Barrett, N. & Tveit, A. (2024). The composition of acousmatic electroacoustic music in a Norwegian context: part II. I A.N. Hagen, R.T. Solberg, T.U. Nærland & M.F. Duch (Red.), *Når musikken tek form: Om skapande praksisar i musikk* (s. 377–435). Fagbokforlaget.
DOI: https://doi.org/10.55669/oa491111

The composition of acousmatic electroacoustic music in a Norwegian context: part II

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Introduction

This chapter aims to expose the compositional process involved in one of the main sub-branches of electroacoustic music that has influenced composers across genres past and present: acousmatic music[128]. The authors are both active in Norway and internationally as composers, performers, producers and educators. Natasha's background is as a composer. Originally from the UK she settled in Norway in 1999 after completing a PhD in electroacoustic composition from City University, London. She has composed, performed and taught throughout the world since 2000. Anders' background is as a composer-performer, having gained a Master's degree

126 Lead author (academic research and artistic research).
127 Collaboration partner (artistic research).
128 For an accurate definition of acousmatic music, see Barrett, 2023, pp. 12–13.

in music from the University of Oslo. His works have been performed internationally and he is active as a teacher in Norway and abroad. Our motivation is driven by what we see as a need to bridge the knowledge gap between score-based contemporary music that visually confirms structure and complexity even before the work is performed, and acousmatic music where primacy of the ear takes centre stage – which has revolutionised a new form of contemporary music creation, structure and expression.

For this chapter, we each composed two acousmatic miniatures and revealed the process of composition by preserving all aspects of the work that composers normally discard. This included our background ideas, sound materials, compositional tests and sketches, technological choices and innovations, and each step of the compositional process whether or not the material or method was eventually discarded. Although we are both proficient in analysing other composers' acousmatic works, (and an earlier version of this article included two such analyses that for the sake of length needed to be removed), this depth of insight is normally impossible to obtain. In the scope of this article, we cannot present all of our results, but have chosen a selection that is representative of the process of acousmatic composition. We then help the reader and listener understand our work by explaining and contextualising the materials in an aural, rather than visual context.

In addition, each of our pieces aim to address the Norwegian music commission fee guidelines[129] that are used as a recommendation for both composers and funding bodies. These guidelines are drawn up by the interest organisations for contemporary and popular music (NKF Norwegian Society of Composers[130] and NOPA Norwegian Society of Composers and Lyricists[131]), and although they have evolved since 2000 to embrace new art forms and technologies, they still use an instrumentation-based definition of workload to define the fees awarded to composers: more

129 https://komponist.no/komponisthjelpen/bestillingssatser

130 https://komponist.no/

131 https://nopa.no/

instruments equate to higher fees. Some amendments for acousmatic electroacoustic music were added a few years ago, but when there is no notated score as visual support, committee members who do not have explicit knowledge or experience of the acousmatic genre understandably find it challenging to compare the work as equal to that of a large ensemble composition. Although commission fees are a lifeline for composers and the survival of a complete genre, there has been no academic study investigating this dislocation between committee knowledge and compositional workload. A clear-cut understanding of complexity in electroacoustic music is not easy without a good knowledge of the genre. For instance, the sound of ocean waves is just a simple recording, yet highly complex in timbre. On the other hand, a sound that alludes to or is reminiscent of the sound of waves, may have involved a considerable amount of creative work – recording, transformations and iterative shaping and control, even before it finds place in a musical structure.

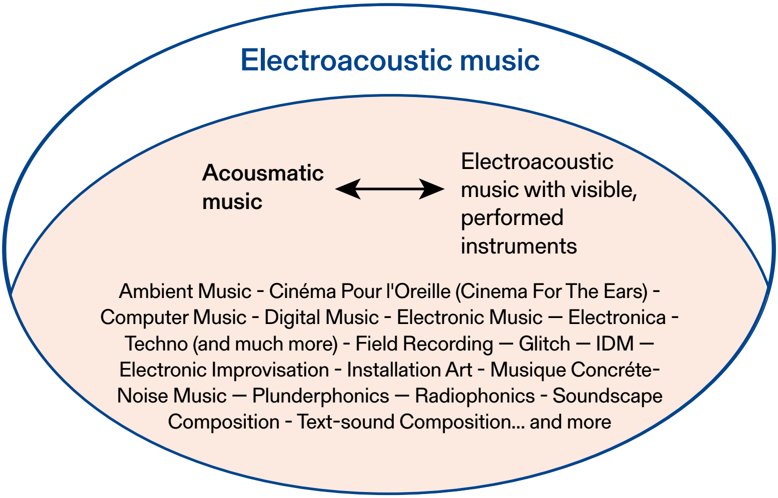
We have both experienced two sides of the commissioning system – from the outside as composers and performers, and from the inside as committee members where we have gained practical insights into how the system could ideally function. Although the main goal of this article is to highlight the process of acousmatic composition to readers, listeners and practitioners of other genres, we see it as a valuable contribution to discuss the work involved in creating our compositions, proven by our material evidence, and place them in what we regard as appropriate commission fee categories.

Our current musical context

In Figure 1 we summarise the architecture of modern electroacoustic. The Figure draws on an international perspective, but with so many Norwegian composers active throughout the world, we can also assume local relevance. The Figure is thus based on the well documented history and culture summarised in *The composition of acousmatic electroacoustic music in a Norwegian context: Part-I* (Barrett, 2023), which spans the 1940's pioneering work of Pierre Schaeffer and the broad diversification of current sound-based art forms.[132] Electroacoustic music is a top-level umbrella term. The two main categories of electroacoustic music are acousmatic music and electroacoustic music with a visual performance element, which also feed into each other in every way *apart from* how the non-visual strategy of acousmatic music changes both composition and listening. In fact, the terms 'Acousmatic', 'Musique Concrète' and 'Tape music' are synonymous, as are the terms 'Instruments and Tape', 'Mixed Music' and 'Electroacoustic music with live instruments'. All are directly connected to both the terminology as well as genre of electroacoustic music, as explained in 'Untangling misunderstood and important terminology in a Norwegian context'. Since the 1990's, genres grew from, reacted to, and diversified from this framework. In *Post-Acousmatic Practice: Re-evaluating Schaeffer's Heritage* (Adkins et al., 2016) the authors discuss what they have labelled 'Post Acousmatic practice' and place 'acousmatic' centre stage amongst a variety of electronic music genres and labels. This is a similar approach to our Figure, however we disagree with the term 'post' because the acousmatic genre is still in its youth and developing far faster than instrumental contemporary music. In our musical analysis we show that technology, aesthetics, knowledge and cultural factors all contribute to this development. In some of the electronica, noise and sound-art genres, practitioners may not consciously realise that their sound-worlds or methods – intuitively shaped and influenced by trends and technologies – share similarities to the sound-worlds and methods of acousmatic music that have infiltrated cultural imagination since the pioneering work of Pierre Schaeffer in the late 1940s (Barrett, 2023). Yet influences are evident in certain aspects of the sounding results, such as acousmatic introductions, interludes or methods. A few illustrative examples include the track 'VIT' on *The Lifeforms* album from *The Future Sound of London* (Future Sound of London, 1994) tracks 'VI Scose Poise' and

132 Basic background reading includes: Bentley, A. & Andean, J. (2019), Chion, M. (1983), Geslin, Y. (2002), Manning, P. (2013).

'Parhelic Triangle' on Autechre's *Confield* album (Autechre, 2000), and the track 'Piece of Paper' on the *ISAM* album by Amon Tobin (Tobin, 2011).



↗ **Figure 1** The umbrella of electroacoustic music.

The impact of technology on our work

Our composition is linked to studio practices and technology, how these have evolved since 1990s and continue to evolve into the future. Until the late 1980s digital technologies were out of reach for most composers who continued to use magnetic tape and analogue technologies. By the late 1990s advanced digital signal processing technologies dropped in price, and although more common in educational institutions, composers could also invest in personal facilities. Exploring and inventing new ways to both compose sound, and compose *with* sound in the digital era had begun. Has the reduced cost led to a democratisation of music technology driving the diversification of electroacoustic music? Only partially. Although at the outset composers were using mainframe computing (and Barrett was using these facilities while studying for a Master's degree in Birmingham in 1994), since desktop and laptop computing, the cost of technology rarely decreases in relation to inflation. Continuous investments must also be expected when software ceases to run on hardware that is only a few years old. Moreover, the latest signal processing algorithms used to be free, albeit not so easy to use, but are now commercialised with attractive user interface and a market-driven price tag. Suitable workspaces and loudspeakers are also increasingly expensive. As both composers and listeners we experience that diversification, as well as technologically driven changes in artistic expression, is occurring by virtue of a democratisation of knowledge and Internet-based sharing. Information, ideas and music are more accessible than ever before; resources explaining how technology works and compositions that have used a specific technology are readily available online, as are digitised textbooks, help groups and forums. When we are constructing new sound processing methods specific to a composition the Internet is a resource of code, examples, bug fixes, and sometimes just a way to detach into the musical world of another composer.

We also experience a simplification of the old, and as a result can explore the birth of new ideas. Many of the previous decade's experiments in what were at the time advanced sound transformation and digital signal processing techniques, are the foundation for today's easy-to-use commercialised software. Less fortunate is that these modern incarnations are generally designed to sidestep the need for technical knowledge and instead emphasise intuitive interfaces and ear-catching results with a few mouse clicks. Examples can be found across the board – from music creation to music production, such as the latest in multi-band compressors and time-stretching algorithms. Yet there is a creative paradox: challenging and pioneering compositional techniques of the 1980s to 1990s have been dramatically simplified. Artistic investigations that would consume days or weeks of thought and experimentation have in some cases been simplified to naivety in real-time software requiring only a basic degree of ear-hand-eye coordination and little technical understanding. Features that are not commercially viable are omitted from software, yet as we will show in our own work, this is a problem which can only be solved by inventing our personal solutions.[133]

In summary, although the change in technology has changed how we work, our explorations are no less challenging than 20 years ago. The time involved in creating a composition has simply shifted in terms of how technology is used and how composition experiments are undertaken. In some instances, non-commercial solutions are chosen. In other instances, using a digital processing method wrapped in an easy-to-use interface becomes a motor skill, freeing work capacity for new experiments. Riding with or against the current of commercialisation can be one of the key differences between the work process of 'popular' and 'non-popular' music created with computers.

Method

Although composers are often generous in providing insights into their own music for analysis purposes, the materials needed for this chapter are those they generally discard whether or not they eventually found their way into the final composition. The sheer quantity of materials, and that they exist primarily in gigabytes of sound and inside computer programs, means that archiving and documentation for a third party is a rare commitment, further impacted by the need to create a written explanation of what the composer intended or was thinking at the time. This is a far more difficult task than for instrumental composition which already exists in a written format, and sits within a framework of known instruments, or sounding objects performed by humans of known physical attributes. Finally, obtaining royalty free permission to use extensive extracts of other composers' sound materials is also prohibitive. Thus demonstrating,

133 The most recent development is the integration of artificial intelligence algorithms such as machine learning into commercial music production software where, as of 2024, the commercial implementation is limited compared to the potential that AI offers.

illustrating and explaining the process of acousmatic composition required each of us to compose new works. Our approach is far from autoethnographic and acknowledges the history and context within which we work. Our research brings forth results exposing what is normally hidden from everyday listeners or from music practitioners outside of our field.

To combine our composition and documentation we agreed on four starting points:

- A common theme: water. Water is a much-used sound source in acousmatic music spanning early works like Toru Takemitsu's 'Water Music' (1968) where it is used as the only sound source, to David Berezan's 'Buoy' (2011) where the ocean serves as both the framework and a prominent sound source. This theme would challenge our abilities to explore original musical avenues yet serve an accessible theme for listeners.
- The audio format: We agreed to compose in the 3D Higher Order Ambisonic (HOA) spatial audio format (Barrett, 2023, pp. 5–7)[134] using any software or code of our choosing. HOA allows advanced creative investigations as well as practical and flexible performance: we can compose spatial musical structure in a way that is not possible in stereo, and is imprecise in surround sound or in 8-channel formats (Barrett, 2023, p. 13), and we can perform the work with spatial accuracy over a full 3D loudspeaker array, decode the work in a reduced version to: surround sound, stereo and binaural[135] 3D sound for headphones. These reduced-scale versions are important for documentation, promotion and for concert organisers who wish to perform the works with sound diffusion (Harrison, 1998; Wilson & Harrison, 2010)[136]. In this arti-

134 For background reading see also Barrett, 2019, and Barrett, 2016.

135 https://en.wikipedia.org/wiki/Sound_localization

136 See also Barrett, 2023, pp. 7–10 for an explanation of sound diffusion performance practice in a Nordic perspective.

cle, our compositions and sound examples are rendered in both binaural and stereo.

- We each composed two works using similar sound materials aimed at different categories in the commission scheme guidelines.
- We agreed to save and describe materials that would be illustrative of our practice. From our experience as composers we already knew that documenting every aspect of our work would be prohibitive due to the sheer magnitude of materials and agreed to preserve those that were most indicative.
- To avoid cross-fertilisation of ideas and methods we worked independently and agreed not to discuss our work until we were finished.

Our method therefore consisted of a parallel process of composition, documentation and archiving. We then compared our results that consisted of artistic creation and factual description, edited the content to avoid duplication and drew some general conclusions. In our final discussion we then take a partly autoethnographical approach to how and why we evaluate our work in relation to the composition commissioning guidelines.

Before continuing it is important to emphasise that composing acousmatic music combines knowledge of digital signal processing, perception, acoustics and in most instances, (including our own), an advanced use of computer tools. Many of our artistic choices and results can only be understood by showing and explaining the technology used in that process. If we remove this technological exposure, not only does the explanation fall apart but moreover the art would not have existed to begin with. All of our technical explanations are fairly basic and familiar to entry level composers, but for readers outside of our field we add references and short explanations.

Natasha Barrett compositions: 'Dream Awake' and 'Sensory Sleep'.

I titled my two compositions 'Dream Awake' (example 9) and 'Sensory Sleep' (example 10).

I have worked with water-based ideas countless times over the last 30 years, and as I aim to compose works that are distinct and unique from each other, my first task involved consolidating what water means for me at this point in time. This involved reminiscing about older works, exploring other composers' works, considering the memories of sounds, spaces and places, and other events these memories may trigger:

- Water as a sound source: trickles of water, 'babbling brooks', streams, rivers, waterfalls, geysers, lakes, ocean waves and currents, water seeping through moss, squelching mud, dripping onto and stimulating the sound of other materials, ice melting and rain. The sounds of rivers and waterfalls are noise-based, and when removed from the complete perceptual experience of 'being there', sound generic: one river will sound very similar to the next. The oceans create a sound that is more shaped in time: the repeating phrase of waves breaking on the shore, sucking back through the stones, shingle and sand, and the thump of the breakers on the cliffs. These sounds are more revealing of the place they were recorded. Many of these sounds call for a long duration to 'speak' and would occupy too much of my miniature composition. But maybe I could allude to sounding memories through the behaviour of my composed sounds – sounds which would not need to be from the sea at all (Barrett, 2023, p. 5).
- Water as play: we all play with water at some time. Trickles and drops falling into a vessel, the suction of an upside-down cup pulled upwards from a tub of water, blowing bubbles through a straw, squeezing a sponge or playing with water as an

instrument. Schaeffer would have liked these sounds (Schaeffer, 1966/2017, pp. 212–216) for their intrinsic potential (Smalley, 1997).[137] I, on the other hand, am attached to them because of memories, and that they imply something that is alive.

- Water as a concept: a thing of recreation, a source of life, a source of death, a carrier of myth and fiction. My 50-minute work 'Trade Winds' (Barrett, 2004) was based on too many of these ideas to revisit them again in my miniatures.

After these thoughts I decided to explore the intersection between abstract music, an allusion to wateriness and the sound of water itself, and then experience how the materials spoke to me.

Technical and artistic framework

The next stage involved recording water-like sounds. My recording techniques echoed the close-microphone playful approach of Schaeffer (Schaeffer, 1966/2017, pp. 268–275 in Barrett, 2023, p. 4). I always record my own sound sources uniquely for a specific composition or suite of thematic works. Only then can I control technical quality, adjust the microphones to explore sonic qualities and experience the complete multi-model situation, the memory of which may seed ideas for sound transformation and musical expression even when only the sound's trace is left on the recording. I recorded with the following microphones:

- An ambisonics microphone: this records the complete 360-degree sound-field. I used a 1st-order ambisonics SPS200 microphone (Soundfield, 2022) due to its frequency and dynamic response, rather than the higher-order (more spatially precise)

137 For an elaboration of Schaeffer's ideas on this topic see Barrett, 2023, p. 4.

alternatives available at the time. I then applied technical solutions to improve the directionality of the spatial recordings.[138]

- Mono microphones: these offer an omni and cardioid directionality.13 I positioned four of these in experimental placements close to the sound sources.
- Hydrophones: these are mono and omni-directional microphones meant for underwater use. I find these microphones interesting as they abstract the identity of the source in the recording.

As the composition is created in the ambisonics spatial domain, material stemming from non-ambisonics recordings require spatial encoding. Our current ambisonics encoding software biases the user to spatialise points in space, while real-world sources create non-uniform sound images in space. My workflow therefore included a solution that I have invented over the last decade to serve a more flexible musical development of spatial images and scenes, integrated with sound transformation as part of the compositional process. We'll return to this later with musical examples.

Sound sources

The sources I chose were simple:

- Water trickling and dripping into a metal container, recorded with all microphones apart from the hydrophones. Qualities hinting to a kind of 'resonant song' appeared while performing with the water and the microphones. I hoped to develop and transform these 'singing' qualities with sound processing.

138 This can be achieved with spatial 'upmixing' software such as Harpex (Berge, 2010) https://en.wikipedia.org/wiki/Microphone

- Natural rain falling into outdoor puddles was recorded with hydrophones and the ambisonics microphone. I particularly liked the hydrophone recordings as they were 'dry' (no spatial acoustic) and 'abstract' (unclear if they were water sources or just chaotic rhythms).
- Rain falling inside a derelict building, recorded with the SPS200. This recording captures a complete scene and would be useful as a window into reality. It is essentially a field recording (Barrett, 2023, p. 15).

Sound transformation and sound creation as part of the compositional process

From approximately two hours of materials, I needed to create sound objects[139] of just a few seconds in duration. My choices were guided by knowledge and experience combined with a good guess as to the possible outcomes of different sound transformation techniques. However, at this stage I was sure about very little, and took a selection of sound extracts with similar features. As we shall see later, one small variation in the source sound can result in significant musical impact.

To illustrate this chapter, I focused on two artistic ideas and how they were explored through an integration of technology and composition.

Artistic idea 1: the flux between the reality of a watery sound landscape, an allusion to rain, and a musical abstraction

The sound sources used to investigate this idea were:

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139 A sound object is a sound phenomenon or event that can be perceived 'as a whole' or as a coherent entity. It does not exist in itself, is not simply a sound surrounded by silence, but concerns the way we direct our listening. (Schaeffer, 1966/2017, pp. 210–212; Chion, 1983, pp. 32–33).

- Rain falling inside a derelict building and into puddles, recorded with the SPS200, (sound example 1).

Sound example 1

- Rain falling in puddles recorded with hydrophones (sound example 2).

Sound example 2

We can hear from the sound examples that granular characteristics are common to both. Just as a sculptor will first select tools appropriate to the media and then swap between them to achieve the desired result, we do the same with sound processing tools. To explore my artistic intentions, I therefore experimented with granulation processing techniques[140] as these would allow me to transform seamlessly from the reality of the source into allusion and then abstraction. There are many tools available for granulation processing and I decided to test three options, not knowing at the outset which would be best for the job. Below I explain the three tools, their features and failures, what happened in the experimental process, and how I then proceeded in the compositional context.

The three tools:

(1) A commercial VST plugin (the GRM Tools VST 'SpaceGrain'[141]): VST plugins are loaded inside a digital audio workstation (DAW). They are intuitive to use, come with fun visual interfaces and haptic

140 Granulation, or granular synthesis, is a sound transformation method where an input sound is cut into smaller segments or grains, and the segments rearranged in some way. All grain parameters can be controlled, such as size, pitch, spectral filtering, density, statistical distribution in time and space, and temporal expansion or contraction.

141 https://inagrm.com/en/store 17 https://cycling74.com/

controls, produce sound in real-time and are the most immediate and user-friendly option for all kinds of sound processing.

(2) Custom-made processes in MaxMSP17: MaxMSP is a visual programming framework where users construct their own real-time custom signal processing routines from high level code encapsulated inside visual objects displayed in a 2D layout. MaxMSP ships with an extensive set of objects and many external packages can also be downloaded. I built my own signal processing routines and interactive interface using the Spat5 package from the Institute for Research and Coordination in Acoustics/Music (IRCAM).

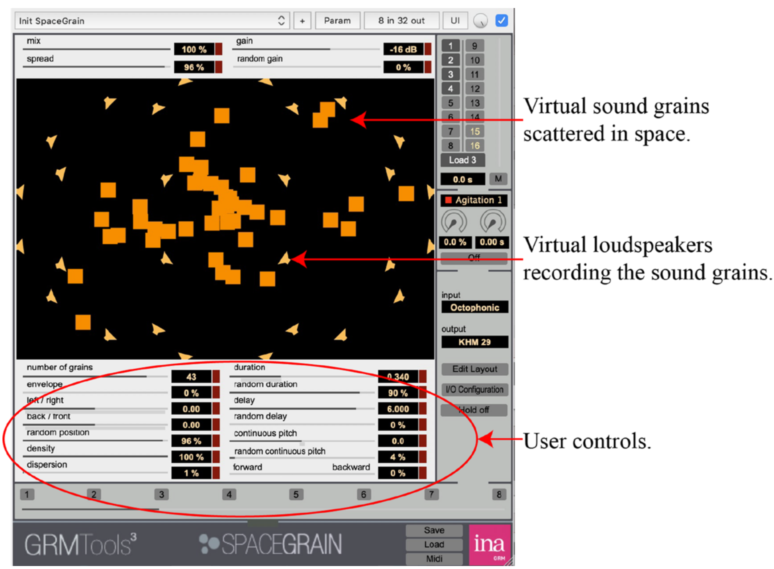
(3) Unique processes programmed in code: the user needs to be proficient in computer programming languages or collaborate with a programmer. As composers, we rarely create graphical interfaces as this is a time-consuming phase mainly applicable for software distribution. The programming approach is itself time consuming compared to the two other methods described above but is the most powerful option. In 2000 I developed a granulation program in collaboration with a programmer and in recent years updated this to include more features. I control the code with a set of commands (a command line and a script[142]) which runs offline (i.e. non-real-time).

In the following I explain what happened to my sounds and musical ideas as I explored each option:

(1) Commercial VST plugin: GRM Tools VST plugin 'SpaceGrain'. In simple terms, this tool segments a mono or stereo input into small 'grains' of sound, scatters the fragments in a virtual space, and the result is then captured by virtual speakers which can

142 A script consists of text commands that then control the signal processing code.

be connected to real speaker feeds or recorded out to a sound file. The plugin allows the user to control everything that defines the grain and the distribution of the scatter. I can either use the plugin's virtual speaker presets or design my own configuration. As I would be working in the 3D ambisonics domain, and the software knows nothing about ambisonics, I made a virtual 3D loudspeaker dome that could later be encoded into ambisonics (where each virtual loudspeaker becomes a source point in the 3D sound-field). In the example below, my dome consists of 29 virtual loudspeakers. This produces a 29-channel sound file. I then encode each channel in its appropriate location in 3D ambisonics space using an ambisonics encoding software. Figure 2 is a screenshot from one of the configurations that I tested.



↗ **Figure 2** GRM Tools VST plugin 'SpaceGrain'.

While listening to the output I can change the parameters in the bottom of the Figure. These parameters can be time varying and controlled by a mouse, by controllers (mapped to midi faders or knobs) or with data tracks[143] in the DAW. The plugin was fun to use but I was unhappy with the results which sounded clumsy. I believe this was because I could not control grain duration, density and spatial distribution in the way I wanted to. There were however interesting artefacts[144], produced erratically for just a few seconds in the transitions between parameter values. I decided to keep some of these artefact sounds in case they were useful (sound examples 3.1–3.2).

Sound example 3.1

Sound example 3.2

(2) A custom-made process in MaxMSP.
I have used MaxMSP extensively since the software was released in 1997 and regard myself as an expert user. My MaxMSP process was constructed using the Spat5.gran~ object. I had previously used this with great success in a live performance, yet now the output contained unwanted clicks when changing variables over time. After a day of frustration and searching user groups for a solution I decided to move on and agreed with myself that I would return here if other processes didn't achieve my goals. Failures like this are common when we experiment with new technology, and are part of the learning process. With perseverance the problem is eventually solved. Later I found that

143 Tracks that contain control data rather than audio.

144 Artefacts are something that commercial software has, over the years of technological change, tried to avoid, as they are regarded as an error, bug or mistake.

the clicks were because I was attempting to control two conflicting parameters.

(3) Fully custom processes.
The revamp of my custom granulation program allows me to spatialise grains in the ambisonics domain. Nearly every grain transformation parameter that you can think of can be controlled by this program, which may sound luxurious, but makes the output less predictable. Controlling the program with a command-line means the results are not modifiable in real-time. Yet this scripting approach does have its advantages: I can program countless transformations around a theme, run the script, and then listen to the results. This way of working removes the hand-eye listening bias (where what you see dictates what you *think* you hear) and allows me to focus on the sound. Use of this method produced many hours and gigabytes of sound in high resolution 3D ambisonics, most of which were discarded. Sound examples 4.1–4.6 are extracts from six outputs that were then mixed inside a DAW and used in 'Dream Awake' between 00:20 and 01:00 in the composition. Each output is two minutes long, but only the highlights were used in the composition.

Sound example 4.1

Sound example 4.2

Sound example 4.3

Sound example 4.4

Sound example 4.5

Sound example 4.6

Artistic idea 2: Singing drips and a counterpoint of droplets

The idea of 'singing drips' that I partly heard and partly imagined while recording felt like a living, almost human quality, that I wanted to explore further. I am also preoccupied with the idea of musical counterpoint and how this can be manifest in space as well as time and timbre, and the drips would lend themselves to this investigation. I began with a few short extracts from the recordings (sound examples 5.1–5.4).

Sound example 5.1

Sound example 5.2

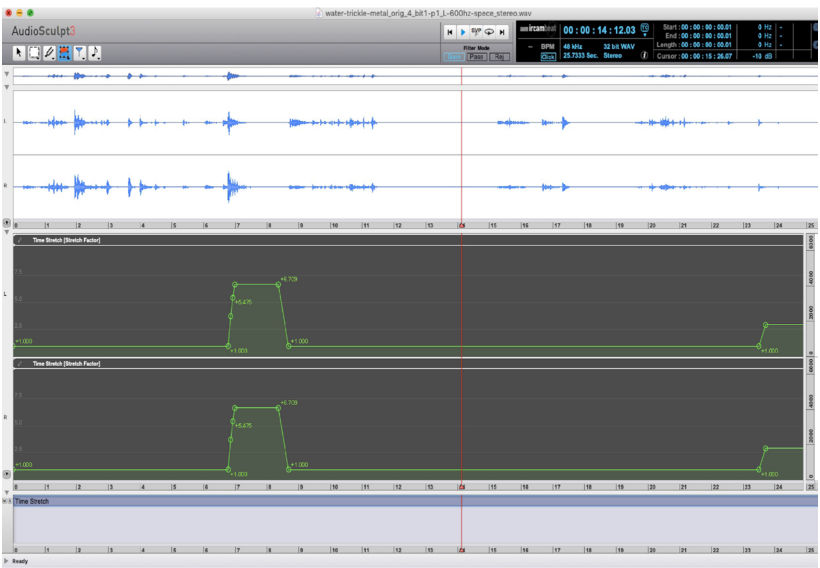
Sound example 5.3

Sound example 5.4

To expose the qualities I was interested in, I guessed that pitch-shifting (playing a sound waveform at a different speed than it was recorded and changing both pitch and duration), time-stretching (changing temporal information without altering pitch), spectral transposition (transposing all the partials in the spectrum by the same amount, Amatriain et al., 2002, p. 39), filtering and spectral stretching (where the spectrum is stretched in the frequency domain, Amatriain et al., 2002, p. 40) would be most useful. The outputs from these experiments were pleasantly surprising, but required what I call micromanagement in sound design, or in other words manually attending to a small portion of a processed sound and mixing it with many other small portions to then create one new complex entity. Below I give examples of how this was done and how it became part of the compositional process that shaped the final work.

(1) Time-stretching
Time-stretching transformations can be achieved with software integrated into the DAW or with standalone software. At the time

of writing, DAW-based algorithms rarely allow the user a great deal of control. Instead, the software aims at the most realistic time-stretch based on an analysis of the spectral-temporal content of the source, without the user needing to know how it works. This is an advantage in some instances but not others: instant realistic time stretches are possible on pitched sources such as musical instruments, while on noisy or non-pitched sounds the algorithms often fail. Although failure in terms of what the software designers intended is not necessarily a bad thing (such as in the example of artefacts with the VST plugin example above), the software prevents the user from experimenting further with these ideas. Some examples of standalone software do allow this, and experimenting with lower-level control over the



↗ **Figure 3** Screenshot from Audiosculpt, time-stretch detail.

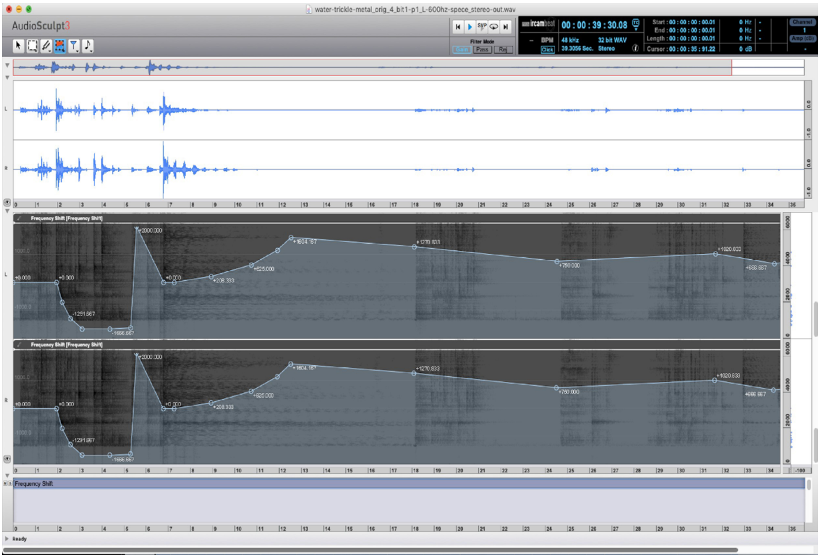
algorithm was necessary for me to explore my singing drops in both temporal and spectral domains. I chose to export my sound extracts out of the DAW and process them in an experimental software made by IRCAM called Audiosculpt (IRCAM, 2010).[145] Here I could control more parameters accurately over time. Figure 3 is a screen-shot from one of the Audiosculpt time-stretches, here applied to example 6.1 and resulting in example 6.2.

Sound example 6.1

Sound example 6.2

(2) Spectral transformations: pitch shift, spectral shift, spectral stretch.
Amongst the many features of Audiosculpt are spectral shifting and precise control over time-modulated spectral filtering. Figure 4 is a screenshot from an Audiosculpt frequency shift applied to the time-stretched output above. The frequency shift is controlled with a breakpoint function aligned with the morphology of the original sound. The result of this process can be heard in sound example 7.

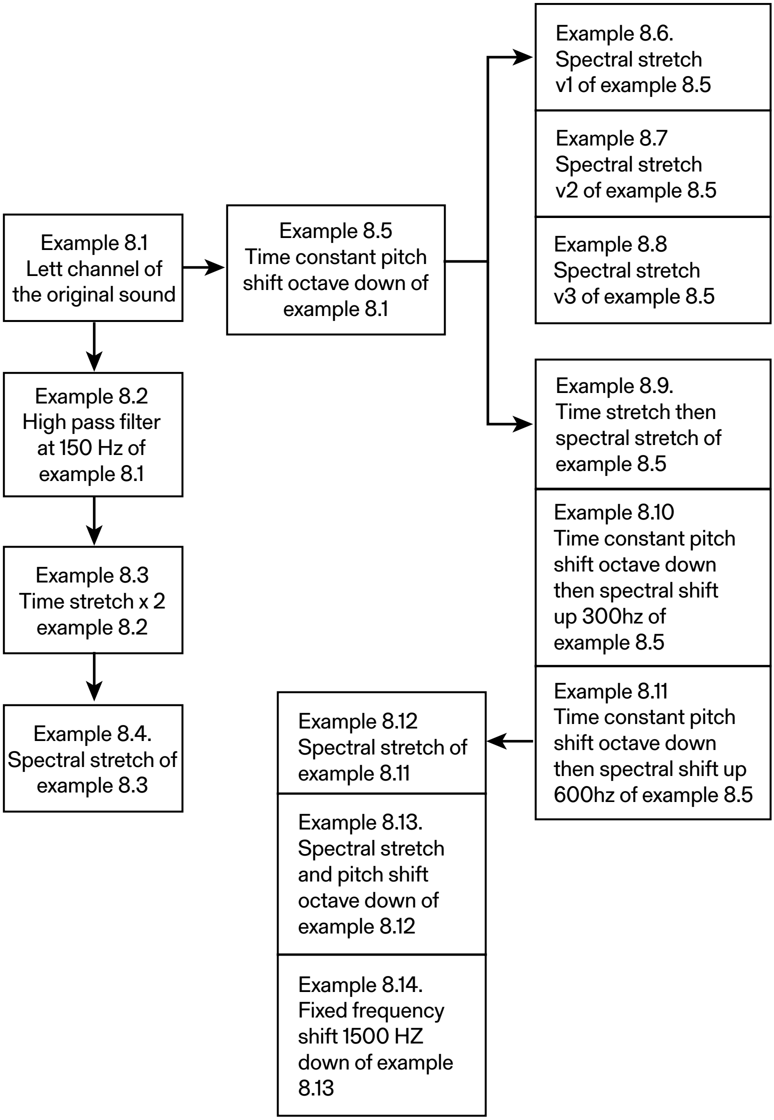
145 Audiosculpt no longer runs on the new operating systems and has been replaced by three new IRCAM software programs: ASAP, Partiels and Ircam-Lab TS2 (https://www.ircamlab.com).



↗ **Figure 4** Screen shot from Audiosculpt frequency shifts.

Sound example 7

Another tool that I decided to revisit was the CDP (Endrich, 1997). This is a suite of non-real-time sound processing algorithms dating from the late 1980s. I used it extensively in the mid-1990s as it was one of the few interesting sound processing options available at the time. Pioneering composer, educator and software designer Trevor Wishart, who programmed many of the algorithms, continues to use it extensively in his composition. The CDP is controlled by a script (similar to my own granulation software), although there is a graphical front end for the PC. In the CDP there are (surprisingly) still a few spectral modification



↗ **Figure 5** A small subset of consecutive CDP transformations corresponding to sound examples 8.1–8.14.

algorithms that exist nowhere else.[146] Here is an example of how I used the spectral transformations in an iterative chain of experiments: approximately 20 variations of one sound were processed. I then selected two that began to speak with the qualities I was looking for and repeated the process. Figure 5 is a table summarising the results of this iterative process, which can be heard in examples 8.1–8.14. Most of the processes are controlled by time modulating parameters, also controlled by data files.

Sound example 8.1
Sound example 8.2
Sound example 8.3
Sound example 8.4
Sound example 8.5
Sound example 8.6
Sound example 8.7
Sound example 8.8
Sound example 8.9
Sound example 8.10
Sound example 8.11

146 The Kyma system is the closest option but requires expensive hardware. Anders explains his use of Kyma later.

Sound example 8.12

Sound example 8.13

Sound example 8.14

Micro-mastering

Some of the examples presented so far sound erratic in spectral and dynamic qualities. This is due to close-microphone recording capturing rapidly changing frequency radiation patterns of the source. Digital transformations emphasise these changes sometimes inappropriately, especially when frequencies are shifted into the ranges of our hearing to which we are most sensitive.[147] Every sound is unique in this respect and requires spectral and volume control at millisecond precision. I call this micro-mastering. Although the new range of analytical mastering VST plugins can speed up this manual adjustment process, they often remove additional qualities of the sound and are commonly incompatible with the ambisonics spatial format.

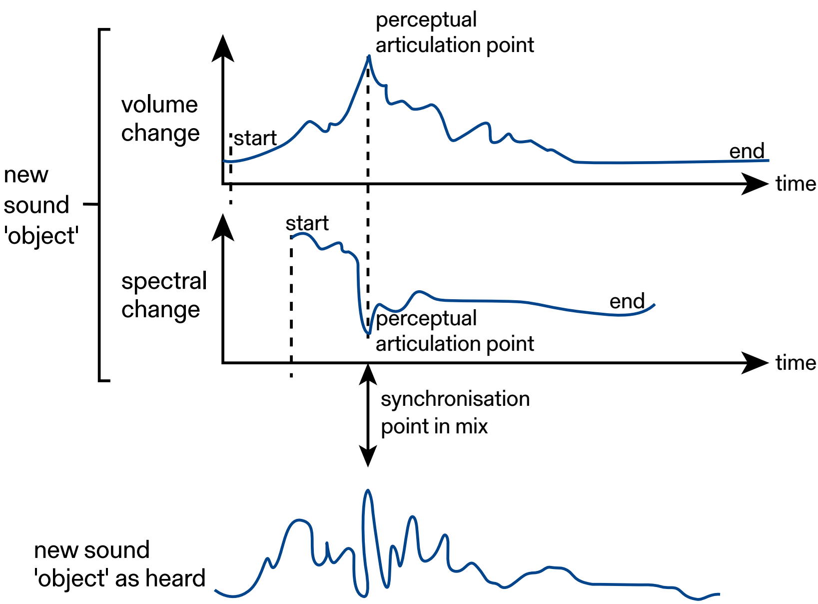
Time, mixing and small composition sketches

We are not composing beat or note-based music where a MIDI sequencer, looping software, or notation programs can be used to organise the timeline. In fact, for most of our sound materials a sequencer is inappropriate. Here I will explain why, and also illustrate how we work. In Figure 6 I have drawn the morphologies for two short sounds: the top part is the volume morphology of sound-1 and the bottom is the spectral morphology

147 Our perception of frequency and volume is non-linear, as shown in Fletcher–Munson curves that plot equal-loudness contours for the human ear. A simple explanation can be found at https://en.wikipedia.org/wiki/Equal-loudness_contour.

of sound-2. In this example, the start of sound-1 begins from silence and then increases to its loudest point before fading away. The *perceptual* articulation is at the loudest point and not at the start of the sound. In sound-2, the perceptual articulation is at the low point of a dramatic spectral sweep.

If I want to merge these two sounds into a single new sound, they must start at different points in time. MIDI cannot be used to control the timeline because even if we were to shift the MIDI note-on message of sound-2 so that the perceptual articulations coincide (which is not easy without seeing the waveform), any small changes in pitch transposition would change the durations of the two sounds and decorrelate the synchronisation. Next, the volume curve of each sound must be modified by



↗ **Figure 6** Manually constructing time.

hand to create an optimal fusion of timbre. As sounds used in the composition are rarely repeated in identical form, each combination requires individual attention. If the composition is created from short sounds, rather than longer layers, hundreds of manual operations like this may be necessary (which clearly impacts the workload of works requiring this micro-mixing technique compared to drone-based music). When I compare this acousmatic composition process to my instrumental orchestration, I have to prepare myself for the time that it will consume. But the results are incredibly satisfying as they are always new and unique.

Composing space

Like most sound transformation processes, spatialisation in the ambisonics format can be achieved with simple VST plugins as well as more customisable options in MaxMSP and programming languages. Ambisonics VST plugins allow us to position and move mono points on the surface of a virtual sphere. Although the results are far removed from spatial reality, the software is user friendly, intuitive and the results are fairly useful. But as I mentioned earlier, real-world spatial-images do not sound like isolated points in space. Creating and controlling spatial images, composing surreal and abstract spatial landscapes and exploring the musicality of spatial-sound counterpoint, for me requires a technical solution in addition to VST plugins.

For this I program my spatialisation in IRCAM's Spat5 MaxMSP package that affords complete control by creating images with clusters of sounds and their directional radiation patterns. I nevertheless use a DAW as a compositional sketch book. The DAW serves as a 'container' for the musical mixes and synchronised spatialisation data. Sound and data are then both passed out of the DAW and into MaxMSP (and Spat5) in real-time for the actual spatialisation. After perfecting the spatialisation, the result is recorded to an encoded HOA sound file. Many composers use Reaper[148] as first choice DAW as it currently provides the best HOA mixing features and the cost is insignificant. I however find the automation (data tracks) in Reaper currently too clumsy for storing my spatial information[149], and instead use Nuendo[150]for this first stage. Reaper must re-enter the workflow for mixing 64-channel HOA files, which is not possible in Nuendo.

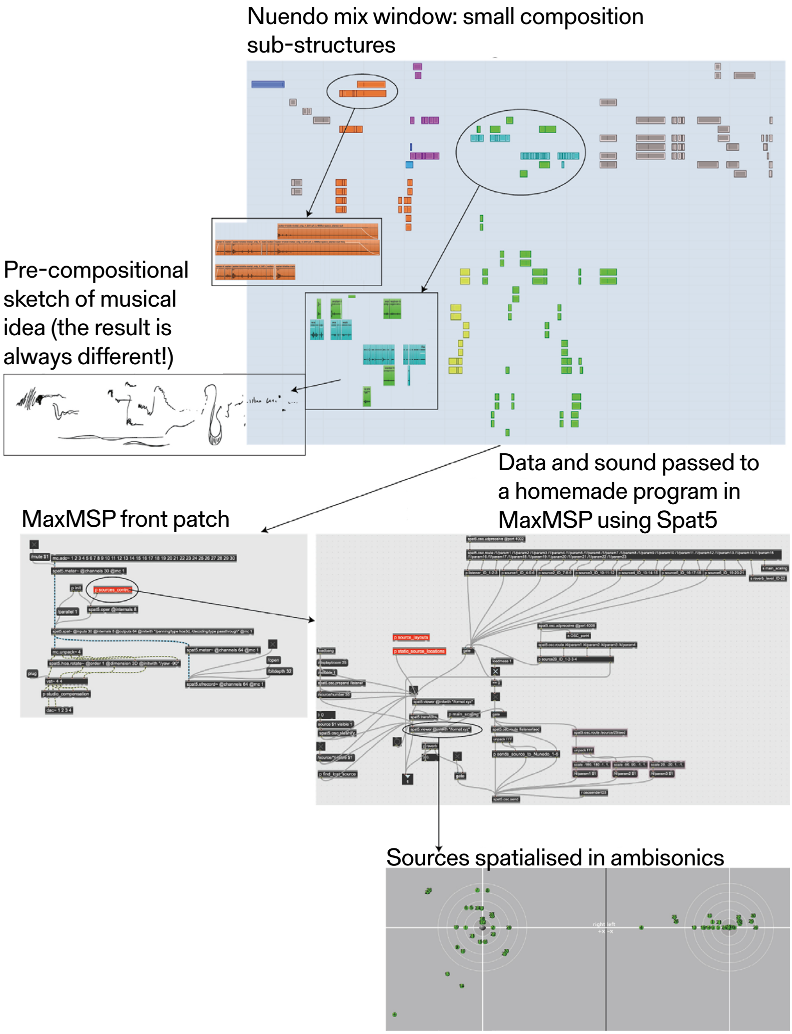
This compositional procedure is summarised in Figure 7 and video example 1. The top portion of Figure 7 is a screenshot of a small mix of mono and multichannel files arranged in Nuendo. Sound and spatial control data are then passed to MaxMSP for processing the space in 3D ambisonics. At the bottom of the Figure is a screen shot of the front and side screen view of the Spat5~ viewer showing my cluster of spatial points (green dots) which create images and scenes in relation to the listener that is in the centre. The video shows the process in action: I create a landscape of points, but these are not all initially sounding. I will gradually send sound to each point and reveal the images and space *through* time. In the video the green points are controlled by data being passed on from Nuendo, as are the sounds. Note how the morphology of the sound is controlled in keeping with the spatial movement. The complete musical context can be heard at 01:00–03:00 in 'Dream Awake'. This is a typical example of how artistic aspects of composition are inseparable from creative technological solutions, implementation and technical knowledge.

Video 1

148 https://www.reaper.fm/

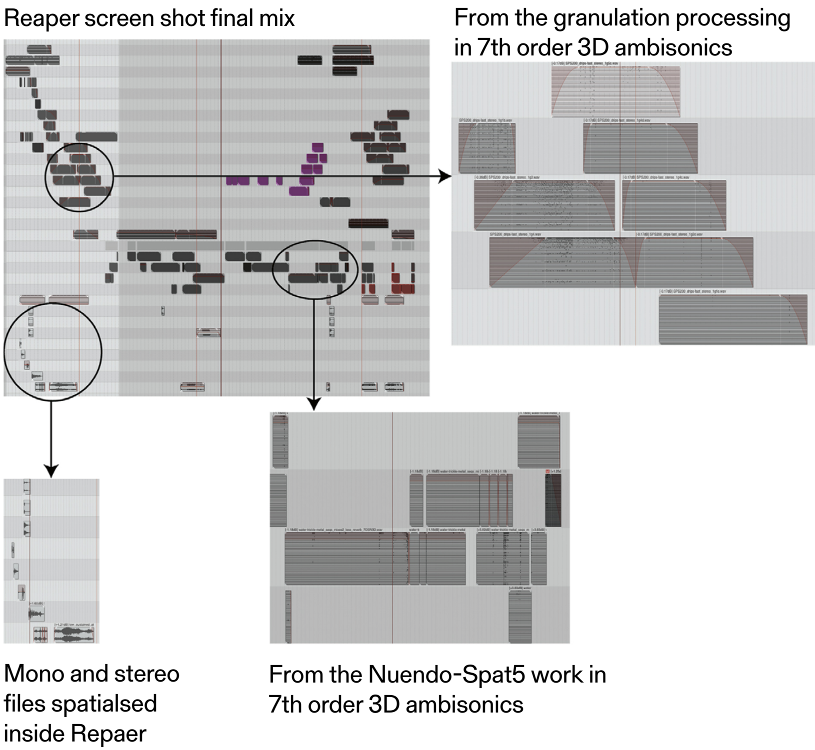
149 This will no doubt improve as the Reaper community is constantly developing the software.

150 https://www.steinberg.net/nuendo/



↗ **Figure 7** Screenshots of a small mix of mono and multichannel files arranged in Nuendo, and data and audio passed on to a custom made MaxMSP patch for spatialisation.

Assembling the composition



↗ **Figure 8** A screenshot and details from the final mix of the composition.

Inside Reaper I combine different formats of ambisonics:

- Highest resolution 7th-order 3D sounds (from the granulations and from the Spat5~ outputs). These are 64-channel sound files.
- Medium resolution 3rd-order 3D sounds (this is the maximum spatial quality of my ambisonics recordings). These are 16-channel sound files.

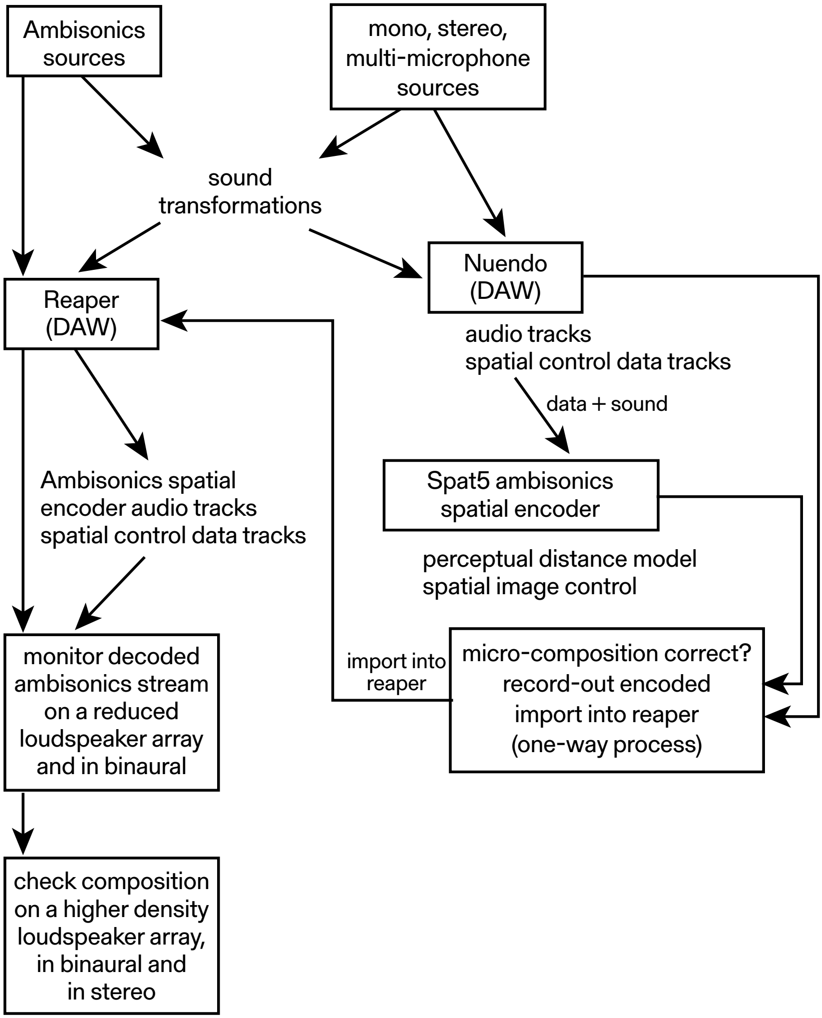
- Mono and stereo sounds, spatialised with ambisonics VST plugins. These are for simple articulations contrasting the more complex spatial scenes and images.

Figure 8 shows a screenshot and details from the final mix of the composition. One obvious problem is that the waveform overview of the HOA sounds is not at all informative of the content. Listening is once again the most reliable tool. I also feel I am a conductor as well as composer: tweaking the timing and dynamics of the phrase as if it were the optimal performance. After experiments with editing, mixing, re-processing, re-editing and remixing, the smaller mixes begin to communicate something musical beyond the single sounds. Then we understand that the composition is taking shape.

A summary of my global compositional and technical workflow is shown in Figure 9.

Although surrounded by computer tools, I also sketch on paper. This allows me to analyse how the aural musical structure is taking shape and understand how to improve, develop or change. In Anders' section he will show some of his most basic sketches.

My work resulted in 'Dream Awake' (example 9) and 'Sensory Sleep' (example 10). As all composers, we are thinking about our audience. In Norway, performing high resolution 3D spatial compositions is a rarity, but the situation is different internationally. Between 2023–2024 alone, my two pieces have been played in ambisonics concerts and festivals in London, Birmingham, Venice, Iceland, Hong Kong, USA and Poland, where all concerts were full 3D (with speakers arranged in both horizontal and vertical dimensions), other than in Venice, which was a surround horizontal array of loudspeakers, similarly to how we more commonly perform in Norway.



↗ **Figure 9** The main workflow.

Sound example 9b

↗ **Dream Awake.**

Sound example 10a

↗ **Sensory Sleep.**

Anders Tveit: ‘Phases’ and ‘... i ett vannglass’

I composed two works entitled ‘Phases’ (sound example 15) and ‘... i ett vannglass’ [...in a glass of water] (Sound Example 17). Like Natasha I have used water sources in my previous work, for example in ‘Currents’ (2021) where I used recordings from water currents and water streams. This time, to explore water in a different way I started by thinking about how water is a substance that is present in all three states and phases of matter: As gas (bubbles, steam/vapour), fluid (water in the sea, rain, etc.), and as solid (ice, snow). I thought this would give a range of different sounds and textures. For my first composition entitled ‘Phases’ my initial idea was to record sounds from these states or phases but also use these different states more conceptually, where sound transformations would shift between various states, reflecting the states of matter. However, as the process moved on, I gradually moved away from this idea which led me to include the pulses of raindrops, the dynamics of waves, and simply, water as a playful component.[151] For my second composition entitled ‘... i et vannglass’ I wanted to compose a simpler piece – something that was more akin to a soundscape with less action and forwardness, with slowly developed immersive sound, with subtle changes and surges.

151 Also see Natasha’s musings on playfulness in section 5 and Barrett, 2023, p. 3.

Technical and artistic framework

Some sound materials were synthesised in Max, but most were recorded using a combination of the following microphones:

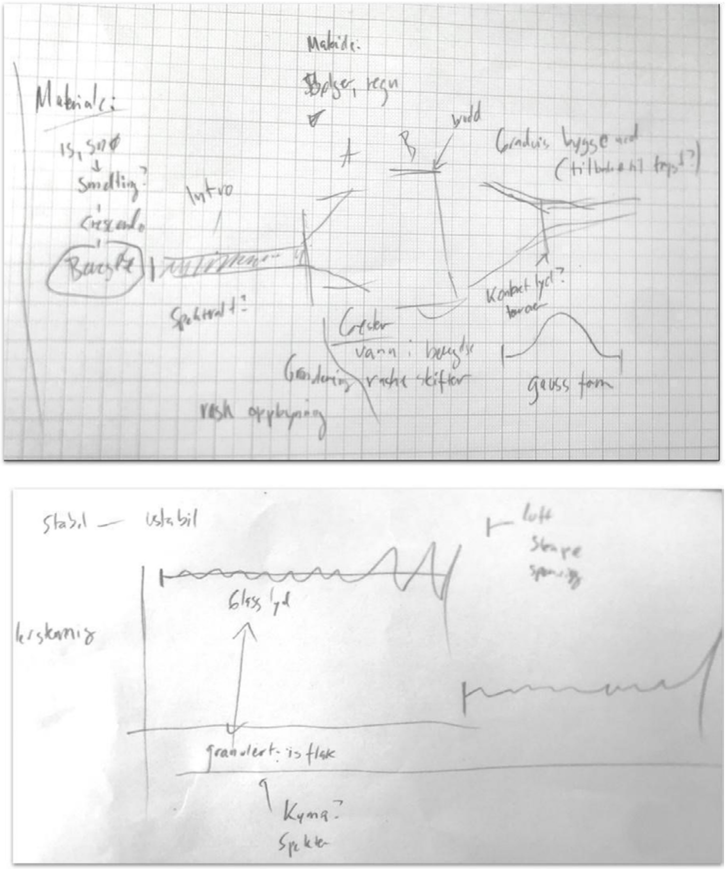
- Different cardioid microphones in mono, stereo or multi-mono arrays.
- Ambisonic microphones: 1st order (CoreSound TetraMic) and a 3rd order Ambisonic Microphone (Zylia ZM-1)
- Combinations of home-made and commercial Piezo (contact) microphones.

Reaper (DAW) was used for assembling, editing, and composing. For audio processing, sound transformations, and manipulation, several plugins hosted in Reaper were used along with self-developed and existing tools in Max and the Kyma system.[152]

Even before I start recording my source material, I usually make small and crude written sketches. Sometimes these sketches can be ideas about concepts, sound textures, dynamics, and how I envision the development of the piece. Or sometimes it is a kind of graphically notated score or combinations of both. It's often open-ended and will exist in many different versions. Although rarely elaborate, getting the ideas down on paper seems important in my general process and I never find it easy to write or make these early sketches on a computer. I find the use of paper quicker and more fluid, although I rarely create a score or a graphic transcription of the piece while I'm composing. I made various rough sketches with keywords and ideas about musical form before I started.

Figure 10 is an example from the two pieces.

152 https://kyma.symbolicsound.com/about-symbolic-sound/ Scaletti, C. & Hebel, K. n.d.



↗ **Figure 10** Above: early sketch 'Phases'. Below: early sketch '… i ett vannglass' with notes and questions to myself.

The sound creation process

I like to explore various combinations and interactions of both abstract (musical) and environmental-based sounds. Therefore, an integral part of my composition process involves sound transformations that create new or hybrid sounds from the recorded material. Here I show a simplified outline and general workflow highlighted by sound examples from both compositions.

a. Recording
   Based on my idea of the various phases of water, I recorded the following:

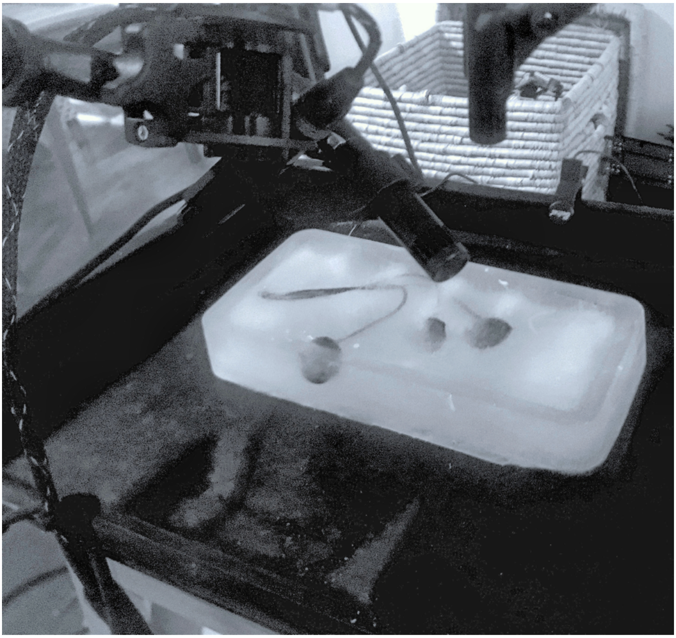
   - Ocean waves (ambisonic recordings).
   - Ice cracking in small puddles (mono).
   - An ice block melting in a metal pan, which involved the freezing of contact microphones inside the ice, as well as multi microphones as overheads.
   - Drips and gushes of water in a sink (stereo).
   - Rain outside my house (stereo).
   - Rain drops on a metal object (used for triggering a synth in Max).
   - Wine glasses filled with water and rubbed with fingers (stereo).
   - Boiling water (stereo).
   - Bubbles and water splashes in a bucket (stereo).
   - Footsteps in snow (stereo), but these were discarded.

b. Selection
   After the recorded material was edited, it was reduced into smaller sound files where a final selection was made by listening for the most interesting timbral and spatial qualities that I thought would fit my compositional idea. I kept the final selection in one folder, as well as some of the original recordings, should I need to revisit these at a later stage.

c. Transformations and variations, iterative processes:
I first decide which material would be interesting to transform or manipulate further. I then edit the transformations and make a new selection process. Some of the sounds in the new selection will be transformed again and the process iteratively repeated. Something which I typically do is to first improvise with the sounds and the transformation processes, and then gradually apply a more parametric approach to controlling the transformation parameters. The sound transformation processes I use can generally be broken down into three main categories. In the compositions that Natasha made for this chapter these categories are fused together, while in my pieces, although the processes are not mutually exclusive (for example, the manipulation of time can affect timbre and vice versa) I can more clearly define them as follows:

- Transformation of time structure: Various delays and granular-based processes, for transforming the time structure of the sound.
- Transformation of timbre: Changing timbral qualities, frequency shifting, filtering, and various spectral sound transformations.
- Spatial sound transformation: reverberation, constructing spatial images from point sources, rotation of sound image(s), manipulation of spatial harmonic components, focusing and blurring of spatial perspectives.

A good example of how our approaches in these pieces differ is in our approach to time. While Natasha worked with temporal factors of on the one hand personal memories and on the other hand the temporal modification in sound processing, I worked with some far longer temporal factors of the sound source, such as the recording of an ice block melting in a metal pan (Figure 11).

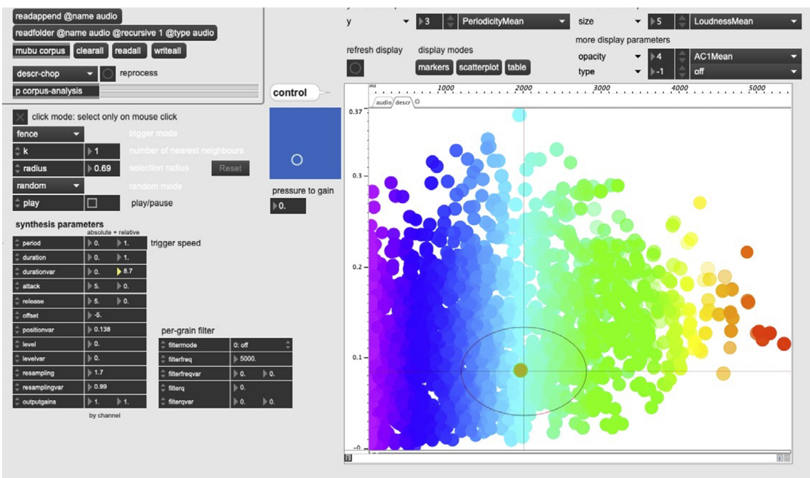


↗ **Figure 11**

Freezing the contact microphones and recording the sound of the melting ice was an interesting challenge and process. However, although some of the recorded sounds were interesting, the *process* of recording was perhaps more interesting than the sounding result! The recorded material was not quite in-line with what I envisioned it to be, where the sound of creaks and bubbles from the melting were just too subtle. Thus, I decided to transform these sounds further in order to get closer to what I had in mind, which was to expand the creaks and bubbles arising from the melting process. (Sound example 11.1: ice melt, extract).

Sound example 11.1

One of the tools I used for this was CataRT (Schwartz, D. et al., 2006) in Max. CataRT is a real-time concatenative sound process where the sound is analysed and linked together into smaller sound-chunks based on properties such as loudness and spectrum, and then these chunks are arranged in a two-dimensional space based on feature similarity. A user-friendly interface shows how the sound chunks are distributed (Figure13). This allows me to create new phrases and gestures in a fluid way by navigating my mouse across the two-dimensional display. By 'surfing' across the display, one can for example choose to focus and manipulate only the louder parts of the sound regardless of where in time the original moment occurred, or create gestures moving between loudness and brightness. (Sound example 11.2: CataRT ice melt, extract).



↗ **Figure 12** CataRT Max patch. The coloured dots represent the distribution of the sound chunks with regards to their analysed properties such as loudness and various spectral features.

Sound example 11.2

Parts of this newly constructed sound can be heard in 'Phases' at 00:48 and at 01:45 (sound example 12).

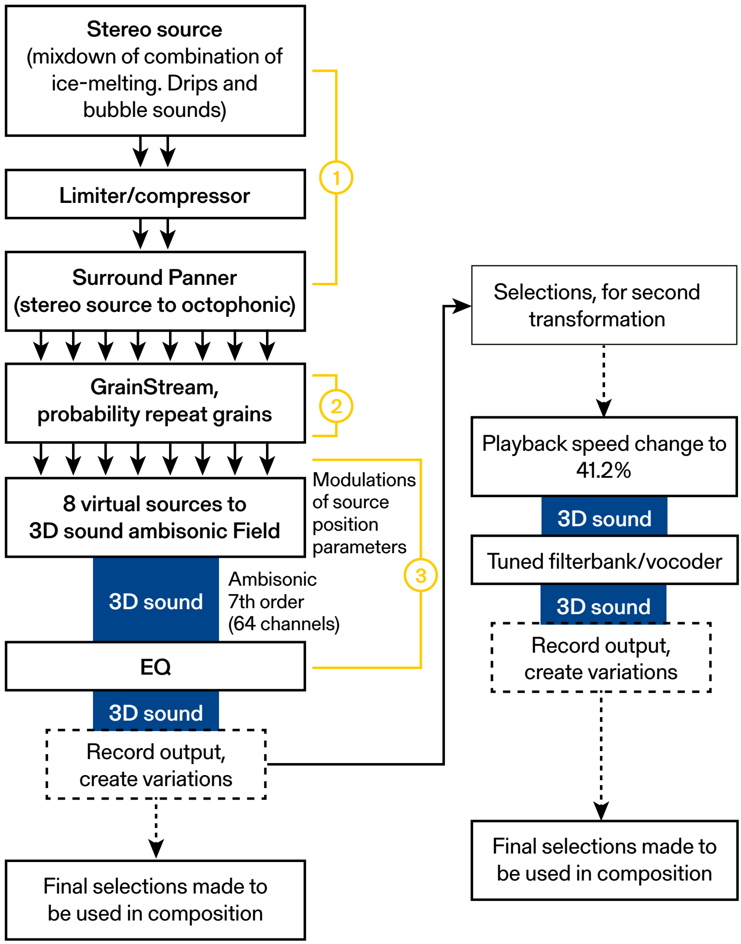
Sound example 12

d. Further transformations and variations
To create more spatially complex phrases with rhythmical and tension-release effects, I used the ice-melting sound as a vantage point for the following three stages:

- The original sound file was combined with various snippets of the drips and bubbles, creating a mix of the two recordings in stereo. In order to create larger varieties of spatial movements with the material, I later up-mixed the stereo sound files to an 8-channel (octophonic) sound file using a surround sound panner where I was spatially improvising with the material.
- I used a multichannel granulation plugin differing from those that Natasha tested (Grain Streamer, Norris, M. 2015), where small chunks of the sound are repeated based on a probability factor depending on a certain loudness threshold, meaning that parts of the sound are unaffected whereas other parts above this threshold will be repeated in small grains, creating an accelerando or ritardando. The parameters were fixed and not changed during the process.
- The octophonic output was then placed as eight virtual sound sources in an ambisonic 3D sound field using the IEM multi encoder VST plugin.[153] The virtual source positions are

153 IEM pluginSuite – Institute of Electronic Music and Acoustics, Austria, n.d. https://plugins.iem.at

modulated creating a slightly varying spatial image. I added an EQ at the end of the processing chain to clarify the result. The signal chain and process can be seen in Figure 13.



↗ **Figure 13** To the left: The three stages of transformation. To the right: The second transformation.

I created several variations using this process and the results are used as one of the prominent sounds for 'Phases' (sound example 13.1).

Sound example 13.1

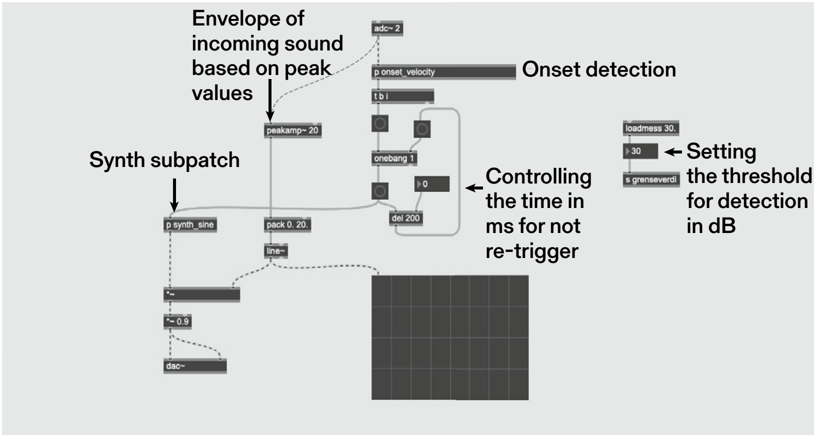
Furthermore, as I wanted to work with harmonic pitch-based material, I added a few more transformations: I first slowed playback speed to 41.2%, then played the sound through a bank of resonating filters, where the filter frequencies are tuned in harmonic ratios as found in musical instruments. This sound type, with surging and resonating gestures, is an acousmatic music trope that I had not intended to use. Nevertheless, I found it useful to create the harmonic content that I was after, and for the piece to come alive (Sound example 13.2).

Sound example 13.2

e Synthesis

Another technique I tend to use is the inclusion of synthetically generated sound. For 'Phases' I wanted to create some bass-heavy sounds that would fit with and against the accelerando and ritardando sounds. I decided to use a single oscillator bass synth that was controlled and triggered by the sound of water drops by way of an envelope follower[154] in MaxMSP (Figure 14). Using the microphone input in the Max-patch, the amplitude envelope of the water droplets controls the amplitude envelope of the synth.

154 An Envelope Follower detects the amplitude envelope (amplitude variation over time) of a sound and produces a control signal that resembles it which then in turn can be used to control other parameters. Roads, C. 1996 p. 623.



↗ **Figure 14** Max patch showing the simple bass synth generator, where the bass synth envelope is shaped by a water droplet sound input.

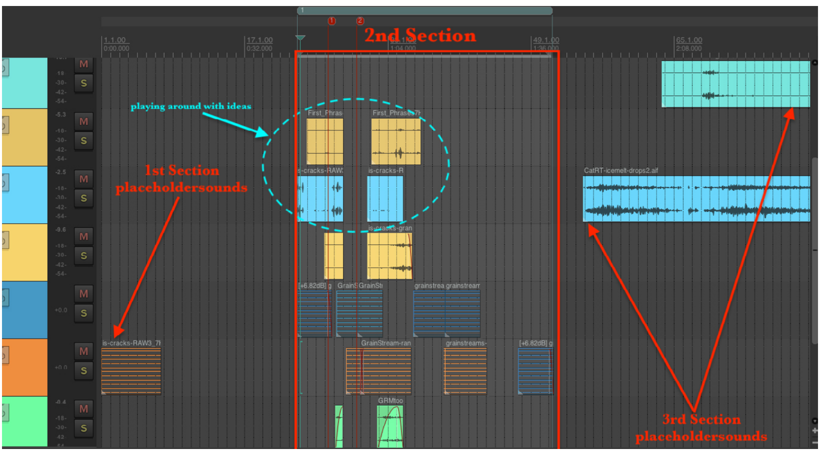
A bowl, water, and a contact microphone were a simple solution for the envelope tracker source. I needed to tune the amplitude detection threshold (the triggering mechanism) precisely, and found a solution that did not re-trigger too quickly. I originally planned to record this sound outdoors on a rainy day. But it did not rain for many days, so I used water drops from a garden hose instead. After I had created several variations, I cut out small parts of the recorded output and then adjusted and quantised the onsets into the rhythms I wanted.

The result can be heard in the opening of the second section (Sound example 14).

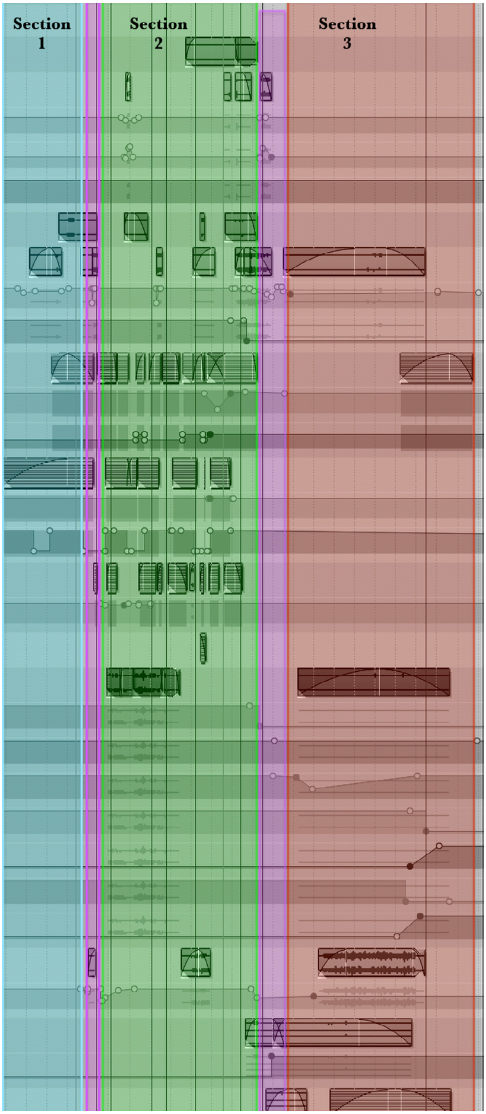
Sound example 14

Sketching, workflow and the composing

After I have gathered a large bulk of the sound material (recorded and transformed), I will typically go back and forth testing ideas in the DAW, listen to the sound material, and sometimes re-do or add more material. I often begin a particular section from the written sketches, and in 'Phases' I started with the second section rather than the first. Figure 15 is a sketch of the beginning of the second section. At this stage, I have an approximate timeline, and some of the sound content are placeholders. Figure 16 shows the final composition, and some of the automatisation controlling time, volume, and real-time sound effects. 'Phases' has three main sections with two small transitions (marked pink in the Figure).

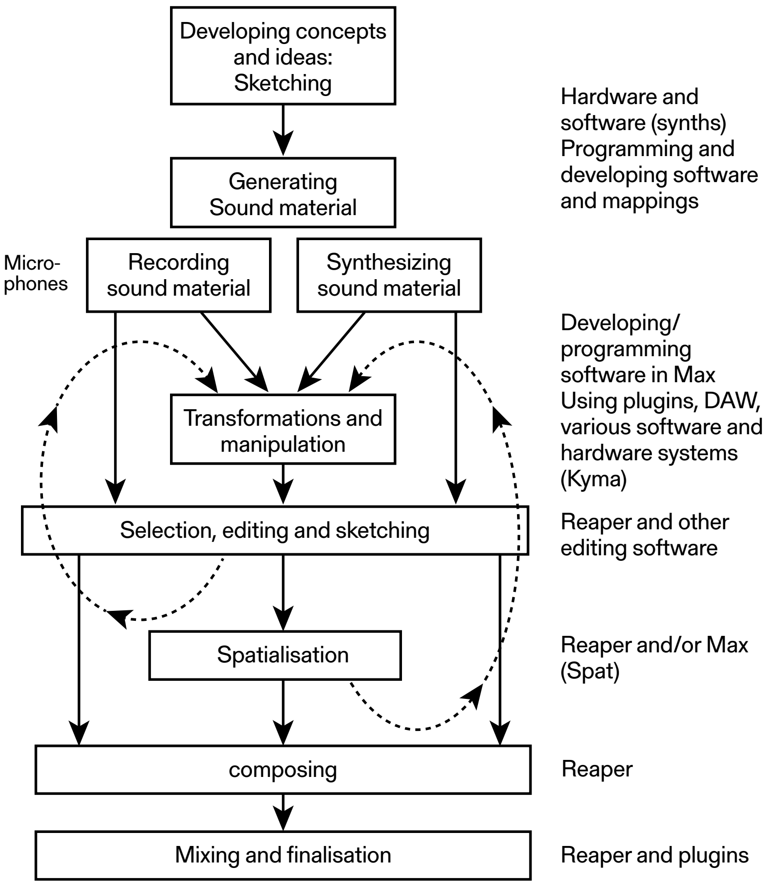


↗ **Figure 15**



↗ **Figure 16**

Although different pieces might call for different approaches, a general overview of my workflow is outlined in Figure 17.



↗ **Figure 17** Overview of my workflow.

The compositions ‘Phases’ and ‘... i et vannglass’

Sound example 15

↗ **‘Phases’.**

Sound example 17

↗ **‘... i et vannglass’.**

‘Phases’ started with the concept of the three states of matter in two ways: recordings of water in different states, and transformations in different states. The compositions then evolved to include other features inspired by simply listening to the surprises the materials offered.

‘Phases’ consists of three main sections, starting with the allusion to water and the transitions from a frozen state to melting, to the coming alive in a playful way before it gradually changes to a gas. The first section starts slowly, gradually building up to the fast and denser second section, and gradually slows down in the third section.

- Section 1: 00:00–00:50
  Begins with a soft drone, the allusion to ice, the melting state, cracks, bubbles, increasing density and a short surge into the second section.

- Section 2: 00:50–02:05
  This section contains harmonic material with accelerando and ritardando, shifts between foreground and background, fluid water sounds and the raindrop bass synth.

- Short Transition: 02:06–02:13
  Ocean waves masking out other sounds,

- Section 3: 02:14–03:19
  In section 3, ocean waves gradually decay and the raindrop on metal is reintroduced in the background. There is then a gradual transition into bubbles, boiling, and the allusion to water vapour with a high-pitched drone that gradually vanishes.

Whereas 'Phases' is about the interaction between abstract and real-world material '... i et vannglass' is a sound exploration of one simple idea: the composition revolves around recordings of water 'resonating through' the sound of glass being rubbed or articulated in various ways. To do this, I applied the processes of cross-synthesis[155] and convolution[156], which is where the spectral qualities of one sound are used to modify another. The pitched sound of circular rubbing motions and pings on glasses filled with water is convolved with the sound of water drops, bubbles, and ocean waves creating the impression of being inside a glass. These processes produced interesting and often unexpected results due to how the properties of one sound impact the other sound. Different perspectives can be heard in the following sound examples:

Sound example 16a

↗ **Audio 16a** Convolving Glass rub + water-bubbles.

155 Cross-synthesis is a sound processing technique where the spectral envelope of one sound is impressed to another, creating a hybrid signal with the timbral qualities of each of the two original sounds (Smith, J.O, 2011).

156 A form of cross-synthesis where the frequency spectrum of two sounds is multiplied. The frequencies that are common in the two sounds will be accentuated (creating resonances), and frequencies that are not common between the two will be attenuated. The convolution process alters the sound in the frequency domain and the time domain. (Roads, C., 1996, pp. 426–428).

Sound example 16b

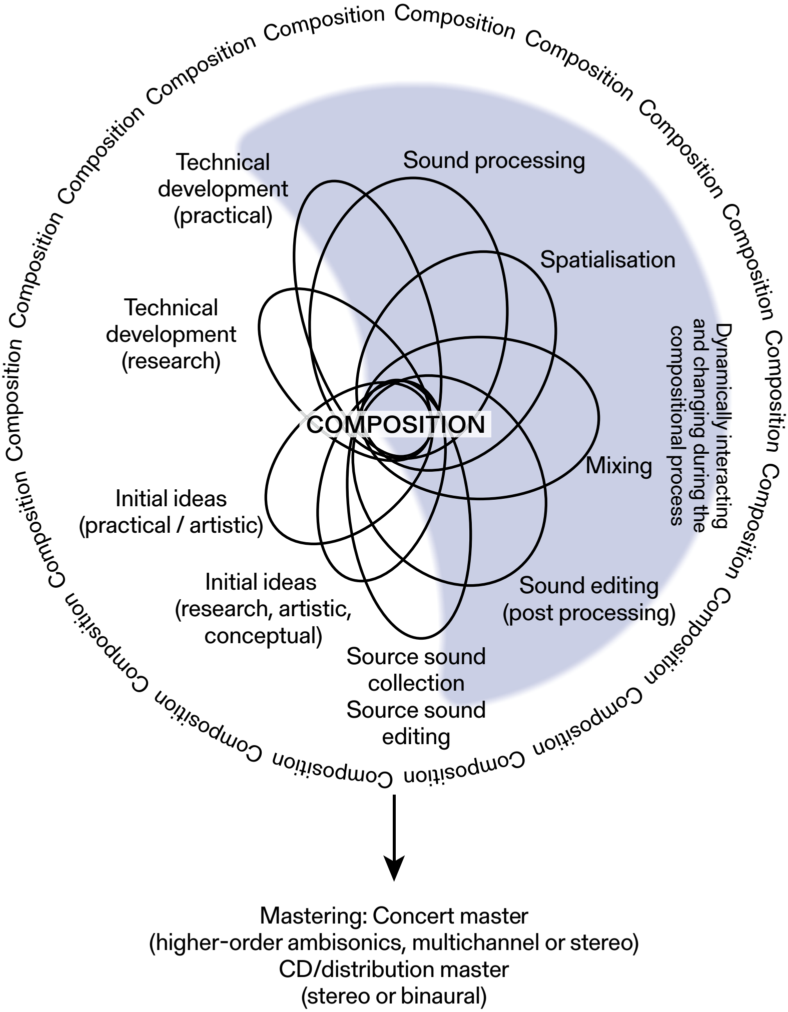
↗ **Audio 16b** Convolving Water bubbles + glass rub.

The convolution sources are also inherently spatial (i.e. ambisonic), which creates quite different results than mono sources.

Convolution was carried out in Reaper using VST plugins and the Kyma system, and involved a substantial amount of trial and error. For example, when two sounds contain similar frequencies, both sounds resonate loudly, sometimes into distortion. Or convolving with long impulses creates blurred results more indicative of the process than the sound qualities I'm interested in. I also reused many of the transformed sound materials from 'Phases', yet the new context gives these materials a different character. The piece is a drone-based composition, and does not have any clear indicative sections and focuses on slow changes of texture and tempo. The title of the piece is a literal play on the expression 'a storm in a teapot', where we are instead taken inside a glass of water. I was quite satisfied with the drone qualities and in some ways enjoy parts of it more than 'Phases'.

Interconnections

In Figure 18 we illustrate how elements of the compositional process connect and are relevant for much of our music. It should be noted that even though 'initial ideas' are on the left, and 'mixing' is on the right, they intersect in the process, which is both central and global, and where elements on the right-hand side change dynamically as the composition takes shape. The size (or importance) of each oval changes as appropriate to the composition that the Figure describes, and is here weighted to describe Dream Awake.



↗ **Figure 18** How elements of the compositional process connect.

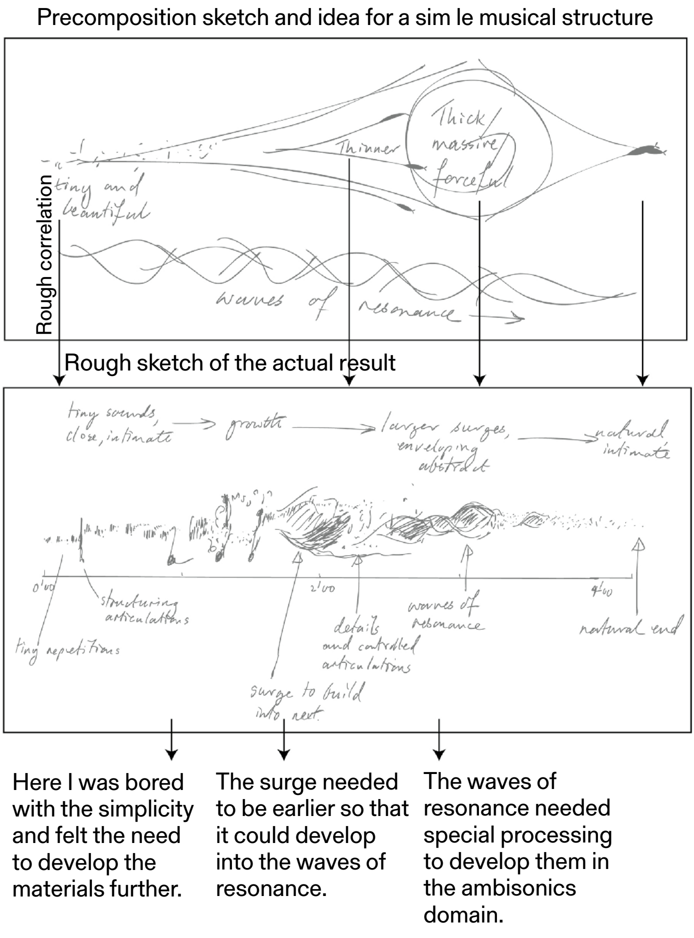
As composers working with technology, we typically take on many roles. These include instrument designer, developer and sound engineer, where the distinction between each role is often blurred, yet vital to the overall composition process. As composers we are also often performers of our works: mostly for stereo formats that require sound diffusion performance, but also for premiers of fixed spatialised works such as ambisonics formats. Although the latter may be easier to distribute, the premier is often the first listening in a large space over high number of speakers. The role of composer to take care of the details of performance, and especially the premier, carries with it more responsibility than instrumental composition where great responsibility is handed over to conductor and performers. Final mastering is also our responsibility: the work cannot be mastered in the same way as purely instrumental or popular music because incorrect spectral compression will destroy the space and the meaning of the sounds. There are many other technical challenges to mastering an HOA 3D format composition, and current lack of knowledge in this area means the workload is transferred to the composer.

The structure and complexity of our pieces

In our introduction we explained that our two pieces aimed to address the commission fee guidelines, where one work was to aim at a higher category and the other at a lower category. The fee system works on a funding application basis, where composer and commissioner agree on a category, and the funding committee decide how much they want to give. The committee may disagree with the chosen category and award less than the guidelines. This may be because the committee lacks insight into the genre, or simply lack sufficient resources to fund all the works they wish to support. There is no follow-up post composition to evaluate the result. Our own category selections are based on our knowledge of the genre, the work involved in each piece, and from Barrett's experience composing both large-scale instrumental and acousmatic pieces where instrumental music is more clearly defined in the category system. Although our category selections can be read as autoethnographic, our experience as composers, listeners, concert organisers, performers and commissioners of other composers' work lends greater bounds to our assessments than a purely autoethnographical perspective.

Natasha decided to create 'Dream Awake' for a high category. This meant that many of the newly created sounds were inappropriately long or too drone-based. Although interesting in various ways, they needed to play for long durations to reveal their qualities. These durational aspects were problematic for a work intending to focus on a rapid and complex counterpoint of materials.

Instead, some of these sounds were saved for recycling in the simpler piece 'Sensory Sleep'. 'Dream Awake' lands in category E of the commission fee guidelines, especially when evaluating the complete spatial result in concert. 'Sensory Sleep' was originally created for category B, and the intention was to use the long-play sound leftovers from 'Dream Awake'. Before starting this piece Natasha made a sketch of the structural idea shown in the top part of Figure 19. Yet many of the materials lacked the rich spectral qualities that she was searching for, and so materials and musical structures needed rethinking. To provide some insights, compare the top part of Figure 19 (the original plan) with the composition in audio example 10 (the actual result). The bottom section of Figure 19 is a rough, post-composition sketch that also highlights some of the differences between the original intention and actual result. In this process Natasha invented a new method of resonance filtering projected directly into the 3D Ambisonics domain to enrich the 'surging' sounds of some of the sounds. This is an investment which can hopefully have bearing on future work. Approximately half of the materials were already composed as cast-offs from 'Dream Awake', reducing the compositional workload. Category C is an appropriate assessment after having revealed that half the materials were cast-offs from another work. Without this, category D would have been more reasonable.



↗ **Figure 19** 'Sensory Sleep' original idea (top), approximate result and comments (bottom).

For Anders' work, '... i ett vannglass' is simpler and is a single sound exploration of one idea, whereas 'Phases' uses a larger range of sound transformations and techniques. For '... i ett vannglass' Anders envisioned a submission for the categories A/B. The materials used in this piece were predominantly reused from 'Phases' except for the glass sounds. Similarly to Natasha's work, the reuse of material meant that the workload from a technical and compositional point of view was a lot less. However, without a listener knowing this, its sounding complexity and novelty would suggest category B/C. In contrast, 'Phases' features greater musical complexity, a larger range of sound transformation techniques and significantly more work.

According to commission fee guidelines, it would be correct to place the work in category D.

As with our compositions, we did not discuss our categorisation until we had arrived at our own conclusions. It is clear that we have similar opinions concerning the recycling of materials that the listener or commissioner may not be aware of (and which we here openly reveal). We also both point to the dichotomy over what complexity is in composition versus complexity if sound source.

Conclusions

Our work is entrenched in the history, theories, influences and technologies summarised in Barrett's 2023 text *The composition of acousmatic electroacoustic music in a Norwegian context: Part-I.* Pioneering British composer Trevor Wishart lists a trio of facts that underlie most, if not all acousmatic composition including our own. This is evident in the work we have presented (Wishart, 1994, pp. 1):

- Any sound whatsoever may be the starting material for a composition.
- Musical structure depends on establishing audible relationships amongst sound materials.
- Sounds are not equivalent to notes. Sounds contain their own structure and cannot be considered to relate in the same way as note-based music.

Sharing this and many other commonalities, we then worked independently throughout the composition and documentation process. Although also sharing common goals, we arrived at quite different sounding results that echo our musical preferences and individual musical language. Some interesting similarities included the following:

Recording techniques and sources: We both used a variety of recording technologies in non-standard ways (i.e., not in the way these technologies would normally be used in sound recording practice), including ambisonics and spot microphones, and different transducers. The differences in our recording techniques were due to the differences in our chosen sound sources: Natasha used hydrophones as this was most appropriate for recording water in puddles, while Anders used piezo transducers as this was most practical for freezing in ice.

Compositional process: We both chose short sound extracts from large quantities of materials and experimented extensively with sound transformation, using reduced listening[157] (Schaeffer, 1966/2017, pp. 212–216; Barrett, 2023) to hone-in on interesting features. Without doubt the creation of our sounds was intertwined with the compositional work, and spatialisation was part of the musical expression. For Natasha, who also composes instrumental music, this acousmatic approach is extremely fun but also labour intensive: there are no known instruments with which to begin and no instrumental performers to interpret (and

157 In reduced listening we listen to the sound for its intrinsic information by ignoring its real or supposed source, or the meaning that the source may convey. Reduced listening refers to the notion of the phenomenological reduction called Époché (suspension of judgement), or bracketing out the sound from its real-world context. Reduced listening does not follow automatically when simply being disconnected from the audio-visual complex but from a specific intention on the part of the listener.

often improve) a score. Iterative processing was imported and we moved away from commercial software to more customisable and flexible alternatives. When using commercial software, we did so in less typical ways.

Workflow: We both experienced that our workflows are more effective than they used to be, mainly because computers are faster and software more stable. We also each designed custom workflows summarised in Figures 9 and 18. Figure 19 is maybe the most interesting as it suggests how elements of the complete compositional process connect and is applicable for all acousmatic music. Most importantly it emphasises that the role of each element is dynamic: the figure that currently captures Natasha's 'Dream Awake' would have different sized lobes for 'Sensory Sleep' or for either of Anders' pieces.

Traditional techniques: We both agreed that some traditional techniques remain extremely useful. These include time-stretching, pitch shifting and selective editing through reduced listening. Pitch shifting was originally achieved by slowing down the playback speed of analogue tape, and although this is now a digital process, it is useful in revealing qualities in sounds that are less obvious when played at normal speed. The same is true for time-stretching which dates from the beginning of the digital era.

Speed of work and how time is used: We both found that real-time processes have changed our way of working. We spend the same amount of time composing, but as some processes are faster, we can invest time exploring new directions that we otherwise would not have time to do. This is maybe one of the most satisfying conclusions as it shows the acousmatic artform will continuously evolve through the curiosity of composers.

Workload and fee category evaluation: We both evaluated our work in relation to the Norwegian commission guidelines by revealing information normally hidden from the end listener.

In this chapter we have aimed to reveal the process of acousmatic composition and removed some of the mystery to the genre when there is no score to use as a reference. Acousmatic composition is heavily integrated with technology, and although our technological explanations have been relatively basic, we hope to have opened a window into the world in which we work.

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