588	0.559	0.572	0.572	0.476	0.507
0.229	0.441	0.563	0.563	0.550	0.550	0.590	0.590	0.563	0.550	0.540	0.501	0.471
0.234	0.473	0.572	0.572	0.555	0.590	0.608	0.608	0.563	0.548	0.511	0.511	0.448
0.239	0.477	0.583	0.583	0.558	0.626	0.626	0.620	0.544	0.544	0.511	0.511	0.394
0.244	0.477	0.586	0.586	0.571	0.630	0.630	0.617	0.543	0.543	0.511	0.511	0.405
0.249	0.477	0.586	0.586	0.575	0.609	0.609	0.593	0.552	0.554	0.554	0.508	0.428
0.254	0.478	0.587	0.587	0.560	0.560	0.558	0.553	0.561	0.561	0.557	0.493	0.420
0.260	0.481	0.590	0.590	0.527	0.527	0.500	0.515	0.562	0.562	0.533	0.454	0.389
0.265	0.486	0.590	0.590	0.491	0.487	0.474	0.474	0.551	0.551	0.501	0.396	0.361
0.270	0.491	0.587	0.587	0.544	0.452	0.500	0.500	0.542	0.542	0.494	0.374	0.374
0.275	0.485	0.587	0.587	0.554	0.438	0.510	0.510	0.545	0.545	0.503	0.382	0.382
0.280	0.482	0.586	0.586	0.530	0.446	0.510	0.510	0.549	0.549	0.498	0.372	0.384
0.285	0.479	0.585	0.585	0.483	0.483	0.496	0.496	0.547	0.547	0.487	0.314	0.392
0.290	0.474	0.584	0.584	0.504	0.496	0.496	0.459	0.539	0.539	0.496	0.354	0.399
0.295	0.402	0.594	0.594	0.559	0.482	0.482	0.401	0.548	0.548	0.491	0.431	0.460

7924Hz	8613Hz	9302Hz	9991Hz	10680Hz	11714Hz	13092Hz	14470Hz	15848Hz	17227Hz	18605Hz	19983Hz	21361Hz
0.357	0.378	0.305	0.250	0.267	0.305	0.226	0.200	0.129	0.129	0.180	0.119	0.000
0.366	0.364	0.295	0.240	0.263	0.285	0.220	0.181	0.111	0.113	0.139	0.105	0.000
0.357	0.348	0.271	0.223	0.240	0.268	0.207	0.168	0.083	0.097	0.111	0.092	0.000
0.330	0.350	0.245	0.218	0.233	0.269	0.187	0.139	0.058	0.082	0.079	0.090	0.000
0.319	0.327	0.224	0.214	0.214	0.260	0.182	0.119	0.056	0.061	0.070	0.077	0.000
0.303	0.282	0.216	0.208	0.176	0.250	0.161	0.111	0.030	0.022	0.055	0.047	0.000
0.272	0.226	0.226	0.198	0.146	0.234	0.123	0.098	0.046	0.002	0.046	0.009	0.000
0.242	0.207	0.212	0.188	0.120	0.229	0.063	0.064	0.039	0.000	0.050	0.000	0.000
0.241	0.177	0.184	0.169	0.108	0.220	0.032	0.050	0.002	0.000	0.033	0.000	0.000
0.231	0.149	0.184	0.130	0.088	0.201	0.033	0.051	0.000	0.000	0.005	0.000	0.000
0.211	0.167	0.189	0.076	0.071	0.168	0.025	0.053	0.000	0.000	0.000	0.000	0.000
0.175	0.150	0.172	0.034	0.068	0.135	0.009	0.040	0.000	0.000	0.000	0.000	0.000
0.173	0.151	0.141	0.000	0.057	0.128	0.000	0.017	0.000	0.000	0.000	0.000	0.000
0.169	0.159	0.105	0.000	0.054	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.184	0.158	0.050	0.000	0.057	0.123	0.004	0.015	0.000	0.000	0.000	0.000	0.000
0.211	0.165	0.117	0.048	0.075	0.160	0.057	0.050	0.000	0.000	0.000	0.000	0.000
0.239	0.214	0.205	0.104	0.125	0.185	0.128	0.072	0.006	0.000	0.000	0.000	0.000
0.289	0.261	0.246	0.163	0.160	0.198	0.170	0.113	0.030	0.000	0.000	0.000	0.000
0.311	0.283	0.254	0.202	0.185	0.211	0.187	0.136	0.040	0.000	0.000	0.000	0.000
0.315	0.287	0.257	0.218	0.189	0.214	0.179	0.135	0.029	0.000	0.000	0.000	0.000
0.294	0.275	0.252	0.212	0.180	0.200	0.151	0.105	0.000	0.000	0.000	0.000	0.000
0.284	0.284	0.251	0.211	0.181	0.163	0.113	0.077	0.000	0.000	0.000	0.000	0.000
0.270	0.292	0.254	0.204	0.190	0.157	0.101	0.050	0.000	0.000	0.000	0.000	0.000
0.240	0.268	0.241	0.180	0.173	0.143	0.094	0.041	0.000	0.000	0.000	0.000	0.000
0.238	0.220	0.205	0.151	0.145	0.112	0.078	0.031	0.000	0.000	0.000	0.000	0.000
0.254	0.207	0.167	0.116	0.119	0.096	0.069	0.047	0.000	0.000	0.000	0.000	0.000
0.242	0.184	0.173	0.088	0.076	0.060	0.039	0.033	0.000	0.000	0.000	0.000	0.000
0.220	0.188	0.170	0.049	0.059	0.064	0.011	0.000	0.000	0.000	0.000	0.000	0.000
0.217	0.191	0.144	0.048	0.043	0.065	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.215	0.196	0.097	0.034	0.025	0.053	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.200	0.197	0.048	0.007	0.009	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.173	0.193	0.020	0.000	0.000	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.155	0.189	0.000	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.153	0.180	0.024	0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.149	0.168	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.172	0.156	0.046	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.201	0.139	0.077	0.000	0.000	0.021	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.231	0.145	0.135	0.070	0.068	0.094	0.044	0.000	0.036	0.000	0.000	0.000	0.000
0.267	0.196	0.232	0.170	0.170	0.161	0.146	0.106	0.129	0.029	0.000	0.000	0.000
0.293	0.244	0.294	0.233	0.231	0.223	0.206	0.179	0.189	0.106	0.041	0.009	0.000
0.322	0.274	0.326	0.275	0.264	0.257	0.234	0.215	0.224	0.153	0.071	0.030	0.000
0.353	0.296	0.333	0.295	0.272	0.268	0.235	0.231	0.237	0.173	0.084	0.048	0.000
0.363	0.294	0.324	0.298	0.264	0.258	0.225	0.225	0.228	0.171	0.079	0.046	0.000
0.355	0.290	0.309	0.269	0.234	0.224	0.217	0.215	0.197	0.146	0.064	0.037	0.000
0.329	0.274	0.303	0.246	0.228	0.227	0.199	0.195	0.150	0.098	0.055	0.017	0.000
0.308	0.269	0.290	0.239	0.219	0.214	0.174	0.152	0.122	0.030	0.028	0.000	0.000
0.312	0.296	0.282	0.227	0.202	0.180	0.134	0.096	0.076	0.000	0.007	0.000	0.000
0.291	0.303	0.290	0.228	0.200	0.171	0.091	0.047	0.020	0.000	0.000	0.000	0.000
0.278	0.288	0.284	0.208	0.171	0.157	0.081	0.025	0.000	0.000	0.000	0.000	0.000
0.260	0.256	0.258	0.174	0.160	0.122	0.070	0.000	0.000	0.000	0.000	0.000	0.000
0.246	0.244	0.212	0.137	0.132	0.103	0.062	0.001	0.000	0.000	0.000	0.000	0.000
0.236	0.220	0.195	0.117	0.105	0.085	0.052	0.000	0.000	0.000	0.000	0.000	0.000
0.220	0.183	0.179	0.084	0.064	0.057	0.014	0.000	0.000	0.000	0.000	0.000	0.000
0.217	0.148	0.161	0.059	0.028	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.230	0.128	0.113	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.234	0.142	0.093	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.233	0.139	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.227	0.116	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.220	0.131	0.089	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.222	0.159	0.130	0.088	0.036	0.094	0.000	0.013	0.061	0.040	0.000	0.000	0.000

3.287	0.540	0.546	0.660	0.660	0.589	0.589	0.512	0.562	0.562	0.490	0.343	0.343
3.292	0.562	0.562	0.666	0.666	0.655	0.620	0.579	0.582	0.582	0.481	0.317	0.389
3.297	0.572	0.596	0.687	0.687	0.675	0.629	0.609	0.599	0.598	0.455	0.367	0.434
3.302	0.572	0.662	0.711	0.711	0.656	0.621	0.611	0.611	0.611	0.482	0.417	0.446
3.307	0.559	0.691	0.725	0.725	0.612	0.599	0.595	0.621	0.621	0.528	0.436	0.436
3.312	0.530	0.699	0.727	0.727	0.602	0.580	0.580	0.626	0.626	0.549	0.454	0.454
3.317	0.490	0.694	0.722	0.722	0.610	0.574	0.574	0.623	0.623	0.555	0.449	0.449
3.323	0.438	0.680	0.717	0.717	0.581	0.581	0.567	0.619	0.619	0.553	0.435	0.435
3.328	0.315	0.669	0.710	0.710	0.578	0.578	0.561	0.616	0.616	0.544	0.427	0.427
3.333	0.361	0.663	0.700	0.700	0.589	0.559	0.555	0.606	0.606	0.529	0.430	0.430
3.338	0.422	0.657	0.692	0.692	0.581	0.559	0.543	0.594	0.594	0.510	0.425	0.425
3.343	0.407	0.650	0.684	0.684	0.558	0.558	0.531	0.587	0.587	0.497	0.420	0.420
3.348	0.386	0.641	0.672	0.672	0.533	0.533	0.518	0.577	0.577	0.489	0.411	0.411
3.353	0.383	0.632	0.661	0.661	0.550	0.512	0.504	0.565	0.565	0.474	0.404	0.404
3.358	0.400	0.620	0.651	0.651	0.516	0.514	0.504	0.548	0.548	0.465	0.395	0.395
3.363	0.359	0.607	0.640	0.640	0.498	0.498	0.475	0.535	0.535	0.449	0.389	0.389
3.367	0.314	0.596	0.627	0.627	0.499	0.465	0.451	0.516	0.516	0.419	0.388	0.388
3.372	0.328	0.584	0.617	0.617	0.494	0.462	0.441	0.492	0.492	0.382	0.377	0.377
3.377	0.323	0.574	0.607	0.607	0.462	0.462	0.443	0.471	0.471	0.362	0.362	0.362
3.382	0.324	0.563	0.596	0.596	0.455	0.439	0.439	0.457	0.457	0.353	0.344	0.344
3.387	0.264	0.553	0.585	0.585	0.466	0.427	0.421	0.441	0.441	0.343	0.327	0.327
3.392	0.254	0.545	0.575	0.575	0.439	0.439	0.413	0.423	0.423	0.347	0.307	0.307
3.397	0.284	0.542	0.562	0.562	0.424	0.447	0.447	0.439	0.439	0.323	0.323	0.315
3.402	0.242	0.543	0.565	0.565	0.470	0.511	0.511	0.480	0.480	0.419	0.419	0.434
3.407	0.323	0.545	0.585	0.585	0.552	0.567	0.567	0.529	0.498	0.483	0.499	0.520
3.412	0.357	0.551	0.594	0.594	0.599	0.607	0.607	0.556	0.496	0.510	0.557	0.574
3.417	0.383	0.555	0.588	0.588	0.626	0.631	0.631	0.543	0.480	0.506	0.587	0.604
3.422	0.381	0.547	0.575	0.575	0.639	0.639	0.636	0.498	0.441	0.471	0.595	0.613
3.427	0.362	0.528	0.553	0.553	0.639	0.639	0.629	0.442	0.362	0.428	0.585	0.605
3.432	0.328	0.502	0.518	0.518	0.628	0.628	0.618	0.416	0.316	0.422	0.559	0.580
3.437	0.276	0.472	0.499	0.499	0.620	0.620	0.608	0.368	0.368	0.416	0.521	0.541
3.442	0.281	0.448	0.503	0.503	0.616	0.616	0.600	0.367	0.367	0.395	0.460	0.489
3.447	0.254	0.450	0.488	0.488	0.609	0.609	0.594	0.416	0.316	0.371	0.371	0.422
3.452	0.260	0.449	0.471	0.487	0.600	0.600	0.587	0.400	0.322	0.355	0.355	0.374
3.457	0.259	0.436	0.477	0.477	0.594	0.594	0.576	0.339	0.339	0.314	0.370	0.374
3.462	0.219	0.427	0.471	0.471	0.584	0.584	0.565	0.340	0.287	0.294	0.396	0.396
3.467	0.214	0.424	0.446	0.446	0.571	0.571	0.555	0.369	0.236	0.289	0.396	0.396
3.472	0.210	0.413	0.440	0.443	0.560	0.560	0.544	0.334	0.274	0.278	0.385	0.385
3.477	0.144	0.394	0.444	0.444	0.551	0.551	0.531	0.278	0.278	0.266	0.363	0.363
3.482	0.067	0.390	0.425	0.425	0.537	0.537	0.519	0.312	0.218	0.241	0.337	0.337

0.235	0.193	0.124	0.212	0.227	0.201	0.122	0.128	0.056	0.048	0.043	0.024	0.000
0.315	0.278	0.225	0.302	0.297	0.266	0.203	0.205	0.143	0.126	0.115	0.103	0.000
0.354	0.324	0.280	0.354	0.348	0.310	0.243	0.252	0.186	0.176	0.157	0.146	0.000
0.364	0.352	0.320	0.374	0.369	0.324	0.275	0.274	0.217	0.210	0.173	0.164	0.005
0.348	0.353	0.334	0.366	0.363	0.313	0.286	0.273	0.229	0.228	0.172	0.156	0.007
0.305	0.328	0.321	0.336	0.329	0.281	0.276	0.259	0.229	0.222	0.162	0.121	0.001
0.247	0.302	0.280	0.280	0.260	0.242	0.242	0.231	0.206	0.191	0.154	0.069	0.000
0.206	0.263	0.214	0.196	0.195	0.199	0.186	0.182	0.155	0.133	0.126	0.048	0.000
0.158	0.199	0.127	0.162	0.111	0.172	0.131	0.135	0.084	0.057	0.074	0.009	0.000
0.103	0.116	0.045	0.102	0.073	0.144	0.082	0.106	0.029	0.004	0.000	0.000	0.000
0.023	0.049	0.000	0.031	0.043	0.124	0.023	0.059	0.000	0.000	0.000	0.000	0.000
0.000	0.022	0.000	0.000	0.026	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.024	0.057	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.013	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.052	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.009	0.000	0.000	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.181	0.117	0.105	0.108	0.059	0.111	0.062	0.051	0.059	0.038	0.019	0.000	0.000
0.266	0.220	0.235	0.217	0.171	0.205	0.153	0.154	0.155	0.123	0.090	0.000	0.000
0.333	0.279	0.311	0.282	0.248	0.256	0.211	0.215	0.221	0.183	0.126	0.062	0.000
0.378	0.312	0.347	0.314	0.300	0.284	0.247	0.251	0.261	0.208	0.155	0.095	0.000
0.399	0.323	0.362	0.328	0.325	0.293	0.270	0.265	0.281	0.206	0.175	0.115	0.000
0.400	0.314	0.352	0.326	0.325	0.287	0.282	0.260	0.280	0.199	0.181	0.119	0.000
0.404	0.314	0.349	0.301	0.301	0.266	0.273	0.252	0.259	0.188	0.175	0.108	0.000
0.384	0.311	0.347	0.288	0.273	0.236	0.244	0.221	0.223	0.168	0.155	0.088	0.000
0.343	0.298	0.343	0.285	0.257	0.243	0.213	0.205	0.177	0.143	0.123	0.045	0.000
0.325	0.326	0.322	0.277	0.251	0.218	0.189	0.170	0.121	0.103	0.073	0.000	0.000
0.306	0.337	0.330	0.274	0.235	0.209	0.166	0.137	0.086	0.056	0.044	0.000	0.000
0.278	0.324	0.327	0.259	0.218	0.202	0.138	0.101	0.039	0.029	0.016	0.000	0.000
0.264	0.286	0.306	0.225	0.208	0.176	0.122	0.057	0.013	0.000	0.003	0.000	0.000
0.270	0.230	0.266	0.192	0.178	0.139	0.105	0.022	0.000	0.000	0.000	0.000	0.000
0.250	0.178	0.225	0.159	0.151	0.136	0.096	0.004	0.000	0.000	0.000	0.000	0.000
0.238	0.176	0.206	0.126	0.120	0.114	0.071	0.000	0.000	0.000	0.000	0.000	0.000
0.212	0.164	0.200	0.111	0.065	0.076	0.029	0.000	0.000	0.000	0.000	0.000	0.000
0.172	0.121	0.162	0.085	0.022	0.030	0.004	0.000	0.000	0.000	0.000	0.000	0.000

Figure 25. Frequency data sheet.

Visualising

The next step in the process of transforming sound involved taking the spectrum analysis CSV file and adding another piece of software. This was developed by Stefan Marks and was called *Music Visualiser*.[31]

In the first iteration of versions *Music Visualiser* would read the CSV file and show the different spectrum values as a distortion of a shape. This shape was a circle wrapped around a circle. It resulted in a doughnut shape, a loop with body. Amplitude, frequency and duration were set in the X, Y and Z dimensions. This resulted in frequency, amplitude spikes in a smooth doughnut shape. With no sound (silence) a perfect round doughnut would be calculated. In this polar coordinate system all relations are circular, opposed to linear.

This was a very simple starting point that caters for dynamic syntax processing. Alongside many views of the sound files in *Smart Beat Detector* in bars and colour renderings I was able to clearly recall the exciting moment the first time a sound file was fossilised. On the screen of my laptop I witnessed four seconds of sound immortalised in a virtual 3D shape. It was also the first time that a sound loop was not shown in a linear way, shooting back and forward between head and tail. Instead it appeared as a circular form, as an actual loop.

The taurus and the radius of the loop can be effected through changes in the sliders in the GUI, as well as the amount of distortion—etching or extruding—and the amount of spectrum revolutions around the main circle. The latter gives the sound fossil a 'twirly'

31 It is also written in *Processing*, which makes the cross platform practice easy.

character. The view could be either points or surface rendered. The last button allowed the user to save the shape in a STL format, ready to be 3D printed.

To be able to print these shapes into 3D objects they had to be rendered from an X-Y-Z dimensional 3D doughnut to an X-Y-Z axis Cartesian space. This process of vertex triangulation, defines a 'normal' by an unambiguous definition of a plane by three points. Every triangle in this context is saved in a huge STL file (Figure 31). Throughout this method one loses information, just like digitising sound or the FFT articulation, but the user does not loose track of the sound, which is the essence of mapping.

Throughout the design process *Music Visualiser* underwent many changes and improvements and the final version actually had *Smart Beat Detector* embedded. This allowed the user to choose a variety of shapes, like spheres and cylinders. It catered for mappings, including transparencies. But the biggest change was the possibility to play sound continuously. This means it was capable of showing the spectrum analysis in an instant visual feedback. This function transformed this tool into another 'aesthetically potent environment', another 'autotelic'.

Throughout the process of visualising I was mostly interested in systems that generated the outcomes. The manual influence effecting the visual appearance of the sound file seemed to contradict this approach. Too many possible options drew me back to a way of making that is closer to the conventional way of designing that I wanted to avoid in this new approach to generative design. Therefore I kept the main doughnut shape, in a ration of 1/10. I set the ring multiplier to its maximum to accent the changes in frequencies and I used eight revolutions to remove the harsh and rocky spikes. This tackled the practical problem of undercut that was essential in the materialisation process of the sound fossils.

The concept of designing the design tools enables learning through exploration from the ground up. The design results can actually inform a change in the program that one is designing with. This is a very important design feedback loop that caters for a nonlinear design research method that is mainly about looping of the entire process of making. It made me realise the strength of the second order cybernetics idea of circularity (Glanville, 2004) and how the maker, the system and the outcomes are continuously looping, effecting one another within a circular controlled environment.

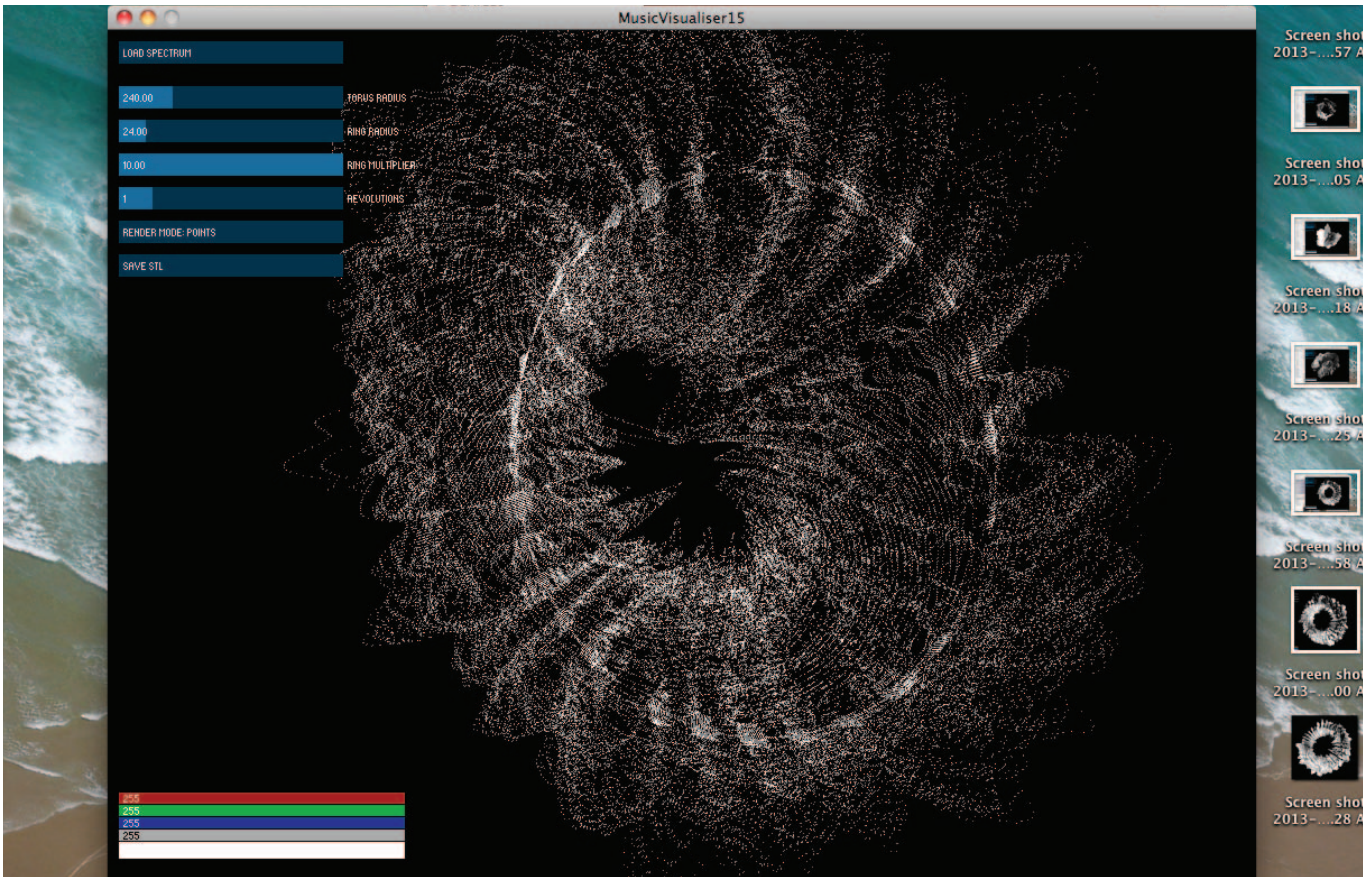


Figure 26. *Music Visualiser* points rendered loop.

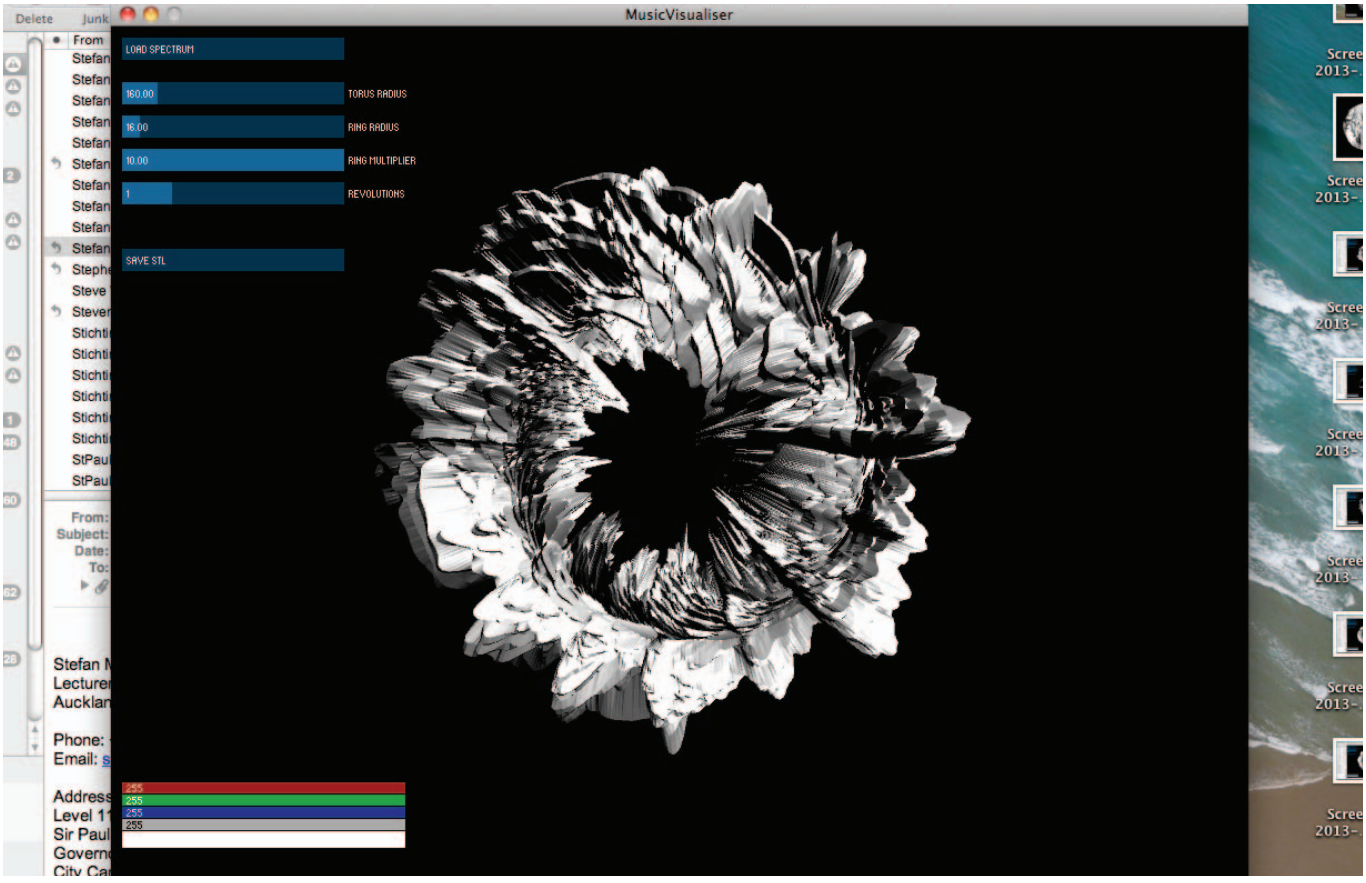


Figure 27. *Music Visualiser* surface rendered loop.

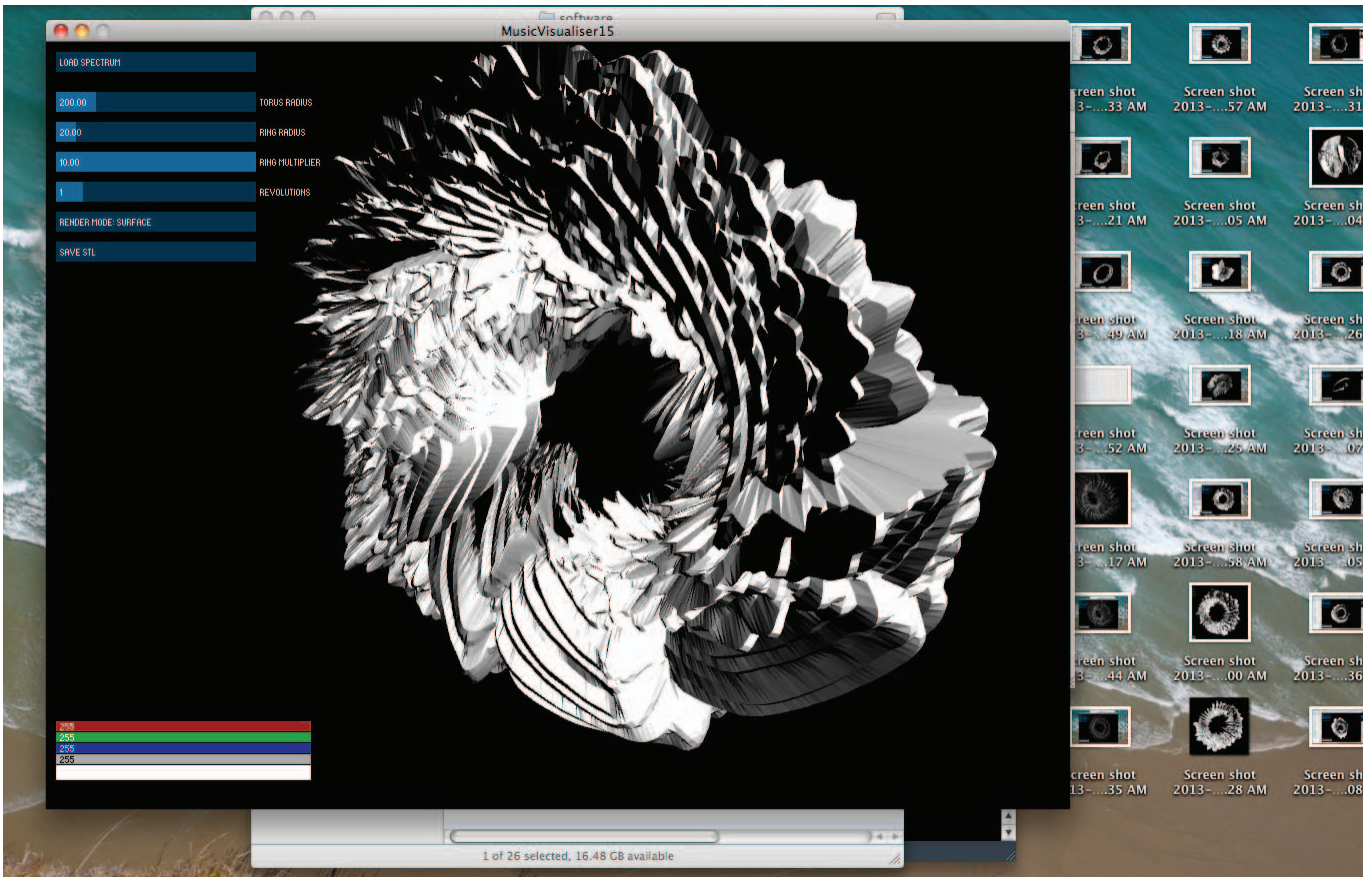


Figure 28. *Music Visualiser* surface rendered loop.

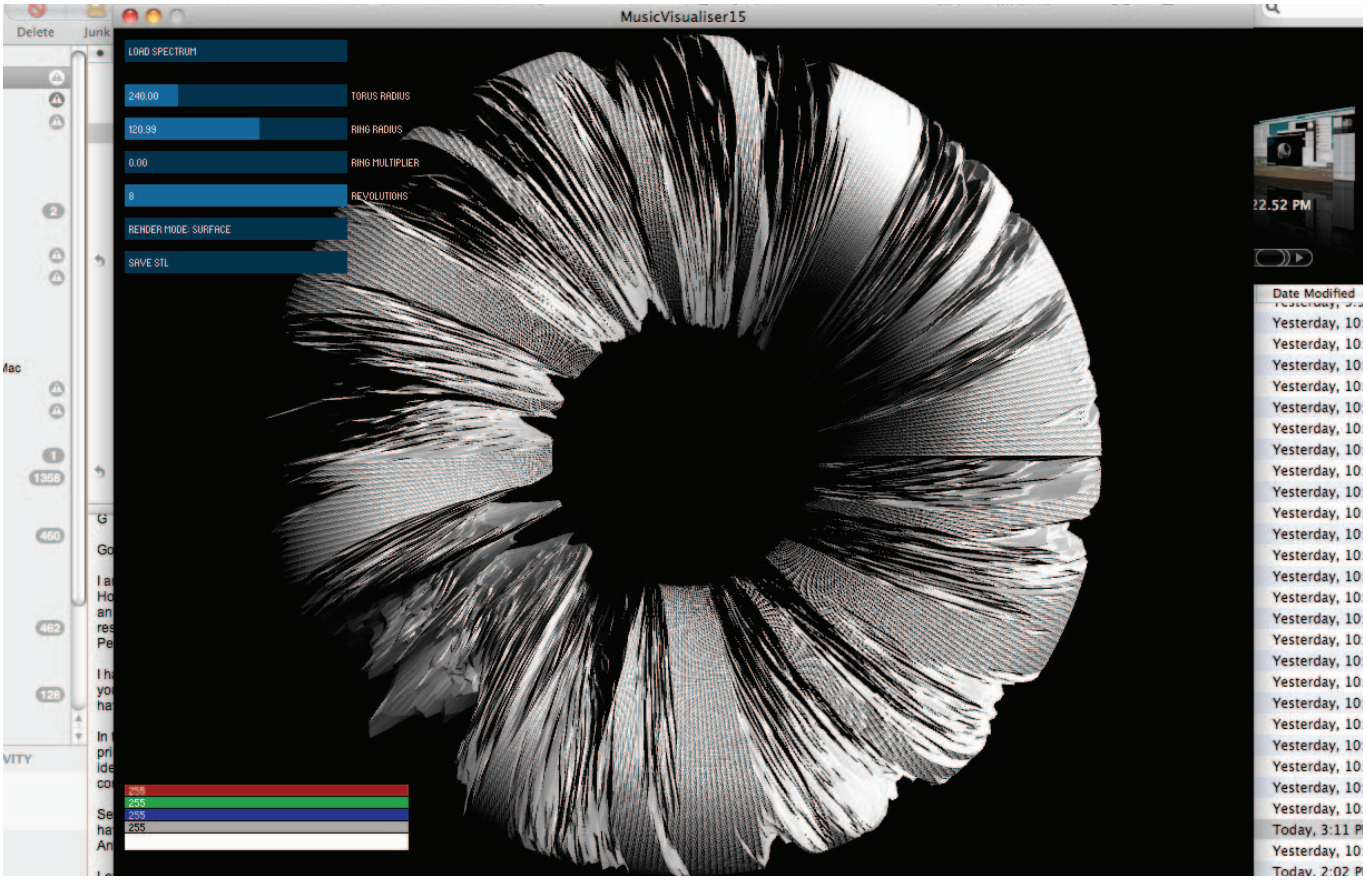


Figure 29. *Music Visualiser* surface rendered loop.

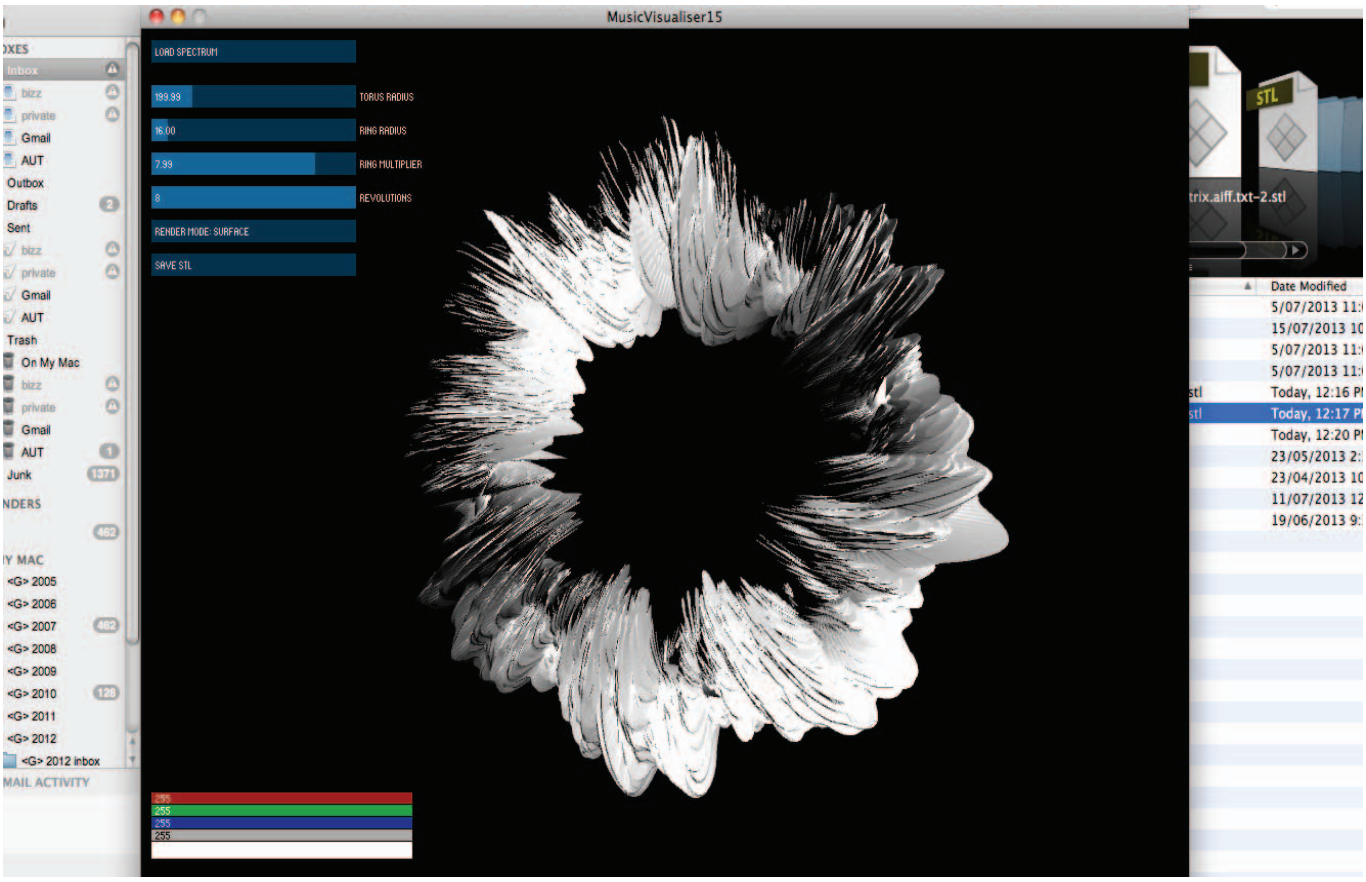


Figure 30. *Music Visualiser* surface rendered loop.

```
solid Ring
facet normal 0.3587056 -0.89720154 0.25760376
outer loop
vertex 264.0914 0.0 -4.1177907
vertex 261.13422 0.0 0.0
vertex 267.51465 1.3533062 -4.1711674
endloop
endfacet
facet normal 0.25726804 -0.96292967 0.081114605
outer loop
vertex 267.51465 1.3533062 -4.1711674
vertex 261.13422 0.0 0.0
vertex 265.89587 1.2721826 0.0
endloop
endfacet
facet normal 0.3767224 -0.91738987 0.12835895
outer loop
vertex 267.51465 1.3533062 -4.1711674
vertex 265.89587 1.2721826 0.0
vertex 271.90182 3.1453114 -4.239573
endloop
endfacet
facet normal 0.35367516 -0.9310603 0.08966933
outer loop
vertex 271.90182 3.1453114 -4.239573
vertex 265.89587 1.2721826 0.0
vertex 270.43912 2.9979916 0.0
endloop
endfacet
facet normal 0.91232675 -0.27287817 0.30528235
outer loop
vertex 271.90182 3.1453114 -4.239573
vertex 270.43912 2.9979916 0.0
vertex 272.40277 4.81141 -4.247384
endloop
```

Figure 31. STL data sheet.

Materialising

"The more you get into material, matter, the more you realise all there is in matter is energy" (Moog in Fjellestad, 2004, 01:03:15-01:03:20).

Generating physical shapes from digital visualisation of invisible sound is a very rewarding exercise. After intensive design research I could see and feel a fossilised version of a dynamic source. At first this is exciting. Emptying the bucket of nylon powder that disguises the solid 3D printed shapes feels like reverse archaeology. The final shapes are discovered from their chaotic loose context. The purpose of each object however is unclear. It raises critical questions. What is the social and outbound relevance of this little, white, plastic shape? Why would I fill my world with an abundance of plastic objects? And how does this relate to an intimate user experience?[32]

It seemed only natural to continue my thesis through the cybernetic lens, and to focus on the process, as opposed to focussing on the object. A concept of creating objects for personal adornment was considered in terms of commercial potential (see Future considerations) although I decided to postpone this investigation and focus on the intimate user experience of sound loops.
One of the 3D printed sound loops actually made me want to take a little bite. It raised the question; what if the physical shape was edible? And what kind of edible material might suit the project?

32. Krueger (1977) explains that current designs of intimate technologies requires not only aesthetic refinements. They also require engineering of the content in such a way that it represents the complexity of the network, allowing users to customise their interaction experience and support.

Conceptually I asked if the materialisation of sound might be an expression of intimacy, and might an object that hinted at the unique and personal be a way of consuming this beyond just viewing or touching it? In other words, was there a more intimate link than touch? Could a loop between materialisation and consuming be close in a more intimate way? I considered a number of options (ice, candy). I chose chocolate as it does not need extreme circumstances to transform from a liquid to a solid state.[33]

One of the qualities of chocolate is that it melts at human body temperature. It is in a temporary state of solidness and its shape shifting behaviour through human interaction suggests its applicability as a material for an intimate user experience.

I undertook an extensive experimental phase of making recyclable and edible moulds by pushing 3D printed halves into clay material like plasticine, pasta dough and fondant. My aim was to get rid of possible undercuts. Experiments with jelly and ice resulted in disappointing results. Aside from the moulding, the making of chocolate challenged my design capabilities. I decided to ask for help. Through a conversation with professional chocolatier Edith Mueller, a pathway was chosen to make the chocolate shapes within a professional environment; this would help to control the transformations that chocolate itself undergoes before it is possible to pour the material into a mould.

This process caused the cocoa butter fat molecules to break down through heating at 48ºC. This made the chocolate fluid. Then these molecules were rejoined by cooling the chocolate to 28ºC while continuously moving the material. This is called tempering. Finally the chocolate was reheated to a constant working temperature of 32ºC. This was a delicate process. Only when done correctly could a shiny solidified object be achieved.

The moulds were made using the 3D printed halves as a model to vacuum form the shapes into a Polyethylene Terephthalate (PET) sheet. This material is commonly used by chocolatiers. The smoothness of the mould's surface was necessary to release the chocolate shapes without undue loss of detail. An edible material enabled me to embody the cycle of intercepting, deciphering and distributing. Chocolate engaged the sensual states: audio, visual, tangible, smell and taste. All of these senses come into play in the exhibition experience, even down to the audio in the 'snap' of bite being simultaneously recorded and fed back to the audience.

Another interesting loop can be seen in the phases of this research project which change from analogue–to digital–to analogue. I took the sounds from a 3D object—vinyl record—and through digital processing I transformed these sounds into a 3D object—a disco doughnut. The project intercepted a solid shape from my physical world, deciphered the time based information, and distributed a solid shape back into this world. In 1978, designer Jay Doblin observed "A product is frozen information"(Doblin, 1978). This might still be true. It is certainly interesting to look at the melting and solidifying processes, the transformative qualities that shift from one information cycle to another.

33. The more I experimented with chocolate, the more conceptually it felt like a good material as it is always explicitly in a state of transition.

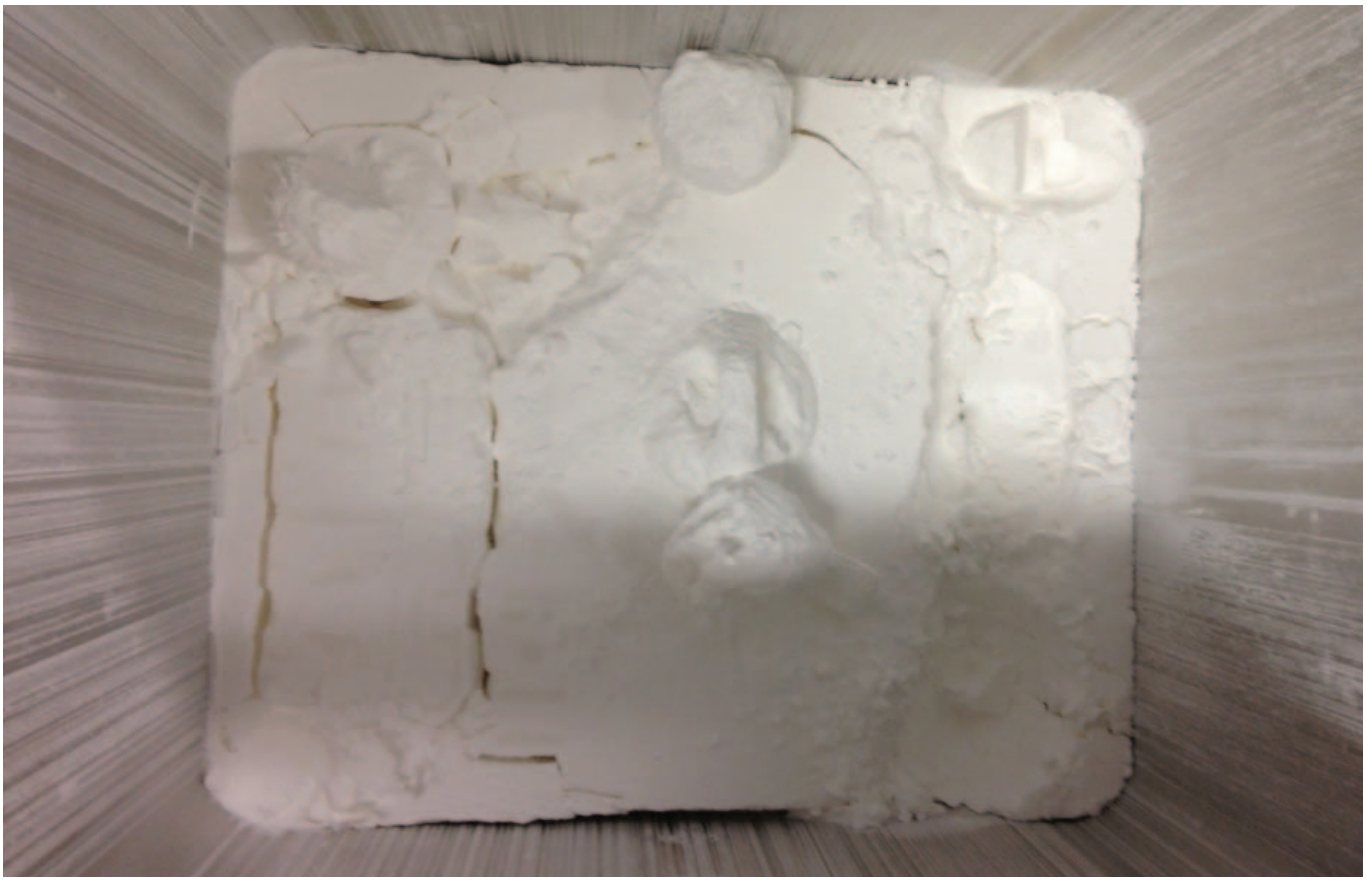


Figure 32. 3D printing bucket.

Figure 33. 3D printed ambient sound loop.

Figure 34. Casting split *Matrix* disco loop in fondant.

Figure 35. Split *Matrix* disco loop in chocolate.

Figure 36. Vacuum forming split Matrix disco loop mould.

Figure 37. Moulded disco loop at Swiss Bliss Chocolaterie.

Exhibiting

The exhibition *Sound Bites* opened on the 18th of December 2013 in Gallery Three St Paul St Galleries in Auckland. It ran for one morning. The exhibition *Sound Bites* showed two interrelated elements:

— a projected ambient sound analysis.

— and an edible Sound Bites selection revealing traces in its subsurface.

One wall in the gallery featured a projection of a continuous loop of ambient sound that was simultaneously recorded while people viewed the exhibition.[34]

The second exhibited work contained materialisations of my intimate ambient sound recordings. These were made of 128 materialised unique sound loops constructed in dark chocolate. The lay out of these small objects was based on a circular presentation, in which the original chronology of recording was re-ordered into a new visual rhythm.

The public was invited to take away a single chocolate sound loop. In other words, they were asked to consume an intimate part of me. In eating the loop they enacted an intimate action on an intimate object that was formed from an intimate loop of sounds. The intimate sounds I recorded of my world would become for a moment, part of the intimate sound of their body. Simultaneously the projection presented the sound of this event. In this regard a loop was suggested.

34. A hidden wireless microphone will be placed under the table to pick up the sound of the audience's engagement with the temporarily solidified sound files.

Beneath each uplifted chocolate object a discreet imprint was revealed, a trace of the objectified sound loop into a layer of fondant. As such the exhibited parts did not disappear. Instead, through user interaction a new rhythm of shape and counter shape arose. This referenced the time of the originating event. A video camera suspended above the exhibited work recorded the incremental disappearance of my presence (and its dissipation into the experience of others).

Although the public would enter the intimacy of my world, through recording an instant visual feedback, I would also become part of their world. This cybernetic circularity of events (Glanville, 2004) underpinned the concept of the exhibition but it also suggested a broader idea related to how we design.

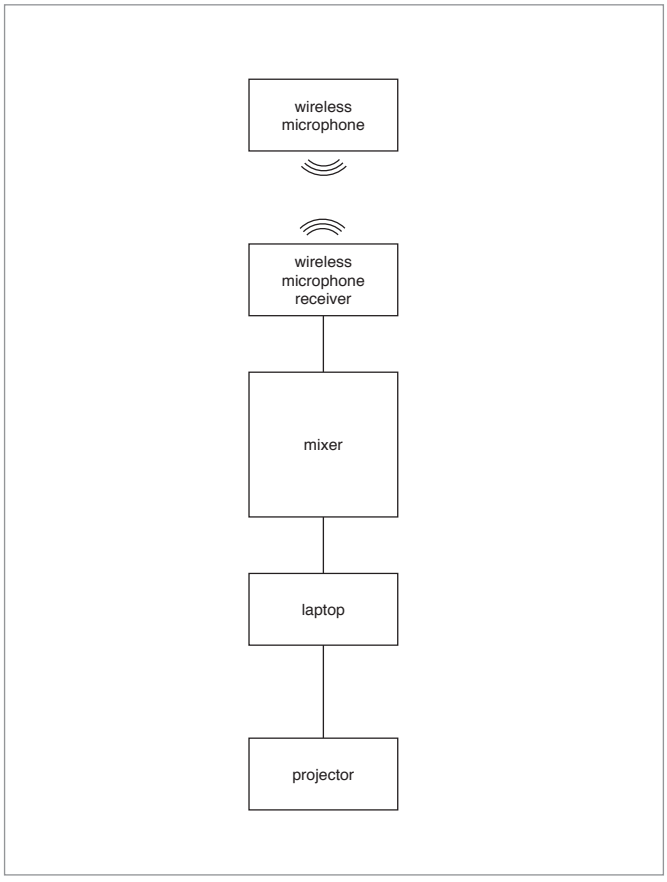


Figure 38. Exhibition technical diagram.

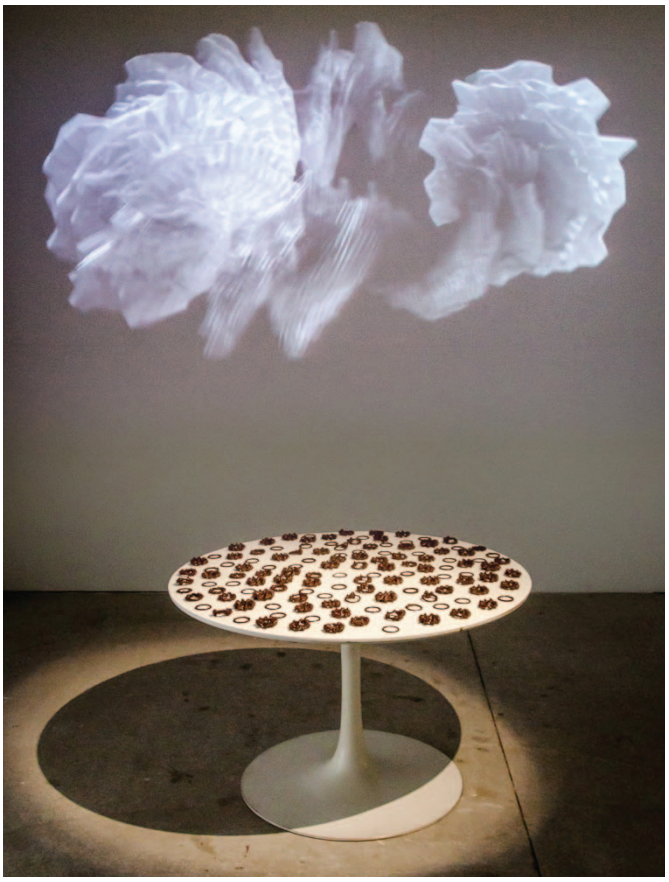


Figure 39. Exhbition, overview.

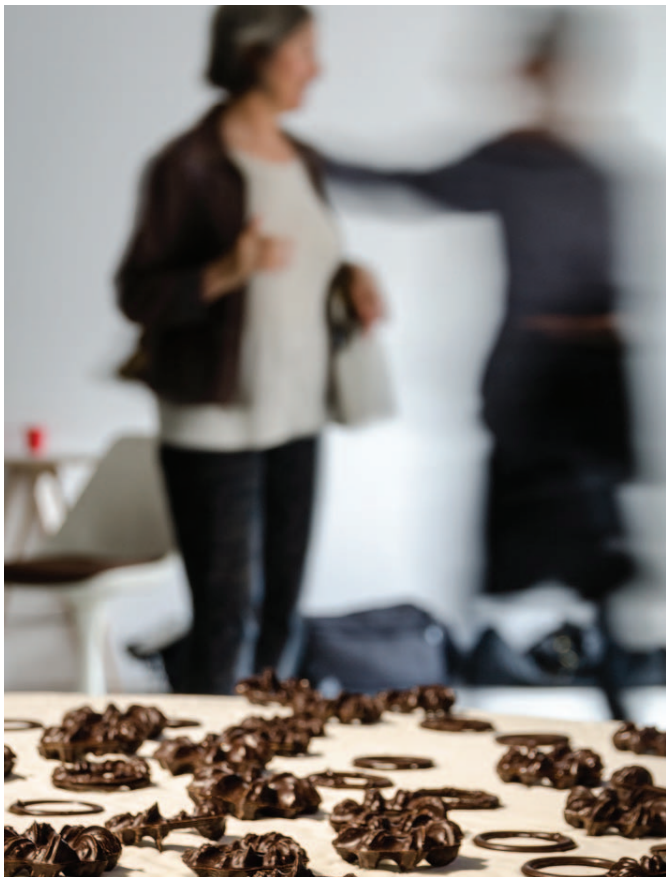


Figure 40. Exhbition, opening.

Figure 41. Exhbition, detail.

Contribution of knowledge

This thesis contributes to knowledge on a number of levels. However, beyond its technological dimensions, its significant contribution is a proposal that design is a circular process operating inside the paradigm of Second Order Cybernetics. Here the designer operates alongside the design and cocreators. I propose that design need not be driven by a fixed question. Rather it may be seen as an environment in which one pursues an idea and its potential. I did not set out to design a table with chocolate artefacts. I asked to what extent could a transmodular design process be used to decipher personally significant sound and translate this into a unique physical user experience?

By adopting the Second Order Cybernetics paradigm the designer no longer operates as a discrete agent who moves the design in a linear direction from a set starting point.

Linearity is an arguably limited way of understanding our world. Tapscott & Williams (2006) and Jenkins (2006) both suggest that polar binaries, single problems, and linear approaches are inadequate for dealing with current paradigm shifts. VanPatter (2007) argues that adaptation, or 'sensemaking' is the driving force behind contemporary design. As designers find themselves increasingly becoming agents for 'social transformation' (VanPatter, 2009), new creative enquiries and new levels of team-based creative problem solving become necessary. In the case of this thesis, design was a form of cocreation. Although I conceptually drove the project, its development was predicated on synergies emanating from a team of skilled copractitioners.

Designers nowadays are faced with applying more than craft-focused solutions. Their outbound and inbound skill set (VanPatter, 2007) has become more intrinsically part of the solution. Thomassen (2010) notes that understanding and adapting to complex situations, creating and envisioning alternatives, and the ability to create quantities of ideas and concepts have become the main ingredients of design.

I believe that designers need skills to participate and cocreate with the stakeholders. They also need collaborative skills. This design research project explored new ways of sense making of a "fuzzy and ambiguous" world of media experiences (VanPatter, 2009, p. 24), and as such it required a mastering of unframed challenges, as opposed to mastering framed challenges (Eikeland, 2006, p.3). Cocreation is not a linear process. I design by strategically linking inputs, one sample of expertise is joined to another. The intersections (synergies) are as important as the essence of each input. I sample, combine, generate, regenerate, evaluate and begin again.

At times it feels that the thesis belongs to many people. This is because it was more than a task completion, it was a framework for creative and analytical exploration and discovery. Being protean, it altered its shape, role and meaning. Facilitating this process to enable unexpected outcomes to arise as well as controlling the progress of the work, shifted my attention as a visual designer dramatically. The thesis was no longer predicated on an aesthetic solution. Instead it was concerned with a way of thinking that encouraged reflective questioning and discovery.

When I walk along the wild coast of Piha Beach I reflect and discover. My feet buried in the warm black sand, leave tracks, just like the water does. The two interact and in a flow of change new patterns arise in a landscape that has been changing for centuries. My own little circles are part of a much broader and richer rhythm. To see these patterns link makes me feel light and grateful. I am able to experience this sense of a greater context than my own. It gives me energy. It assures me that nothing or nobody really disappears. It articulates my actions.

In this world I intercept, decipher and distribute.

Objects are processes.

Matter is energy.

Future considerations

I intend to continue my investigation into the cocreative possibilities of transmodular design. Throughout my research I encountered domains that overlap with my project, such as generative design methods, patterns, ecosystemic organisations and digital and analogue ontology. Through studying these ideas as a practice-led researcher I believe new combinations and directions will surface.

My considerations of the potential of Second Order Cybernetics will hopefully continue to support new approaches to my design work, in which systemic circular feedback loops will locate the inner and outer self within the system. The realisation that "everything is in some sense constantly interacting with everything else" (Briggs, 1992) is a fruitful observation as it opens the mind to inner clarity and outer complexity.

Beyond concerns with process I see the material outcome of the thesis as having rich commercial applications. By developing a user participatory online service I could enable people to have their intimate personal sounds transformed through transmodular design into a symbolic piece of jewellery. This could be a physical object to remember a moment in time. The idea that one could take the intimate sounds of one's life and translate these into jewellery suggests a level of integration where personal sounds could become unique adornments.

Through this, one might celebrate the first sounds of a new born child, the atmosphere of a place one has lived, or the last words of a beloved.

References

Bibliography

Ashby, W. R. (1958). *An introduction to cybernetics* (3rd ed.). London, UK: Chapman & Hall.

Beer, S. (1959). *Cybernetic and management*. London, UK: English Universities Press.

Bennett, A. (Ed.). (2006). *Design studies—Theory and research in graphic design*. New York, NY: Princeton Architectural Press.

Bidner, S., & Feuerstein, T. (2004). *Sample minds, materials on sampling culture*. Köln, Germany: Verlag der Buchhandlung Walther König.

Briggs, C. L. (1992). *Fractals: The pattern of chaos; discovering a new aesthetic of art, science and nature*. New York, NY: Touchstone.

Burdick A. (1992). *Design in context & perimeters*. Émigré (Vol. 21).

Castells, M. (1996). *The rise of the network society, the information age: economy, society and culture* (Vol. I). Sussex, UK: Wiley Blackwell.

Csikszentmihályi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper & Row.

Csikszentmihályi, M. (1997). *Creativity: Flow and the psychology of discovery and invention*. New York, NY: Harper Collins.

Doblin, J. (1978). *Innovation: A cookbook approach*. White paper. London, UK: Secker and Warburg.

Eikeland, J.R. (2006). *Design leadership: Cross-pollinating design and management*. In *Proceedings of: 5th NordCode Seminar: Connecting Fields*.

Fjellestad, H. (2004). *Moog*. [video documentary]. London, UK: Plexfilm.

Frascara, J. (1997). *User-centered graphic design: mass communication and social change*. London, UK: Taylor & Francis.

Frayling, C. (1993). Research in Art and Design. *Royal College of Art Research Papers, 1*(1), 1-5.

Friedlander, P. (1998). *Visual music*. Retrieved June 24, 2010, from paulfriedlander.com/text/visualmusic.html.

Glanville, R. (1996). *Robin McKinnon-Wood and Gordon Pask: A lifelong conversation*. Retrieved November 8, 2010, from http://www2.venus.co.uk/gordonpask/candhk.htm.

Glanville, R. (2004). The purpose of second-order cybernetics. *Kybernetes 33*, (9/10), 1379-1386.

Godin, S. (2009). *The tribes we lead*. Retrieved April 6, 2010, from http://www.ted.com/talks/lang/eng/seth_godin_on_the_tribes_we_lead.html.

Gray, C. (1996). Inquiry through practice: Developing appropriate research strategies in art and design. *No guru, no method,* 82–89. Finland: University of Arts and Design Helsinki.

Hamilton, J. (2011). The voices of the exegesis. In K. Friedman & L. Justice, (Eds.), *Practice, Knowledge, Vision: Doctoral Education in Design*. School of Design, Hong Kong Polytechnic University, Hong Kong. Retrieved October 16, 2013, from http://eprints.edu.au/41832/.

Hamilton, J., & Jaaniste, L. (2010). A Connective model for the practice-led research exegesis: An analysis of content and structure. *Journal of Writing in Creative Practice, 3*(1), 31-44.

Huizinga, J. (1949). *Homo ludens: A study of the play-element in culture*. London, UK: Routledge & Kegan Paul Ltd.

Ings, W. (2013). The authored voice: Emerging approaches to exegesis design in creative practice PhDs. *Access: Critical Perspectives on Communication, Cultural & Policy Studies*. Unpublished journal article; publication pending.

Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York, NY: New York University Press.

Koopman, T., & Samama L., Van Wely, B., & Lefeber-Morsman, M. (2007). *Mozart Mechanisch / Mechanical Mozart*. Utrecht, The Netherlands: National Museum from Musical Clock to Street Organ.

Krueger, M. (1977). *Responsive environments*. In *Proceedings of the NCC conference*, 422-433.

Lockwood, T. (Ed.). (2010). *Design thinking—integrating innovation, customer experience, and brand value*. New York, NY: Design Management Institute/Allworth Press.

Masten, A. S., & Reed, M. G. (2002). Resilience in development. In C. R. Snyder & S. J. Lopez (Eds.), *The handbook of positive psychology*, 74–88. New York: Oxford University Press.

Maturana, H. (1970). The biology of cognition. In H. Maturana, and F. Varela (Eds.), *Autopoiesis and cognition, Boston studies in the philosophy of science* (Vol. 42.). Dordrecht ,The Netherlands: D. Reidel.

Maturana, H. (1997). *Metadesign*. In *Proceedings of Diez Años de Post-Racionalismo en Chile*. Retrieved October 16, 2013, from http://www.inteco.cl/articulos/006/texto_ing.htm.

McLuhan, M. (1964). *Understanding media: The extensions of man*. New York, NY: McGraw Hill.

Milech, B., & Schilo, A. (2004). Exit Jesus: Relating the exegesis and the creative/production components of a research thesis. In Text: *Illuminating the Exegesis*. Special Issue 3. Retrieved October, 2013, from http://www.textjournal.com.au/speciss/issue3/content.htm.

Pask, G. (1969). The meaning of cybernetics in the behavioral sciences (the cybernetics of behavior and cognition: extending the meaning of 'goal')", *Progress in Cybernetics, Vol. 1*: 15–44. New York, NY: Gordon and Breach.

Pask, G. (1971). A comment, a case history, and a plan. In J. Reichardt (Ed)., *Cybernetics, Art and Ideas*, 76-99.
Pask, G. (1975), *Conversation, cognition and learning*, Amsterdam, The Netherlands: Elsevier.

Rock M. (1996). The designer as author. *Eye, 20*. Retrieved December 28, 2012, from http://www.eyemagazine.com/feature/article/the-designer-as-author.

Sanders, L. & Simons, G. (2009). *A social vision for value co-creation in Design*. Retrieved Ocober 16, 2013, from http://www.osbr.ca/ojs/index.php/osbr/article/view/1012/973.

Schön, D. (1983). *The reflective practitioner: How professionals think in action*. London, UK: Temple Smith.

Scrivener, S. (2000). Reflection in and on action and practice in creative-production doctoral projects in art & design. The foundations of practice-based research. *Working Papers in Art & Design*, 1. University of Hertfordshire, Centre for Research into Practice.

Scrivener, S. & Ings, W. (2009). Framing the typography extract from the exegesis of the thesis talking pictures. *Studies in Material Thinking*. Retrieved October 16, 2013, from https://www.materialthinking.org/papers/24.

Strang, G. (1994). Wavelets, *American Scientist 82*(3), 250-255. Retrieved 23 October 23, 2014, from http://www.cybertester.com/data/wavelet.pdf.

Tapscott, D. & Williams, A. D. (2006). *Wikinomics : how mass collaboration changes everything*. New York: Portfolio.

Thomas, J. C. & Carroll, J. M. (1979). The psychological study of design. *Design Studies, 1*(1), 5-11.

Thomassen, A. (2003). *In control*. Portsmouth, UK: University of Portsmouth.

Thomassen, A. (2010). *Designing social innovation; the redefinition of design as a transformative force*, in *Proceedings of the Creative Grounds Conference*. Utrecht, The Netherlands: Utrecht School of the Arts

Toffler, A. (1980). *The third wave*. New York, NY: Bantam Books.

Van Dijk, J. (1999). *The network society: Social aspects of new media*. New York, NY: Sage.

Van Melle, G. (2007). *18+, Almost two decades of Pop Design for Tivoli by Gerbrand van Melle*. Utrecht, The Netherlands: Gerbrand van Melle.

VanPatter, G.K. (2007). Rethinking wicked problems (part 2): Unpacking paradigms, bridging universes (part 2), in: *NextDesign Leadership Institute Journal*.

VanPatter, G.K. (2009). *Design 1.0, 2.0, 3.0, 4.0 - Understanding futures that have already arrived!*. In *Proceedings of Swinburne University / School of Design: Design Thinking Conference*.

Von Foerster, H. (1975). *The cybernetics of cybernetics*. Biological Computer Laboratory, Champaign/Urbana. Minneaopolis, MN: Future Systems.

Von Foerster, H. (2004). Sounds and music. In S. Bidner & T. Feuerstein (Eds.), *Sample Minds, Materials on Sampling*. Köln, Germany: Verlag der Buchhandlung Walther König. [Originally published Von Foerster, H., & Beauchamp J.W. (1969). *Music by Computers,* 3-10. New York, NY: John Wiley & Sons.]

Wallick, K. (2012). Generative process: Thick drawing. *International Journal of Art & Design Education, 31*, (1), 9-29.

Weinberger, D. (2007). *Everything is miscellaneous: The power of the new digital disorder*. New York, NY: Times Books.

Weisstein, E. W. (2003). *CRC concise encyclopedia of mathematics*. Boca Raton, FL: CRC Press.

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through design as a method for interaction design research in *Proceedings of HCI. CHI07,* 493-502. New York, NY: ACM Press.

References

Figures and tables

Figure 1. Hans van Melle (1904 - 1994). Photo of photo, original photographer and date not established. Van Melle, G. (2011).

Figure 2. Front Cover for *18+*. Van Melle, G. (2009).

Figure 3. Double page spread for *18+*. Van Melle, G. (2009).

Figure 4. Double page spread for *18+*. Van Melle, G. . (2009).

Figure 5. 12" Sleeve designs for *Deviate Records* and *Prime Records*. Van Melle, G. (2013).

Figure 6. Magazine advertisement for *PIAS Benelux*. Van Melle, G. (2001).

Figure 7. Still from the interactive installation *Foucault*. Van Melle, G. (1999).

Figure 8. Double page spread for *Mozart Mechanisch / Mechanical Mozart*. Van Melle, G. (2007)..

Figure 9. Live performance by Eboman. Eboman. Retrieved July 18, 2010, from http://www.flickr.com/photos/eboman/4132704669/.

Figure 10. I*nstrument for The Sonification of Everyday Things*. Paul, D.P. Retrieved October 28, 2013, from http://www.yatzer.com/instrument-sonification-everyday-things-Dennis-P-Paul.

Figure 11. Tōhoku Japanese Earthquake Sculpture. Jerram, L. Retrieved September 14, 2013, from http://www.lukejerram.com/projects/tōhoku_earthquake.

Figure 12. Listening to the Ocean on a Shore of Gypsum Sand. Kogan, G., & Stearns, P., & and Tesene D. Retrieved October 3, 2013, from http://www.creativeapplications.net/processing/listening-to-the-ocean-on-a-shore-of-gypsum-sand/.

Figure 13. Gordon Pask and his *Musicolour* (1961). Retrieved July 14, 2010 , from http://we-makemoney-not-art.com/archives/2008/02/molly-wright-steenson-is-a.php.

Figure 14. Mental state presented in terms of challenge level and skill level (Csikszentmihalyi's flow model, 1997). Van Melle, G. (2013).

Figure 15. Order of increasing frequencies, or decreasing wavelengths, based on Usbyte table. Van Melle, G. (2010). Adapted, July 2010, from http://www.usbyte.com/common/approximate_wavelength.htm.

Figure 16. Digitalising of vinyl selections. Van Melle, G. (2013).

Figure 17. iPhone as a recording device for ambient sounds. Van Melle, G. (2013).

Figure 18. Ambient sound recordings across four nights and four days. Van Melle, G. (2013). Retrieved July 1, 2013, from desktop screen shot *Smart Beat Detector 1.4* by Marks, S.

Figure 19. Ambient recording in *Audacity 2.0.3*. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot.

Figure 20. Disco loop *The Matrix,* in *Audacity 2.0.3*. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot.

Figure 21. *Max MSP* and *Grasshopper* environment. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot.

Figure 22. *Grasshopper* and *Rhino* environment. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot.

Figure 23. *Smart Beat Detector* GUI processing disco loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Smart Beat Detector 1.4* by Marks, S.

Figure 24. *Smart Beat Detector GUI* processing ambient sound. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Smart Beat Detector 1.4* by Marks, S.

Figure 25. Frequency data sheet.

Figure 26. *Music Visualiser* points rendered loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Music Visualiser 1.5* by Marks, S.

Figure 27. *Music Visualiser* surface rendered loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Music Visualiser 1.5* by Marks, S.

Figure 28. *Music Visualiser* surface rendered loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Music Visualiser 1.5* by Marks, S.

Figure 29. *Music Visualiser* surface rendered loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Music Visualiser 1.5* by Marks, S.

Figure 30. *Music Visualiser* surface rendered loop. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot *Music Visualiser 1.5* by Marks, S.

Figure 31. STL data sheet. Van Melle, G. (2013). Retrieved July, 2013, from desktop screen shot from *TextEdit 1.6*.

Figure 32. 3D printing bucket. Van Melle, G. (2013).

Figure 33. 3D printed ambient sound loop. Van Melle, G. (2013).

Figure 34. Casting split *Matrix* disco loop in fondant. Van Melle, G. (2013).

Figure 35. Split *Matrix* disco loop in chocolate. Van Melle, G. (2013).

Figure 36. Vacuum forming split Matrix disco loop mould. Van Melle, G. (2013).

Figure 37. Moulded disco loop at Swiss Bliss Chocolaterie. Van Melle, G. (2013).

Figure 38. Exhbition technical diagram. Van Melle, G. (2013).

Figure 39. Exhbition, overview. Marks, S. (2013).

Figure 40. Exhbition, opening. Marks, S. (2013).

Figure 41. Exhbition, detail. Marks, S. (2013).

Table 1. Recording overview based on Von Foerster's division (2004). Van Melle, G. (2013).

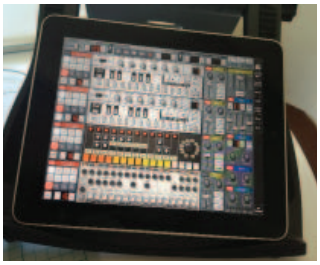
Appendix

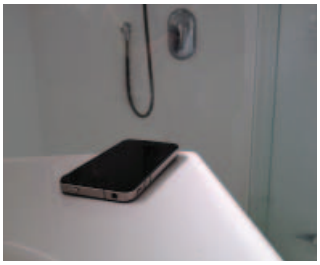
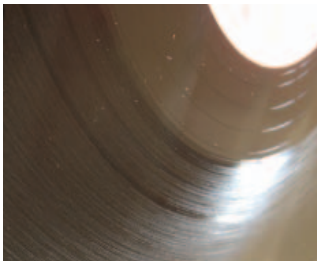
A visual chronology

This appendix provides an image-led documentation of the research process visualised as a chronological display of images of the Transmodular design process; Collecting, Selecting, Analysing, Visualising, Materialising, Exhibiting as well as Marks in black sand.

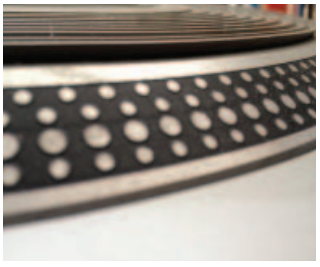
Collecting

This sequence of images cover my activities from making beat patterns, to making recording devices and a mixing set up.

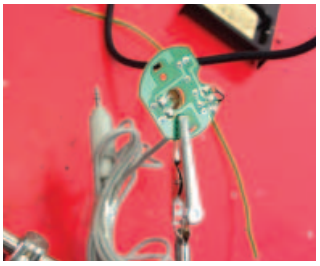
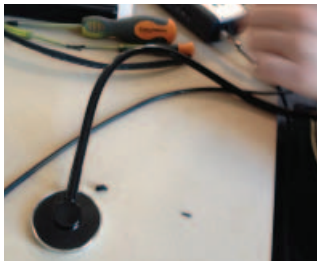






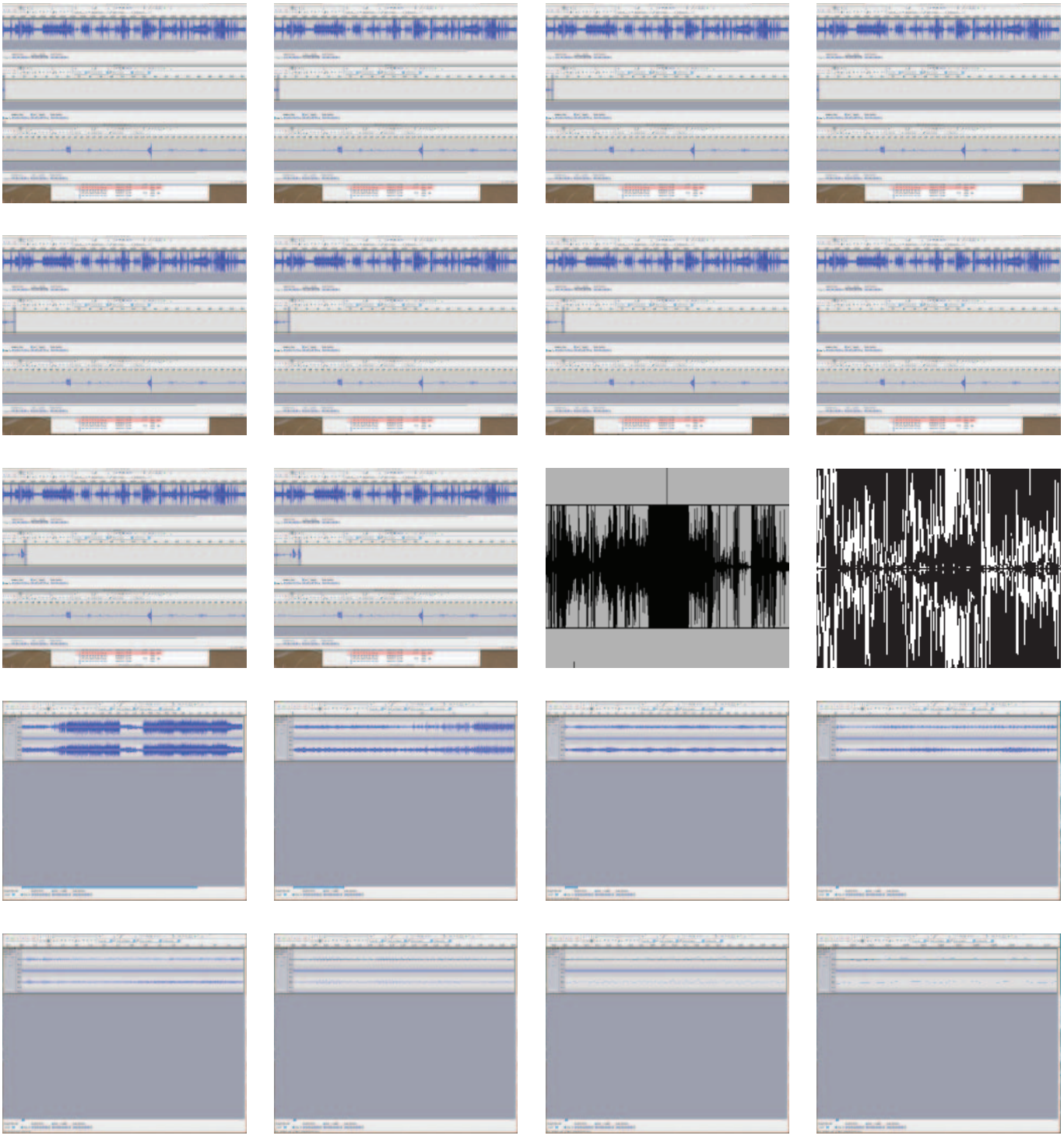




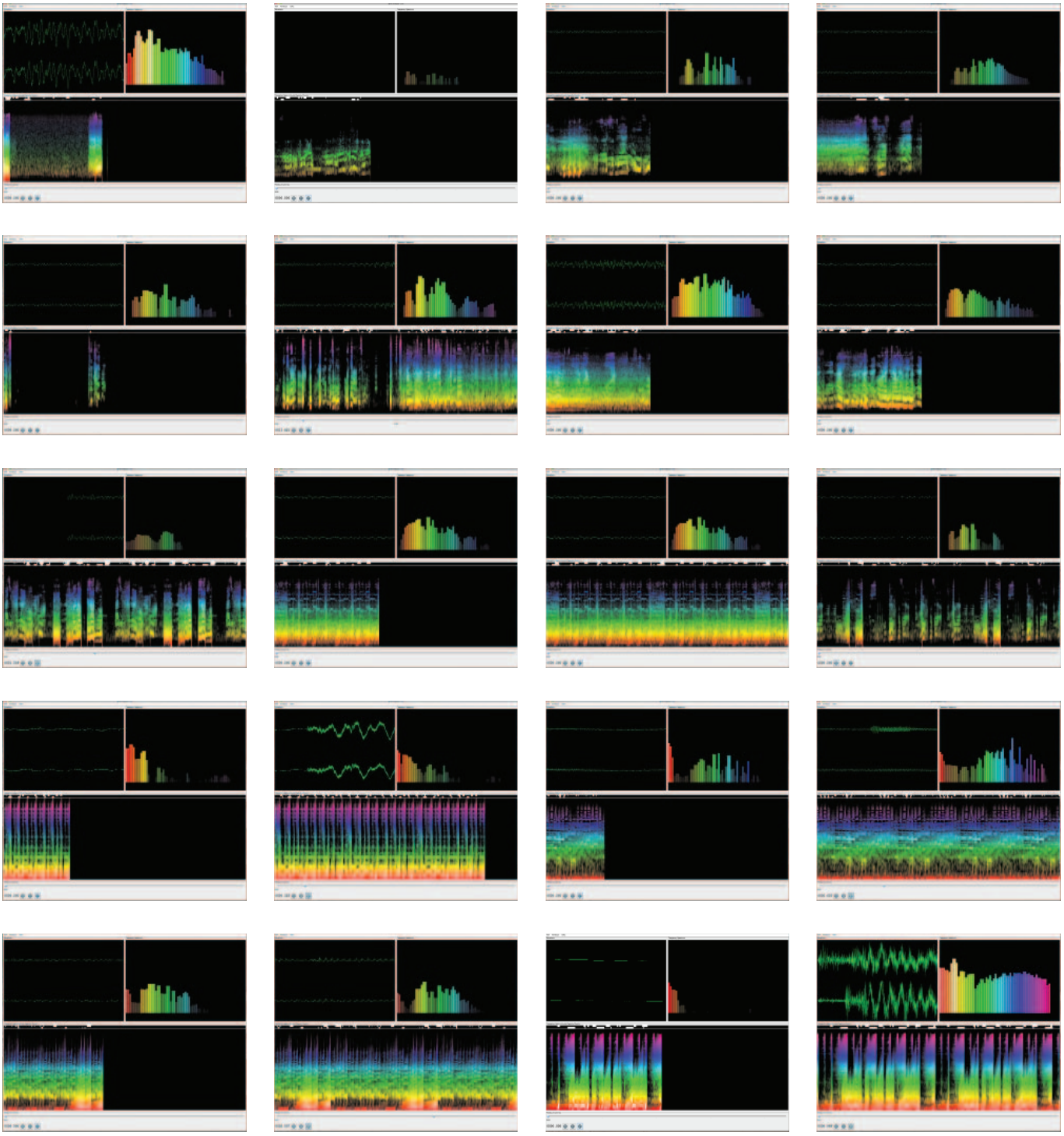
Selecting

These images are screen shots, taken while working with the digital audio files in *Audacity*.



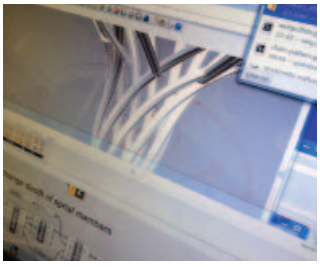
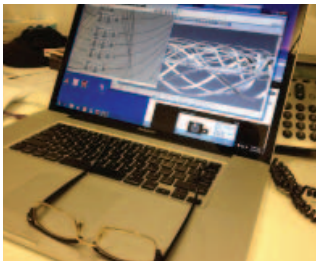
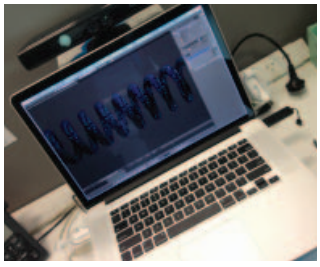
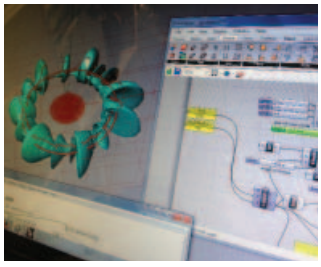
Analysing

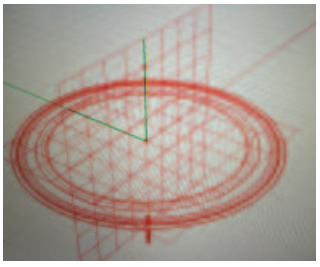
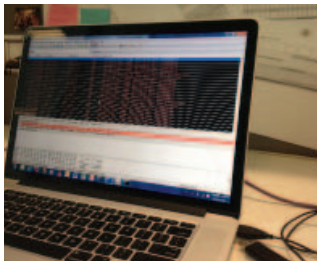
This series gives insight in the variety of visual feedback of ambient audio files and disco loops, analysed in *Smart Beat Detector*.

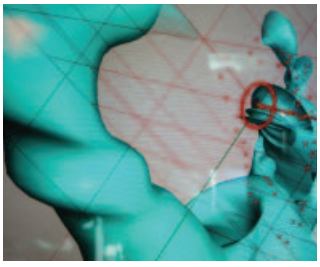
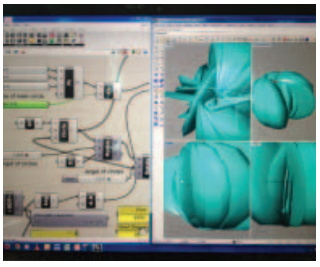
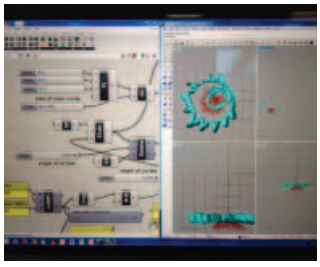
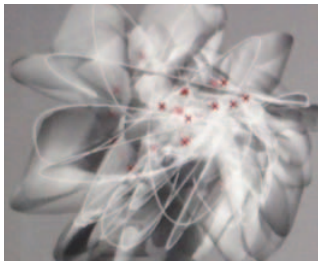


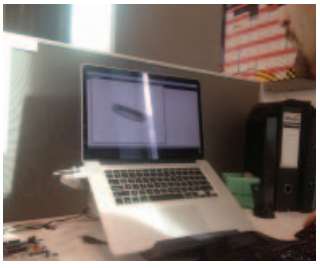
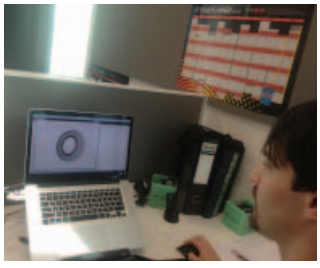
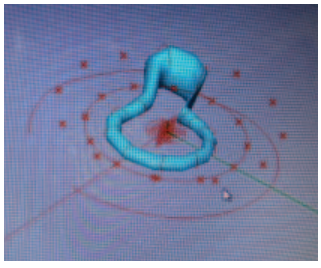
Visualising

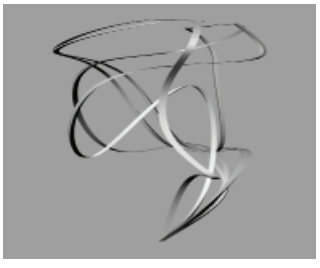
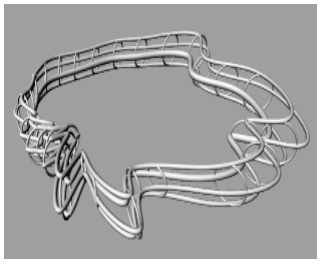
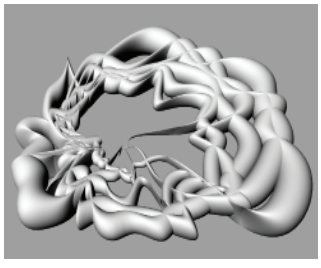
This is an overview of the first steps of visiualising within the *Max MSP*, *Rhino* and *Grasshopper* environment.

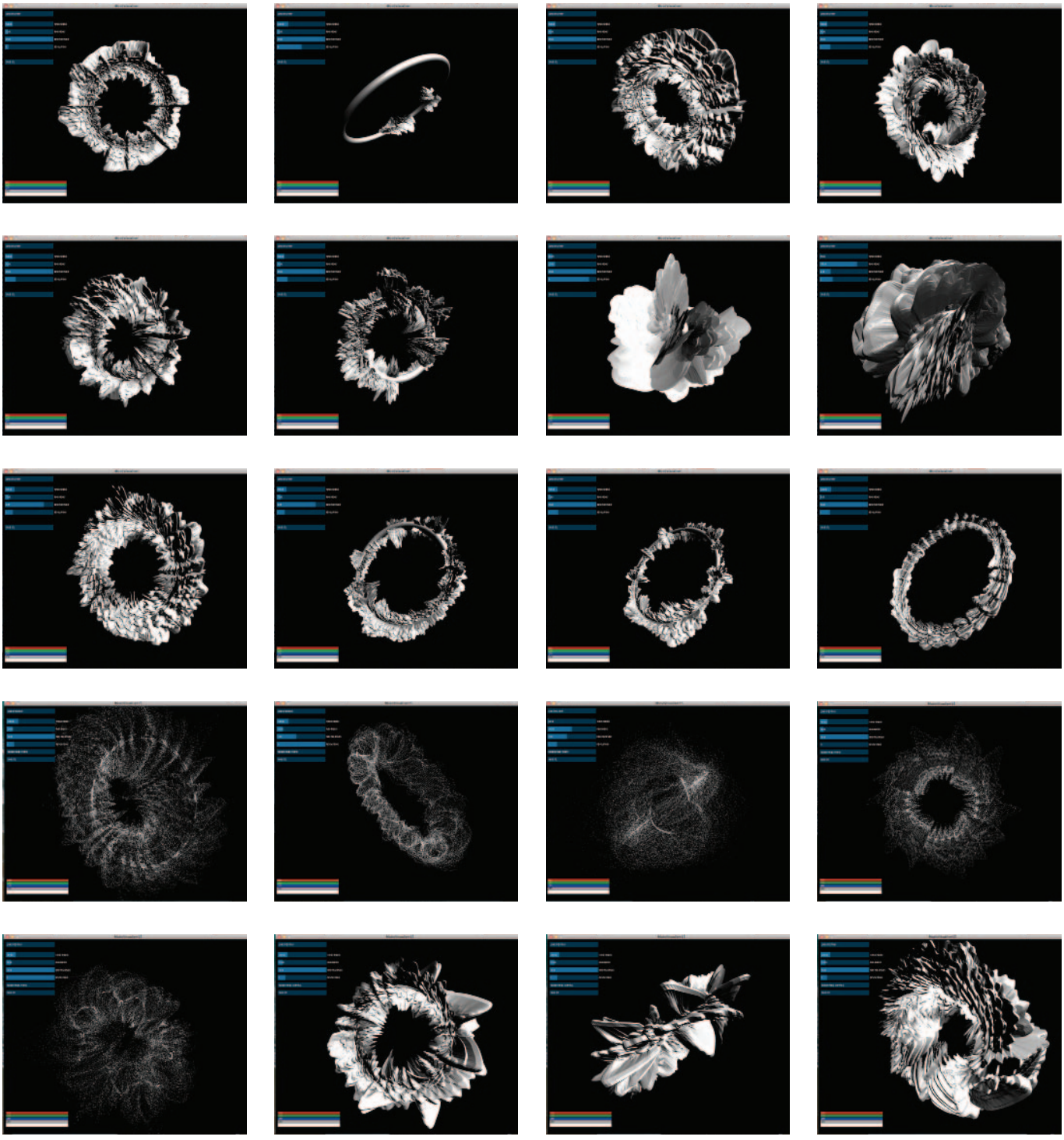





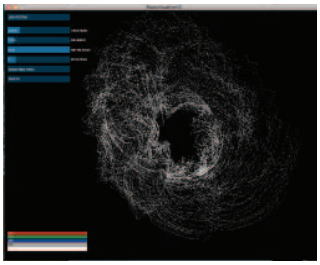
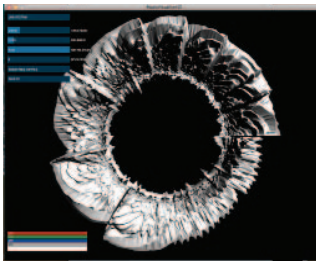
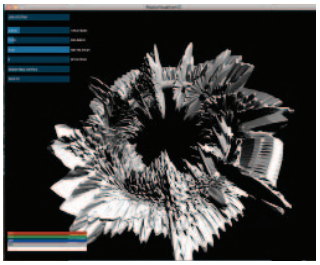
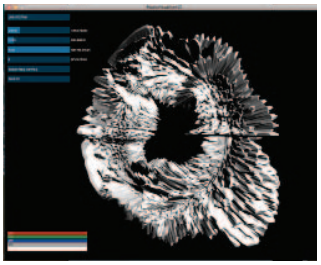
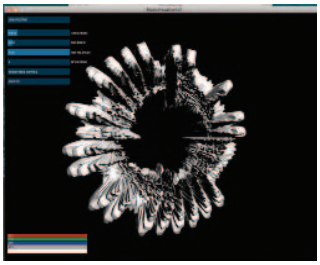
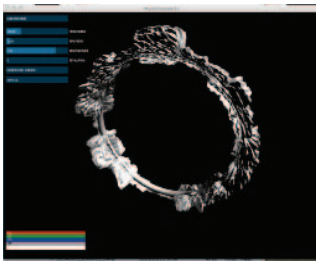




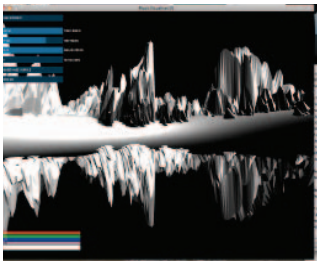
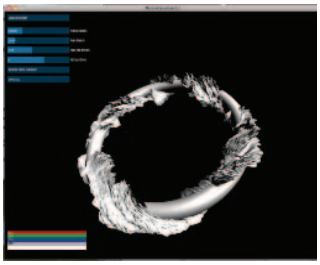
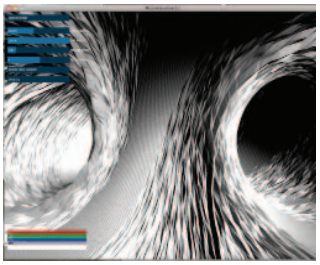
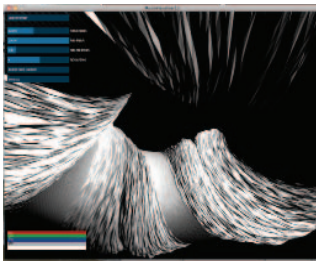
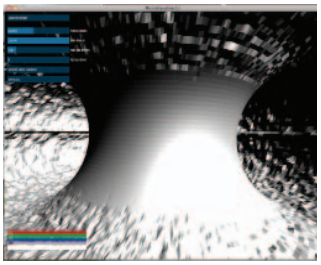
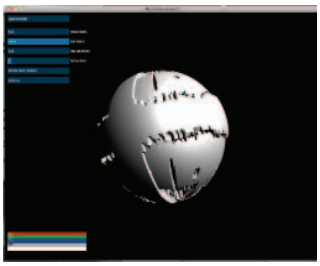
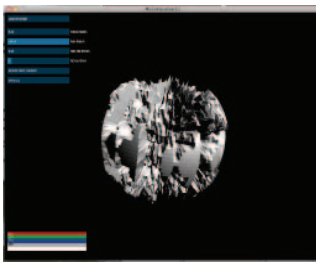
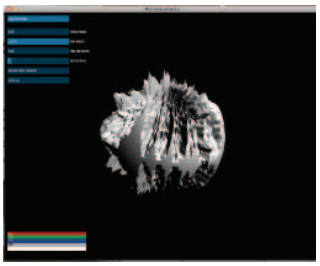
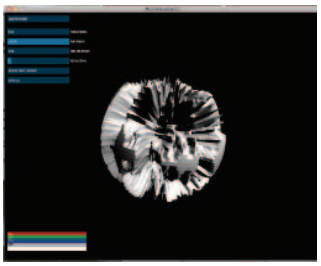
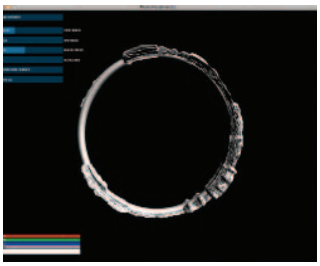
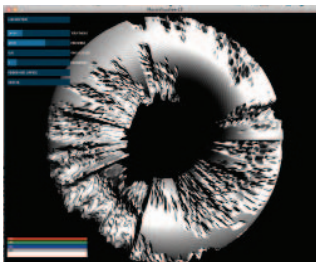
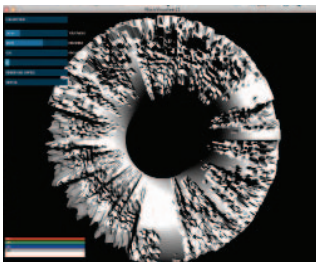
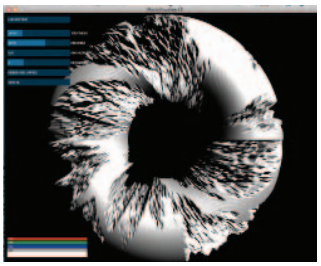




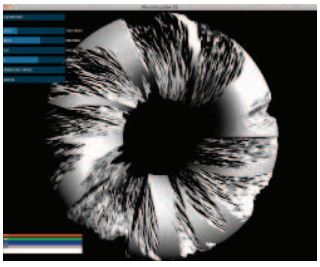
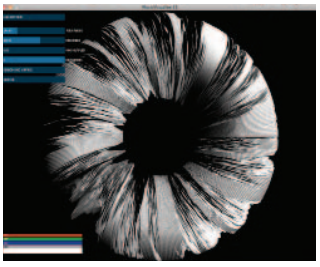
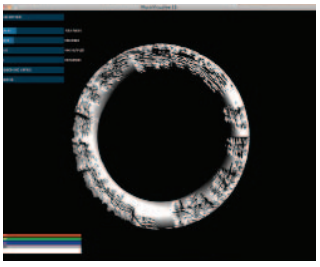
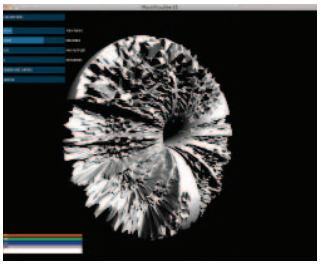
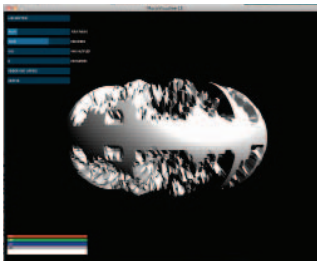
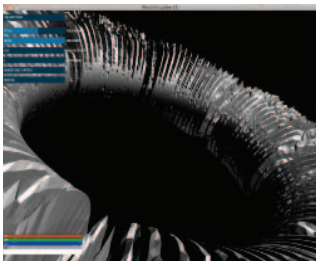
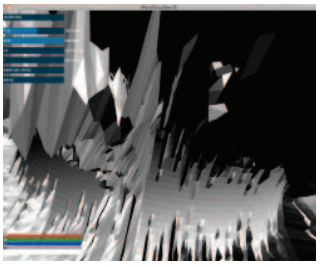
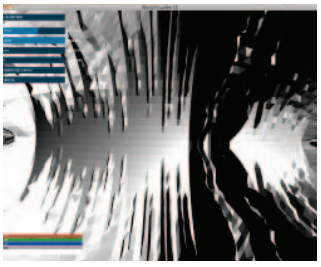
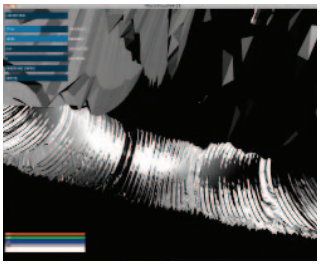
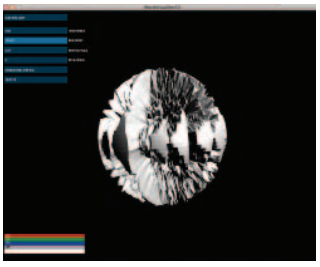
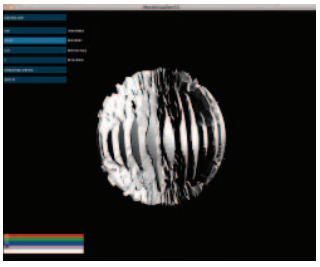
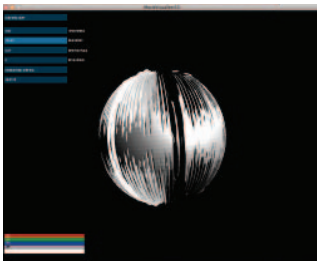
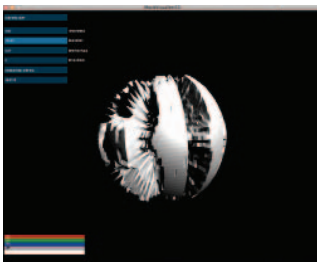
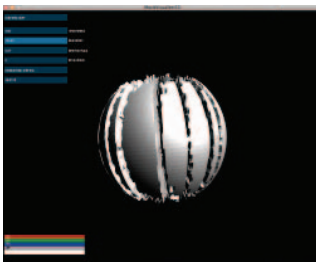
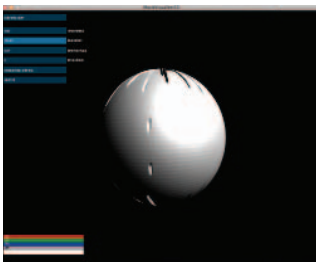
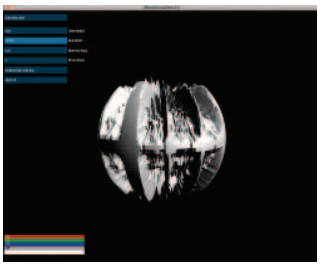
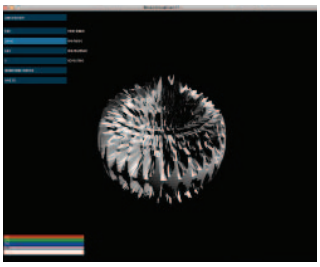
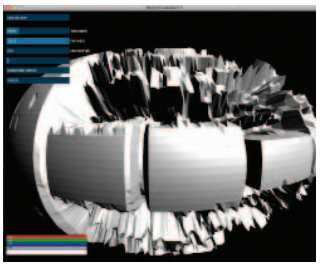
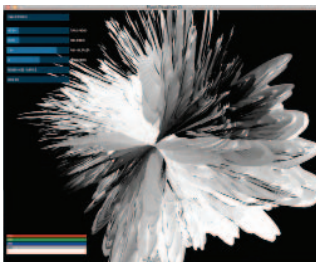
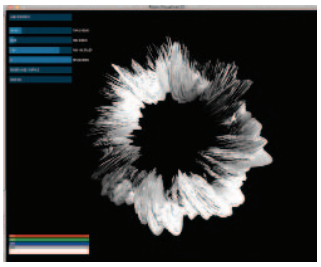
Visualising

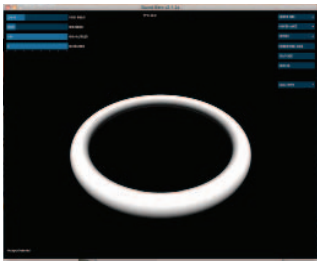
This sequence shows screen shots, made throughout the process of a variety of sound loops within different parameters in *Sound Visualiser*.

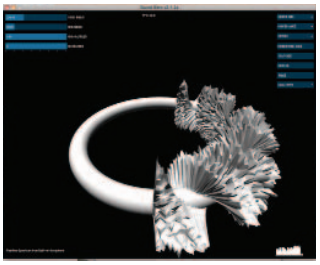
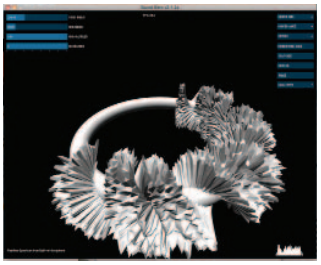
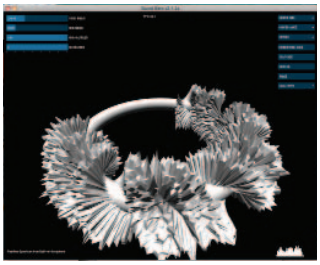
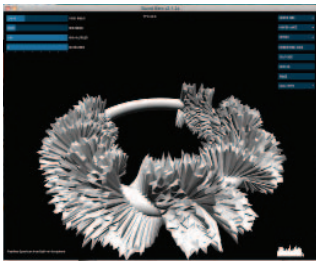
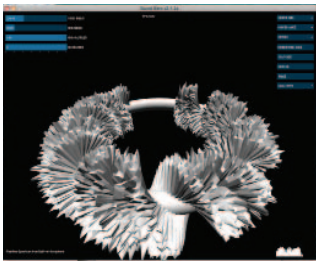
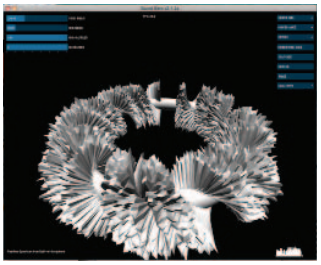
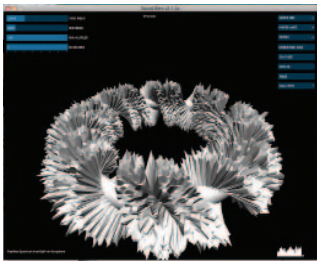
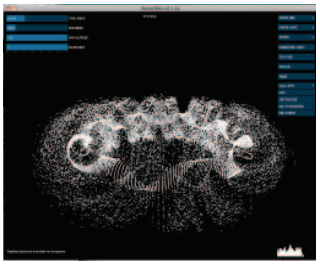
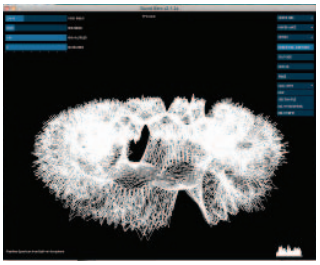


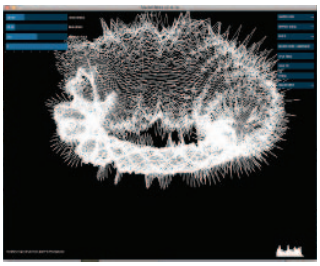
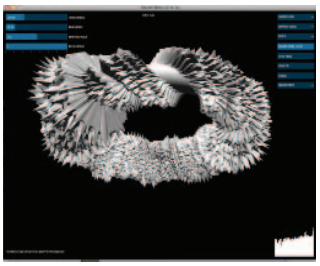
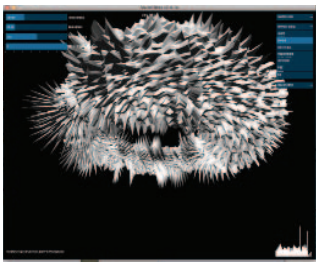
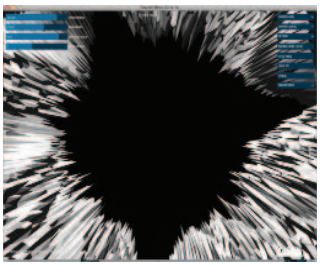
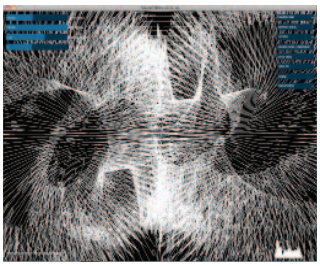
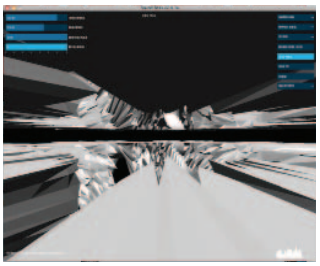
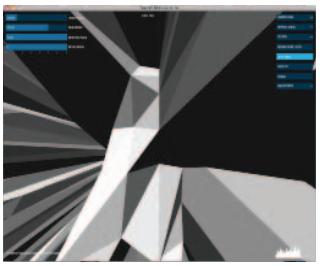
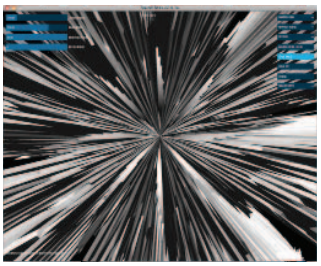







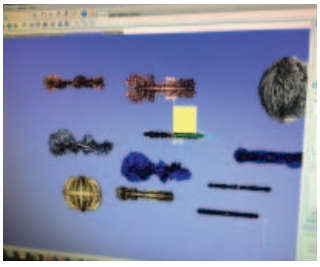


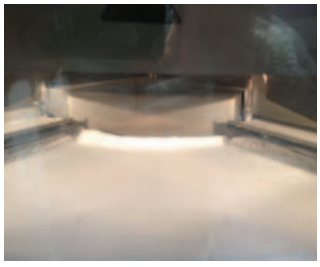
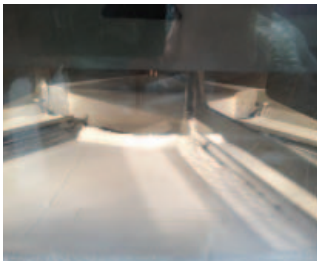
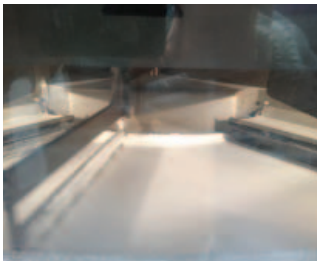










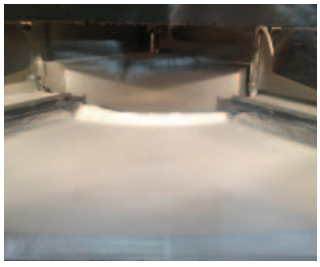
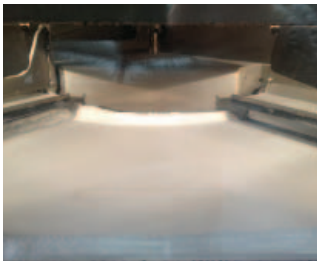









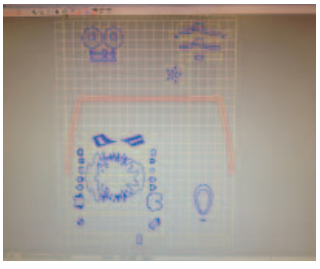
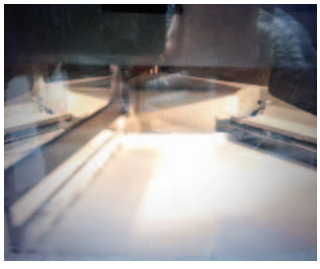
Materialising

The following images were taken while making the first batches of 3D printed objects in the Colab Additive Manufacturing Lab, during moulding fabrication and while making chocolate.



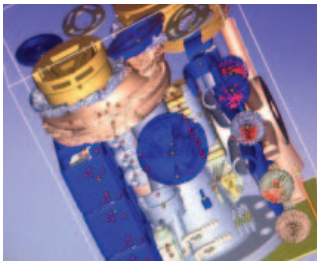
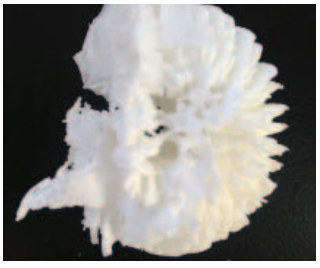
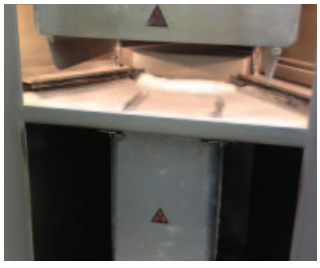





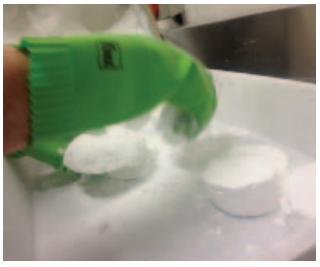



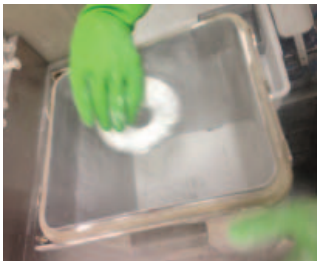


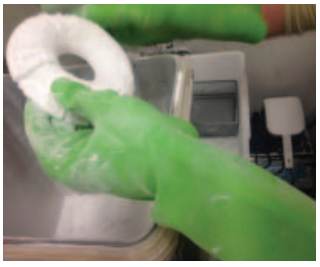
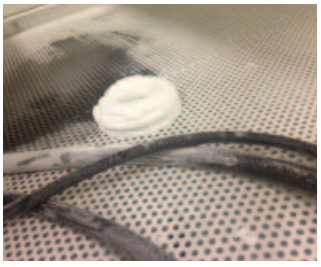


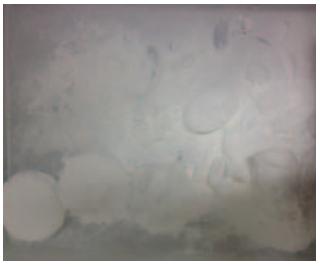
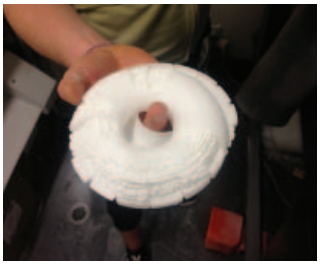
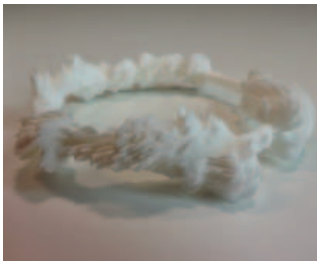






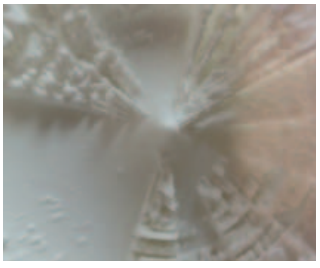






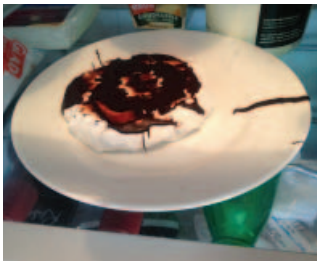






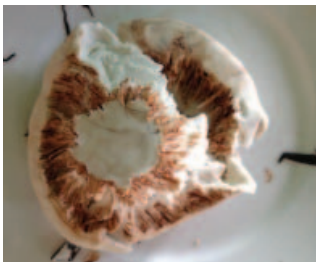


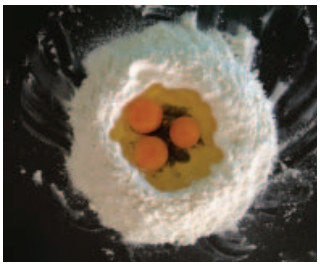


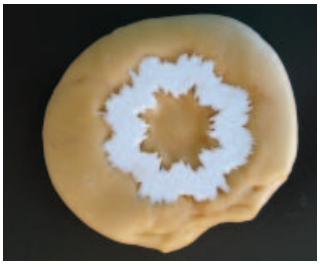


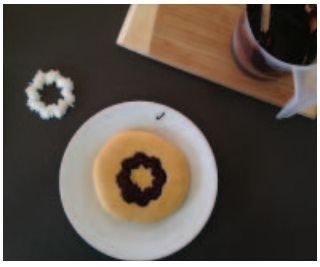




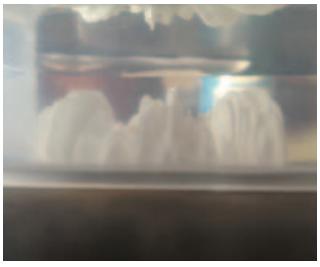


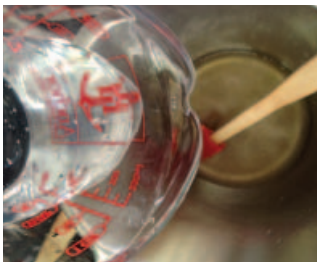


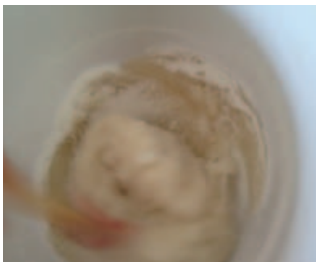


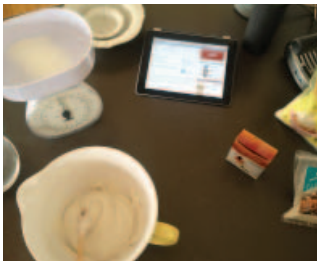










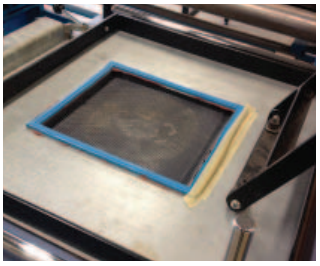


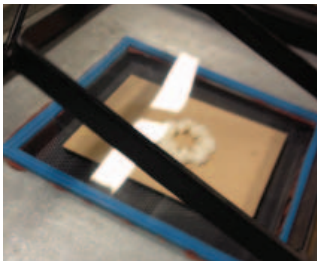
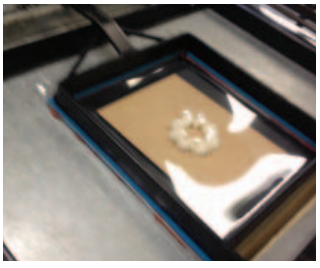
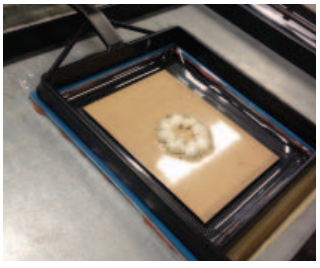
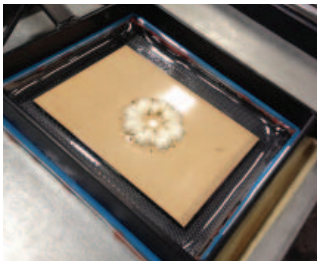


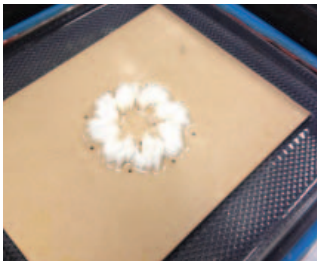
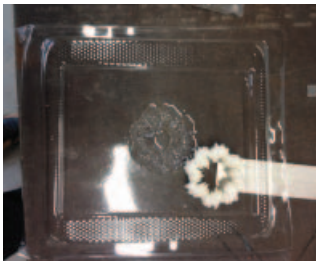


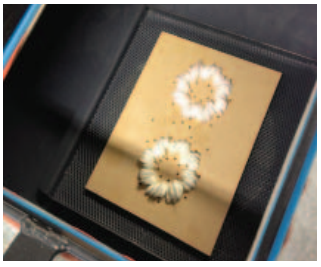
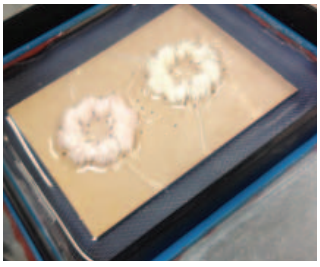






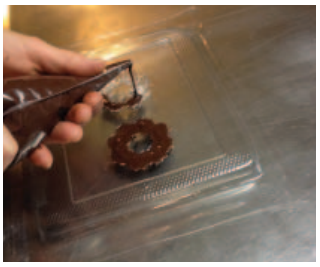



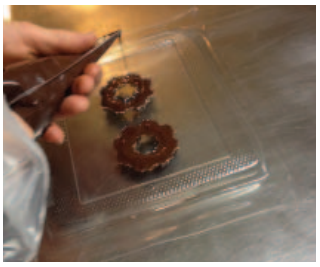
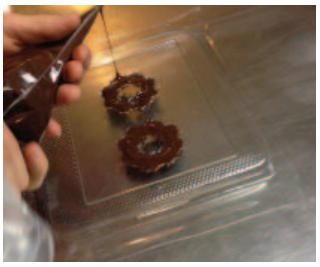


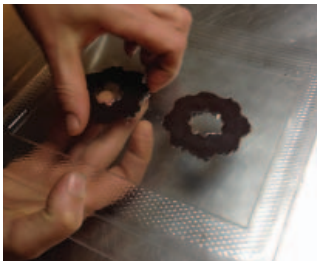








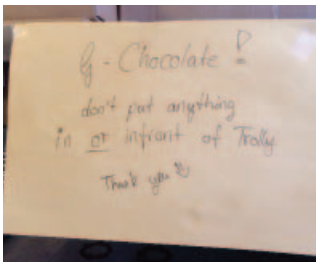
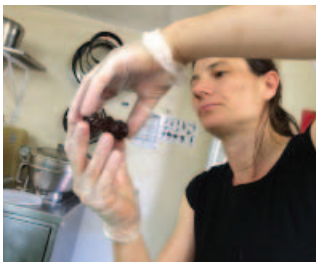












g - Chocolate !
don't put anything
in or infront of Trolly
Thank you


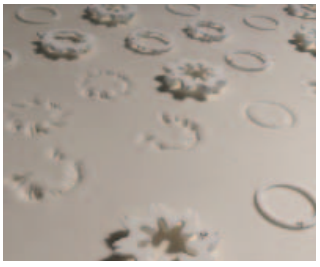
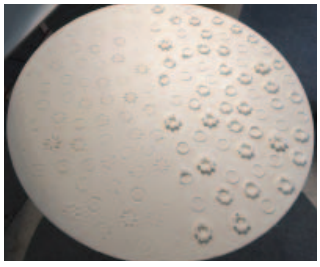



Exhibiting

This image sequence is an overview of the transformed gallery space and the exhibition.

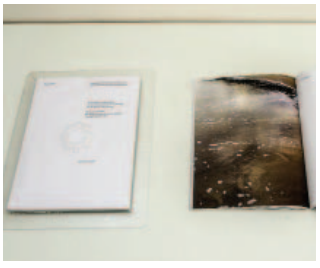
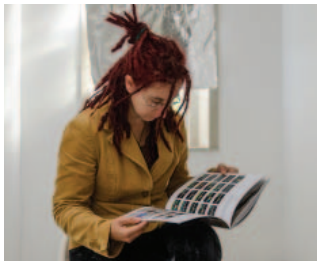








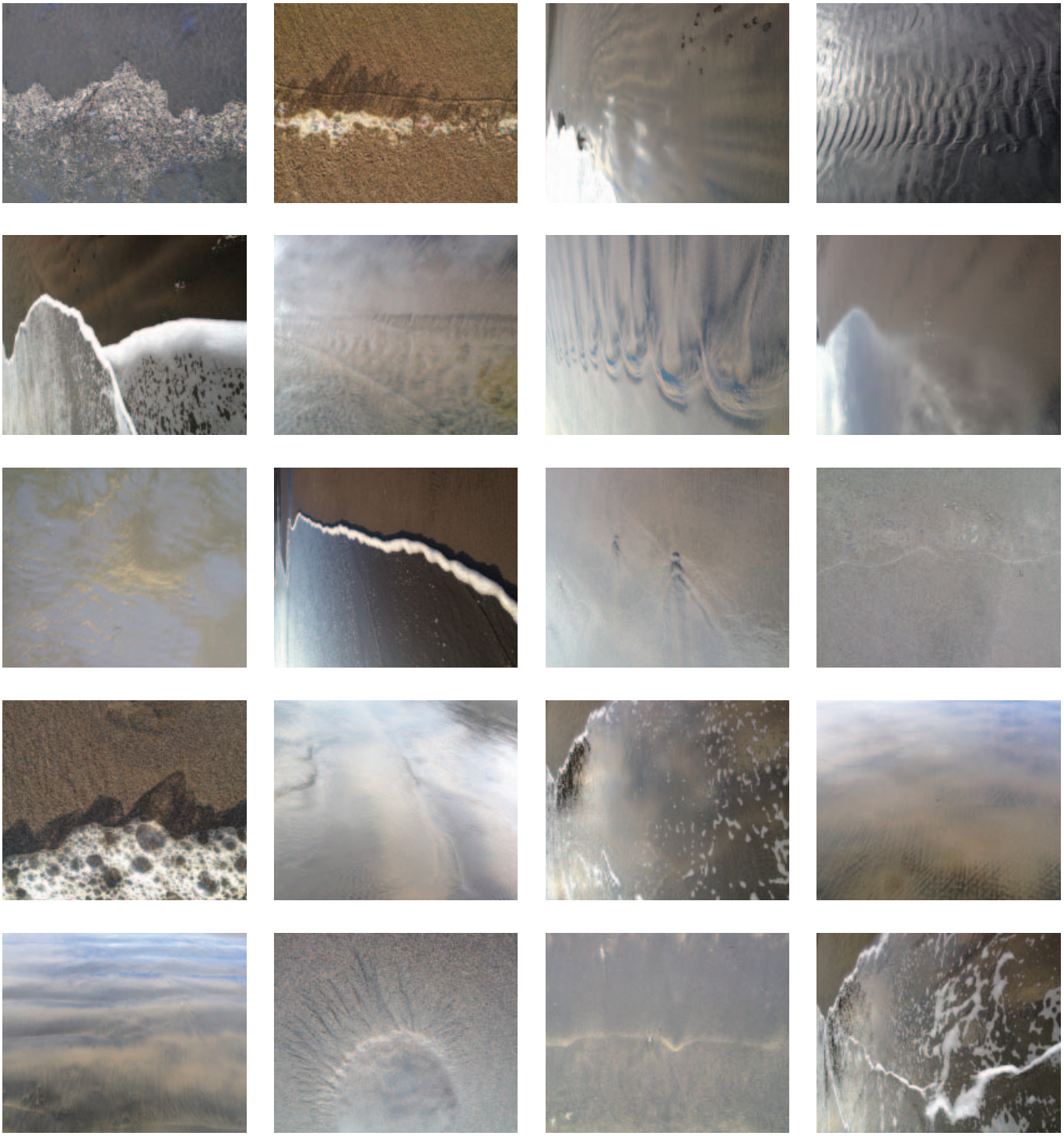




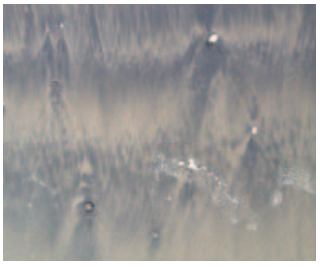


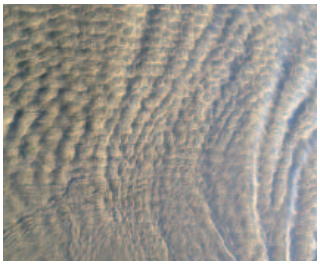

Appendix

Marks in black sand

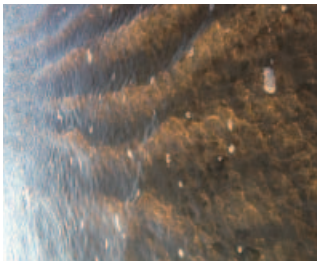
These images show details of the processes at Piha Beach of which I am part on a daily base.

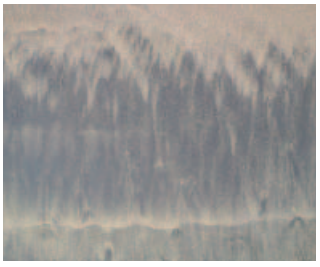
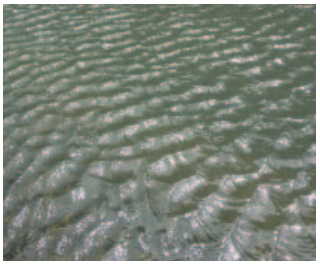
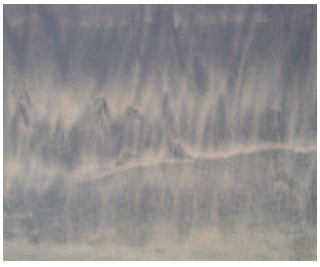
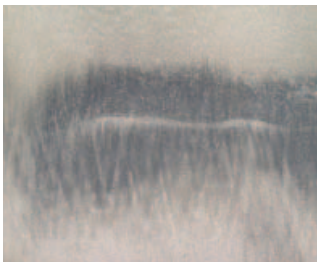
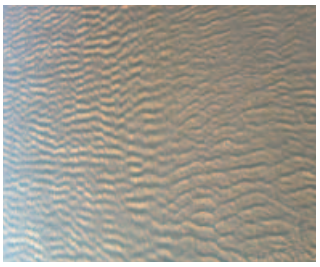


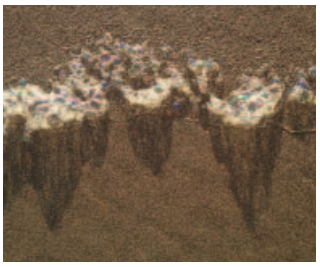
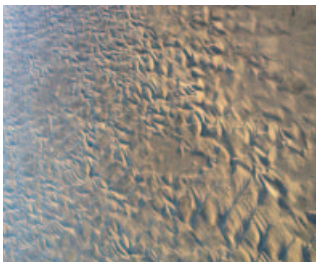






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