

**BEYOND THE PIANO: THE SUPER INSTRUMENT. WIDENING THE
INSTRUMENTAL CAPACITIES IN THE CONTEXT OF THE PIANO MUSIC OF THE
21ST CENTURY**

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Abstract

Thanks to the development of new technology, musical instruments are no more tied to their existing acoustic or technical limitations as almost all parameters can be augmented or modified in real time. An increasing number of composers, performers, and computer programmers have thus become interested in different ways of “supersizing” acoustic instruments in order to open up previously-unheard instrumental sounds. This leads us to the question of what constitutes a super instrument and what challenges does it pose aesthetically and technically? This work explores the effects that super instruments have on the identity of a given solo instrument, on the identity of a composition and on the experience of performing this kind of repertoire. The super instrument comes to be defined as a bundle of more than one instrumental lines that achieve a coherent overall identity when generated in real time. On the basis of my own personal experience of performing the works discussed in this dissertation, super instruments vary a great deal but each has a transformative effect on the identity and performance practice of the pianist. This discussion approaches the topic from the viewpoint of contemporary keyboard music, showcasing examples of super instrument compositions of the 21st century. Thus, the main purposes of this practise based research project is to explore the essence and role of piano or toy piano in a super instrument constellation, as well as the performer’s role as a “super instrumentalist”. I consider these issues in relation to case studies drawn from my own compositional work and a selection of works composed by Karlheinz Essl and Jeff Brown.

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Chapter 1

INTRODUCTION

1.1 What is a Super Instrument

“...super- (comb. form) 1. above, over; beyond: *superstructure* 2. to a great or extreme degree: *superabundant*. 3 extra large of its kind: *supercontinent* 4. of a higher kind (especially in names of classificatory divisions): *superfamily*.
- Origin from L. Super-, from super “above, beyond” (The Concise Oxford Dictionary, p. 1437)

Thanks to the development of faster computers and more efficient computer programs, the possibilities of altering and extending the capabilities of concert instruments or acoustic room qualities seem limitless. Music instruments are no longer tied to their existing acoustic or technical limitations as almost all musical and technical parameters can be augmented or modified. How should we define a super instrument and what are the implications and challenges of its development in the 21st century for composers, performers, and listeners?

The author of this dissertation believes that a super instrument has three fundamental properties that differentiate it from other performing situations: The first defining characteristic of a super instrument is that it offers possibilities that could not be achieved on a regular instrument, increasing the performer's capabilities well beyond what could be achieved normally. The author's guitar piece “Sonnenschände – Sonnenwende” (2011) presents a clear example of a super instrument constellation that allows the soloist to attain sonic results that would be physically impossible in a normal situation¹. In short, it should essentially increase the capabilities of a regular acoustic concert instrument, and thus also widen the technical and artistic possibilities of the performer.

A second consideration with regard to any definition of a super instrument is the extent to which it may contain a variety of different parts. According to the definition above,

¹ The original acoustic concert instrument has been multiplied with the help of an electronic player, which extends the overall sonic texture.

the word “super” refers to such attributes as “above, over, beyond, or “larger of its kind”, rather than “different”. If this definition is applied to the idea of a super instrument, it is clear that any expansion of the instrumental capabilities it offers should feel organic in some way, either in terms of the compositional structure and/or of the capabilities of the performer.

The author's third definition of a super instrument is that its musical output should be produced or controlled as a “live system”². This distinguishes a true super instrument from other situations where a fixed media background has been used.

The specific characteristics of each super instrument will vary, depending on the context of the composition. A super instrument might offer the following possibilities, for example:

1. Managing very fast tempi otherwise unplayable by a human performer
2. Playing in multiple octave ranges
3. Timbral transformation of the solo instrument so as to create a wider range of sonorities
4. Controlling larger sound masses than otherwise acoustically possible
5. Enabling different tuning systems
6. Extending the range of dynamics
7. Altering the acoustic space (reverberation, sense of the “room”)
8. Achieving increased flexibility with regard to musical form

A super-instrument is often piece-specific. It differs from a hyper instrument³ in its flexibility and abstract nature. Whereas Machover's hyper score software is an engine that has been designed to perform specific tasks, the super instrument is treated within this dissertation as a wider concept that does not refer to any particular computer program or instrumental combination. Super instruments can, but do not necessarily have to, include electronic tools or means: they can also be purely acoustic. Widening

² For the purposes of this dissertation, a “live system” refers to any kind of reactive or pro-active systems of sonic organisation.

³ This terminology was originally introduced by composer Tod Machover.

the performer's capabilities is not always the main purpose of using electronics - composers choose to apply them for a variety of reasons⁴. In the context of this dissertation, the most important quality of a super instrument is that it provides extended technical and expressive qualities for the performer and lets them exceed their existing instrumental skills. This also differentiates a super instrument performance from other performances with (live) electronics.

The author argues that a true super instrument not only transforms the identity of its given solo instrument but also two other identities: that of the composition and of the performer. It changes the way composers compose because a super instrument has its own specific requirements; and performers must transform their whole approach, sometimes acquiring new skills in the process. Therefore the super instruments presented in this thesis have been considered both from the perspective of the compositional design and the implications this has for the performer.

1.2 Historical Context

Composers have always been eager to develop new performance techniques that open previously unheard instrumental and expressive qualities. The celebrated castrati of the Baroque Era⁵ explored the limits of operatic performance and human voice simultaneously to numerous virtuoso composers⁶ who produced increasingly demanding vocal and instrumental works. The evolution of virtuoso techniques accelerated again within the Romantic Era, boosted by the idea of a composer/performer as a genius who could conjure incredible sonic worlds and atmospheres from his or her musical instrument. Virtuoso violinist Niccolò Paganini can be seen as the embodiment of an artist who changed the way his instrument was to be played, whilst in the genre of piano music virtuoso techniques were greatly developed for example by Franz Liszt and Charles Alkan who, in addition to being innovative composers, were also popular performers who managed to extend the pianos' instrumental identity as a solo keyboard

⁴ These can be, for example, reasons related to the composition techniques or structural aspects.

⁵ However, the castrati singers continued to exist beyond the Baroque era. Alessandro Moreschi (1858-1922) is commonly regarded as the last castrato.

⁶ For example Bach, Corelli, Handel, Rameau, Tartini, and Vivaldi, among others

instrument into that of an entire orchestra. The orchestral qualities of the piano have also been exploited by numerous other composers in the classical standard repertoire, such as Beethoven, Brahms, or Rachmaninoff, to mention just a few. This idea was also supported by legendary piano pedagogue Heinrich Neuhaus, who argued that unlike any other instrument, the piano is essentially an orchestra by itself.

Transforming a solo instrument into an “orchestra” controlled by one performer is one of the purposes of contemporary super instrument composers. This discussion suggests that modern composers’ attempts at supersising a musical instrument eventually serve the same purposes as skillfully conducted explorations of their past colleagues, and should be seen as a continuum.

1.3 The Composition Examples

The following discussion approaches this topic from the viewpoint of contemporary keyboard music since the author has acquired some experience performing this repertoire as a pianist. This dissertation will be considering a number of her own compositions in dialogue with a small selection of Karlheinz Essl's and Jeff Brown's super instrument compositions, since performing these pieces has informed her compositional thinking.

As will be shown by many of the discussed composition examples below, in some cases the piano can be transformed into a full scale orchestra controlled by one performing musician⁷. Schwartz regards a live-electronic composition as a “concerto in modern guise” (Schwartz, 1989, 102). McNutt argues that performing with a live electroacoustic system resembles a chamber music performance in which the other ensemble members cannot be seen. However, such a situation lacks all the regular means of human interaction that could facilitate the communication between performers (McNutt, 2003, 299). Berweck lists similar viewpoints expressed by various performers. Many of them argue that electroacoustic works can never be treated as solo compositions (and, just

⁷ A good example for this is an entirely digital orchestra that the soloist controls by him or herself. Uljas Pulkkis’ concerto for piano and genelec orchestra will be discussed in the next chapter.

like a human performer, an electronic system is susceptible for making mistakes⁸) (Berweck, 2012, 10). This also has an impact on the performance techniques used by the author, as well as the techniques and technologies that were used in her super instrument compositions.

Based on the conclusions drawn from the composition examples presented below, the definition of a super instrument and its most important common functions can be summarised in a following manner:

1. Definition: a super instrument is a combination of at least two merged instrumental or electronic colours, tools, or identities to create a new coherent entity, a hybrid instrument, combining the sonic and instrumental characteristics of the original instruments, tools, or technologies in order to multiply the capacities of both instrument and performer. It is a system that consists of proactive live components that are in constant dialogue with each other. The instrument should be controlled either by a human performer or a real-time functioning computer based system.
2. Functions and purposes: extending the capabilities of the traditional instruments, and by extension the capabilities of the performer, in terms of instrumental range, harmony, timbre, or spatial, textural, acoustic, technical, or technological qualities, which allows the concert instrument to become an ensemble controlled by a single performer.

1.4 Research Methods

A composer working with super (or hyper⁹) instruments has to take into account the special characteristics of the instrumentation in terms of applied composition techniques, sonic language, and aesthetics. This thesis explores these special

⁸ Berweck criticises these statements because a malfunctioning electronic part can ruin an entire performance, whereas a mistake made by human performer does not necessarily have such an impact (Berweck 2012, 11).

⁹ Many functions of “super instrument” and “hyper instrument” overlap. This view is supported by Karlheinz Essl who does not distinguish these two concepts from each other (a private discussion at Essl Museum, Klosterneuburg, 2.7.2013). However, Tod Machover uses the latter term only in reference to his hyper score software.

characteristics, instrumental properties, and their manifestations in different compositions, as well as the notational challenges related to this kind of works. Even if electroacoustic music and various computer based solutions and processes form a large part of this discussion, this dissertation does not aim to be a thorough technical manual. The author has chosen a practice-based research approach, which has been carried out as a cross-disciplinary artistic project from the perspective of a composer and performer and, in the case of electronic works, also from the view-point of the programmer/composer and the sound technician. In some cases also the listeners' perspective will be discussed.

Concentrating on the repertoire written for one's own instrument enables the researcher to explore the discussed repertoire from within, as a performer. Combining the roles of performer and researcher is a relatively popular research method within the field of performance studies. In addition to established internationally known artist-researchers - such as Helmut Lachenmann, Yehudi Menuhin, or Charles Rosen -, this approach is also attracting a growing body of research-oriented performing musicians of the younger generation. Such research has been carried out for example by Korhonen-Björkman, Sivuoja-Gunaratnam, and Pestova.

Korhonen-Björkman discusses the issues relating to the researchers' simultaneous presence as performers of their research objects. She gives the example of Janet Schmalfeldt's research on Beethoven's "Bagatelles" op. 126. Schmalfeldt decided to explore this topic from the viewpoints of her "performer self" and "analyser self", the two complementary sides of her performer identity (Schmalfeldt in Korhonen-Björkman, 2008, 3). Although Schmalfeldt's approach has attracted criticism (Ibid.), her method can be useful when discussing a repertoire that does not have a vast performance tradition or reception history (Kallionpää, 2008, 1). This dissertation referred too, for example, to the publications of Cook (1999) who has based his methodology on performance analysis and music psychology.

Exploratory research is often used in social sciences in order to investigate problems that are relatively new or hard to define, or situations in which it is difficult to gain

definitive information. Due to the apparent lack of prior specific research on this topic, this project adopts an inductive approach which aims to discuss the specific aspects highlighted by the research object. The purpose of this research has been to illustrate how different composers, performers, sound technicians and programmers deal with the super instrument concept. The “all is data”¹⁰ principle of the grounded theory is also present in the selection of the source materials: in addition to the research literature, some of the information has been collected from presentations, musical scores, composition lessons, and private discussions. Borgdorff’s idea of the “practice-based research” (Borgdorff, 2009, 7) has been applied when discussing the author’s own works and performances within this thesis; the artistic practice itself has been used here as a research method. In addition to considering the composition examples of this dissertation as independent works (which of course is their primary function), they are also being regarded as research projects, with the purpose of gathering information from the perspectives of composer, performer, and listener. Borgdorff divides this field roughly into three different categories: “research on the arts, research for the arts and research in the arts” (Borgdorff, 2009, 5-6). However, there is a fine line between the different approaches that Borgdorff suggests; in this thesis the author has explored the possibility of a co-existence of all these methods within the artistic research. According to Borgdorff’s second category, one of the main targets of arts research is to provide and create new technical or artistic information that “may find its way into concrete (artistic) practices in one way or another” (Borgdorff, 2009, 6), which is also one of the aims of this discussion.

Every composition presented within this thesis has been rehearsed and in most cases performed by the author, thereby limiting the selection of compositions to works for piano and toy piano. The works discussed here have been selected to shed some light on the performer, composer, or instrumental identities and functions related to super instruments or super instrument compositions.

¹⁰ “All is data” principle has been explained by Glaser in the following manner: “It means that exactly what is going on in the research scene is the data, what ever the source, whether interview, observations, documents. It is not just what is being, how it is being and the conditions of its being told, but all the data surrounding what is being told.” - B.G. Glaser, “All is Data” in *Grounded Theory Review*. Issue no. 2. Volume 6. 2007., 1) <http://groundedtheoryreview.com/2007/03/30/1194/> (accessed 4.6.2014))

1.5 Performer and Medium

Researchers' approaches towards performer physicality within a musical performance vary. For example, Nicholas Cook defines the essence of the learning process of a piano composition primarily as an analytical activity (Cook, 1990, 77). Moreover, the instrumental techniques form an equally important part of a successful musical performance. Even if analytical knowledge of the music is undeniably important, focusing on the physical aspects of a musical performance is also necessary, a point of view also supported by Neuhaus: the shortcomings of the instrumentalists' knowledge of the aspects of their own physicality inevitably affect the general artistic outcome of a concert performance, even if a good command of instrumental techniques helps to acquire the desired results (Neuhaus, 1986, 10-11). Moreover, Hämeenniemi also suggests that performers approach compositions mainly from the instrumental or technical perspective: "...whereas a composer approaches a musical composition in terms of its structure and composition techniques in addition to its instant sonic results, a performing musician mainly approaches it, on top of the general sonic/aural outcome, from the perspective of performative physicality, namely in terms of motorics and instrumental techniques." (Hämeenniemi, 2007, 34, translated by the author). The author suggests that a musical performance consists of the following two aspects: 1) energy and presence of the performer 2) instrumental techniques. The instrumentalist transmits the musical material both sonically and visually. The sound quality, room/space, instrumental techniques, and sound source form the core elements of the performer's and listener's experience. The audience receives an acoustic solo piano performance differently from a laptop orchestra's multi-channel performance, in which physical elements are minimised and thus the audience cannot distinguish the sound source.

It is impossible to define exactly (or measure) energy and presence, as they depend on the performers' and listeners' subjective experiences. Every performer has their own "aura": there is no standard and/or "objective" performer identity. Moreover, the aspects of physicality (or instrumental techniques) also depend on the tastes of each performer.

Some musicians use large physical gestures as a part of their artistic expression¹¹, whereas others¹² prefer more restricted bodily presence with equally valid artistic results. The nature of the repertoire also dictates how a composition should be played. In addition, the use of technology has an impact on the performing experience: the use of strictly controlled electronic background may constrain the performing artist¹³ (Chadabe, 1997, 68; Kimura, 1995, 71), whereas a more flexible one can have an enriching and empowering effect. It makes a difference whether one is playing to the medium or controlling the medium. “The musician has to feel in charge of their performance” (Pestova, 2008, 68).

Super instrument compositions are often based on the idea of general sound that consists of several complementary elements. “Related Rocks” (1997) by Magnus Lindberg and “Mantra” (1970) by Karlheinz Stockhausen are constructed this way. Both works make use of two pianos, percussion¹⁴, and electronics¹⁵ to create a unified sonic environment without separate instrumental identities. Moreover, electronic sound modification forms an important part of the compositional structure of both compositions. In the case of “Mantra”, the intervals of the 13-tone row (mantra) get expanded and the ring modulators are used to “form a new kind of harmonic and timbral relationship” (Lopez-Lezcano, 2008, 1). “Mantra” seamlessly incorporates the aspects of traditional virtuoso techniques and the extended electronic soundscape created by real-time sound processing (Pestova, 2008, 7).

The fixed functions linked to specific performer identities are often challenged in super instrument works. Instead of concentrating on playing their main instrument, the performers may be required to not only play additional instruments, but also to control

¹¹ Such as, for example, Olli Mustonen or David Isserlis

¹² For example Grigory Sokolov

¹³ The author once witnessed a performance of a flute piece controlled with a click track: although the highly acclaimed virtuoso soloist managed to perform the piece correctly, she could not be fully present in the situation. Focusing on tempo took away energy and concentration that she could have used for the benefit of her instrumental performance. The situation might have been avoidable, had the composer chosen to use a different time controlling system. Various solutions allow the computer to “read” the actions of the player in real-time, thus helping him or her instead of simply functioning as a metronome.

¹⁴ Whereas “Related Rocks” requires separate percussion players, the pianists of “Mantra” perform the percussion elements themselves.

¹⁵ Stockhausen used sine wave generators and ring modulators in “Mantra”. “Related Rocks” incorporates IRCAM electronics.

an electronic system. This results in the development of innovative performance techniques, as well as the formation of performer identities that flexibly adapt themselves to the sonic, technical, and technological effects and functions of the instruments and technological tools. A super instrument work differs from regular instrumental compositions in terms of the amount of accessible performance techniques and capacities of the instrument itself, which is why performing on a hybrid instrument may not necessarily fit the experiences, expectations, and education of a traditionally trained classical musician. Unlike organists and harpsichordists who are used to playing multiple manuals, pianists rarely have to deal with more than one keyboard at a time. Moreover, a super instrument composition is often a sequence of at least partially indeterminate events rather than a fixed and thoroughly notated entity which one could practice beforehand in every detail. The performers thus need to develop performance models specifically suited to the particular sonic and technical (and sometimes also visual)¹⁶ requirements of every super instrument composition.

The examples of super instruments will be considered in two different categories, since they have a different impact on the mode of performance, both from the perspective of the performer and of the listener:

1. Performance with live electronics (see chapter 3. below)
2. Performance with multiple instruments (see chapter 4. below)

Chapter 2

Super Instrument: A Pre-History

This chapter considers a number of different instrumental constellations that could be regarded as natural forerunners to the super instrument, or possibly even early examples. In each case they will be interrogated with reference to the three criteria that were presented in 1.1, above:

¹⁶ For example, this kind of a musical performance can contain theatrical elements. Also sculptures, video art, or dance might be intercorporated to works in which the visual outcome plays an important role, as is the case, for example, with my work “Safari de la Mort” (2013).

1. Increased capabilities for the instrument and the performer
2. Fully integrated as composition and performance concept
3. Live system

Example 1: The Church Organ, Double Manual Harpsichord, and Modified Keyboard Instruments

Double manual keyboard instruments offer more technical possibilities than a normal grand piano, which only has one keyboard on a single level. A church organ is an (early) example of a solo instrument that can even replace an entire orchestra if necessary, even though played by only one performer. The different stops allow the multiplication of octave ranges, the timbres can be manually altered, and the foot pedals enable a third independently controlled manual for the bass line and effects. Most importantly, the performers are not solely limited to the keys that are in the immediate reach of their hands because the stops allow the duplications of the desired pitches and chords, thus resulting to a fuller, orchestral sound.

Double manual harpsichords share many instrumental features with the organ. The two manuals thus enable fast repetitions of the same pitch within the same octave range that would not be achievable on a piano, while doublings of harmonies and pitches are also possible. In each of these cases the sonic result can be made much more impressive than the original material as input at source. On the other hand, these instruments lack the piano's variety of dynamics. Harpsichords and organs originally had just one manual and, adding another, multiplied the capabilities of such historical prototypes. However, these are nowadays normal qualities of standard instruments, which is why it would be an exaggeration to call them super instruments in spite of their obvious benefits.

Various instrument designers have attempted to extend the piano's technical possibilities. The double manual keyboard instrument is a piano with a mechanism similar to that of a double manual harpsichord. It was developed by pianist and instrument designer Christopher Taylor, based on the "Emánuel Moór Pianoforte"

which was designed at the beginning of the 20th century. The main advantage of this particular piano is that it allows the pianist to reach wider intervals with less effort. Virtuoso passages (such as, for example, double octaves) become considerably easier to play, which makes them sound faster and stronger. Taylor's instrument has thus a lot of new instrumental possibilities for super instrument performers and composers.

Other modified or extended keyboards exist. Pianist Sarah Nicholls has invented an Inside-Out-Piano (2008) to better access the extended techniques that are otherwise difficult to reach (Nicholls, 2014, 1). Following the example of the cabinet or giraffe pianos, Nicholls has put a regular piano back together in “a new way, with the strings going up from the keyboard” (Ibid.). The bowed piano is another example of instrumental modification that enables the pianist to conjure new kind of sounds just by playing the piano strings with a bow made from horsehair or nylon fishing-line. The instrument was originally investigated by composer Curtis Curtis-Smith in 1972 and it was later elaborated on by composers George Crumb and Stephen Scott. Especially Scott’s work “Entrada” for 10 pianists illustrates the versatility of this technique by stripping the piano from its original principles of sound production¹⁷ and transforming it into a super instrument ensemble consisting of synthetic-sounding “string” instruments.

In some cases the composers develop their own instruments. The electromagnetically-prepared piano¹⁸ (or the magnetic resonator piano) was invented by composers Per Bloland and Andrew McPherson in collaboration with their research group¹⁹. McPherson has written several works²⁰ specifically for this super instrument which allows extended techniques that are not available on a regular piano. The system enables the innovative use of harmonics²¹ and overtones, vibrato effects, wider possibilities of

¹⁷ For example, the solution enables a crescendo on a single pitch, which is usually associated with string instruments.

¹⁸ Creating sounds by electromagnetically resonating the piano strings was already explored by Richard Eisenmann in 1886. Alvin Lucier has used electromagnetic manipulation in his works “Music on a Long Thin Wire” (1977) and “Music for Piano with Magnetic Strings” (1995).

¹⁹ The instrument was originally designed by Per Bloland in collaboration with Steven Backer and Edgar Berdahl in 2005-2006 at the Stanford University’s Center for Computer Research in Music and Acoustics (CCRMA). Later on (in 2012) Andrew McPherson added a new amplifier circuit board to it and a new rack and an electromagnet-height adjustment mechanism were also implemented (Bloland, 2015, 1). <http://magneticpiano.com/> (accessed 8.2.2015)

²⁰ For example “Secrets of Antikythera” (2009).

²¹ Including the resonance of partials and subharmonics (Bloland, 2011, 4)

polyphony, and new kinds of sonic colours. “Through the use of electromagnets, it is possible to imbue the piano with capabilities formerly associated with stringed instruments, such as infinite sustain and the ability to vary dynamics throughout the duration of a note” (Bloland, 2011, 4). Although the instrument consists of hardware, software, and a specific electronic interface, the piano functions purely acoustically and no speakers are required. The system is based on direct electromagnetic manipulation of the strings (Bloland, 2011, 1) and it can be installed on any acoustic piano. The magnetic resonator piano is an illustrative example of a super instrument constellation: in spite of possessing all the characteristics of a conventional piano, the solution enables the performer and composer to achieve sonic results that would not be possible in normal circumstances.

Example 2: Prepared Piano or Extended Techniques

Prepared piano was originally invented by John Cage, who was familiar with Henry Cowell’s “string piano”. The latter term meant using extended techniques such as plucking the piano strings and running one’s fingers and fingernails on them (Bernstein in Nicholls, 2002, 78). Although the prepared piano appeared for the first time in the “Second Construction” (1940) by Cage, the composer attributed it to his later work “Bacchanale”. Cage started to use more complex preparations in the latter piece, which eventually resulted in a combination of twelve preparations that the composer named “gamut”: their purpose was to make a solo piano sound like a small percussion ensemble (Ibid.). Prepared piano (and extended techniques) has also played a significant role in many compositions by George Crumb (1929), and other numerous composers, up until the present day.

Prepared instruments can produce interesting timbres from the listener's perspective and increase the possibilities available to composers. The performer's approach to attack, phrasing, and fingering differ from the ones used on the original instrument. Each composer uses prepared instruments and extended techniques for different reasons, which is why they form a grey area within our discussion. To what extent and how such techniques have been used determines whether a regular piano becomes a true super

instrument or not. Although the extended techniques often change the sound or timbre (as well as the performance techniques), they do not automatically multiply or fortify the instrumentalists' set of skills. For example, Ishii counts the use of performer's singing or speaking voice as an extended technique (Ishii, 2005, 13), although such does not significantly augment the sonic possibilities dependent on the performer's abilities on their main instrument. This might be different if the pianist has a classically trained voice that is being used as an organic part of the composition and the performance, as an equally important instrument instead of merely being an additional effect.

Various electronic tools or devices can also be used in order to attain new kinds of sonic results. An example of such is the “EBow” (electronic bow), which was originally developed for electric guitar in order to change its sonic colour to allow its timbre to resemble the string instruments or singing voice. It can be used for the same purposes on the strings of the grand piano when the sostenuto pedal is pressed down. Essl has applied it in some of his works alongside with other sonic and harmonic extension methods (for example, in “Stern” (2013) and “Sequitur XIII). Olga Neuwirth has used EBow within her ensemble work “Hooloomooloo” (1996-1997). This composition is structured around microtonal tensions between different instrumental groups in a constant dialogue with the sine tones produced by the EBow, which is placed on the low keys of the piano to produce a sine tone of “d”. The material realised with the help of the EBow is paired with the fixed media background in order to form the harmonic cell on which the whole piece is based (S. Drees, 2001, 2). Although the music consist of alterations between fast and aggressive bursts and quiet and fragile passages, the latter always reveal the underlying presence of the sinusoidal tones on which all the other harmonies are reflected by the acoustic instruments. Another example of pairing an EBow with a piano is Kelly Moran’s solo piano work “Deviations²²”. In this composition little is left of the original instrumental timbre, which the composer has almost entirely replaced with the resonances created by different EBows. Each EBow reacts to the others as well, which leads to a constant change of the harmonic situations. Occasionally some extended techniques are being used (for example, plucking the piano strings) but the piano is not being played in the regular sense: it just “sounds” by itself.

²² <http://www.youtube.com/watch?v=SOLSKDFEccQ>

Example 3: Electronic Piano, Synthesizer, and Its Predecessors

Contemporary electronical musical instruments feature a great variety of tools capable of extending the instrumentalists' technical capabilities but it should also be remembered that such innovations are by no means a new pursuit. Instrument designers and composers throughout history have attempted to create such superior instruments. For example, Leonardo da Vinci designed a revolutionary keyboard instrument, the “Viola Organista”, that was supposed to combine the qualities of string- and keyboard instruments and to function as a one man orchestra²³. Moreover, the electronically controlled instruments of the 20th century (developed prior or in parallel with the early versions of the synthesizer), such as the mellotron, orchestron, or optigan, to mention just a few, can also be seen as results of the same pursuits. Even if most of these 20th century keyboard instruments seem relatively primitive when compared to the instrumental standards of the 21st century (or even the standards of the late 20th century), their significance within the evolution of the electronic instruments of today cannot be denied. Their function was similar to that of the synthesizer: musicians needed and wanted tools that would widen the possibilities of the ordinary concert performances. According to Emmerson, sound synthesis was one of the most significant ruptures between the past and the present. It enabled sound production without a physical contact to an acoustic sound source (Emmerson, 9, 2012). This provides immeasurable possibilities of creating super instruments that are not tied to the natural acoustic circumstances or the mechanical qualities of musical instruments.

According to Mukuma, “the identity of instruments is culturally defined, i.e. every instrument is defined by its musical zone, in which it fulfills a specific cultural function” (Mukuma, 2010, 84). However, defining the identity of super instruments is more challenging because they fit no ready cultural categories, every super instrument can differ from the others. Each super/hyper instrument, performance, or composition must be defined in its own terms. One should also remember that the same concept has different meanings depending on time and context. Historical piano manufacturers had

²³ It is not known if Leonardo da Vinci also built the instrument he designed. Hans Hayden built the same instrument in 1575 as “Geigenwerk” and it has been reconstructed in the 20th century by Akio Obuschi (1993) and Stawomir Zubrzyński. The latter has also played it in various concert performances.

attempted to give their instrument orchestral qualities by adding different effect pedals to it, with varying success. Banowetz takes a critical approach towards some of these experiments. He was concerned that the novelty pedals²⁴ of the early years of the piano would make the instrument into “a vulgar musical toy” (Banowetz, 1985, 5). Other kind of pedals were also explored. The janissary pedals were popular among the performers and composers of the 18th century. Their purpose was to enable the use of various percussion effects within a keyboard performance (Dolge, 1911, 35). New perspectives opened up with the raise of electronic instruments. Viennese architect Emerich Spielmann presented an electronic instrument called “super piano²⁵” at the beginning of the 20th century, the purpose of which was to exceed the possibilities of the regular piano. In today's terms this historical super instrument would hardly count as one, as all its functions are easily exceeded by a modern synthesizer or basic electronic keyboard.

The synthesizer was not a direct end result of an uninterrupted line of product development. It was preceded by various existing electronic instruments, developed parallel to the synthesizer, that were based on different mechanisms and systems. One of them was the mellotron, an electro-mechanically functioning keyboard instrument that uses the same mechanism as a tape recorder. Pressing down a key activates a tape that is connected to it, whereas releasing the key makes it stop playing it (Awde, 2008, 17). Similarly to the super piano, the mellotron is principally a sampler. On top of various different sounds, the instrument also provides six rhythmic background sets, each of which consists of three rhythmic setups and fill tracks, with the possibility of mixing the latter ones together. Merging together different rhythms is not possible²⁶ (J.R. Herbst, Mellotron Mk Service Manual, 5). Variety pianist Geoff Unwin, who frequently performed on the mellotron, was convinced that the functions of this particular keyboard allowed him to provide more accomplished performances than he could have given with his own basic piano technique (Awde, 2008, 69), which shows that he regarded it as a sort of a super instrument at the time. In this context the

²⁴ In addition to creating different special effects, their purpose was to change the volume and sonic colour.

²⁵ Super piano was basically a very early version of a sampler. Its main function was to record acoustic sounds and to process them afterwards. However, super piano was not a success, as it had numerous mechanical problems.

²⁶ http://www.cem3374.com/docs/Manuals/Misc/Mellotron_MkII_SM.pdf (Accessed 16.12.2014)

mellotron can be regarded as an early super instrument prototype, even if not the most sophisticated kind in today's terms. The same applies to other predecessors of synthesizers, even though most of them are merely remembered as curiosities²⁷ of 20th century instrumental building.

Example 4: A Performer Singing/Playing into a Microphone or the Use of Amplification

In general, a regular acoustic performance that is simply amplified by microphones does not qualify as a super instrument performance within the context of this dissertation. In most of cases the purpose of the amplification is merely to increase the volume, which does not provide the instrumentalist with any kind of additional capabilities or available techniques. The performer is still dependent on their existing instrumental skills, just as he or she would be within any acoustic performance. However, amplification can be an essential part of a performance in which, for example, the spectrum of the sound is in focus. An acoustically performed, real-time-recorded sound can be completely transformed through live processing, which enables the performer to produce more complex microtonal or spectral structures and/or harmonies than could actually be played on the instrument. This approach could thus play a part in a super instrument performance, even though amplification alone cannot do so. Normally such highly sophisticated processes and operations need an additional computerised system.

Example 5: Live Performance with a Fixed Electronic Medium

In our day and age, almost all sound modification is carried out digitally. However, the first composers of electronic music had to rely on analogue equipment. In contemporary performances, the tape part of a fixed media composition is usually replaced with a digital format, for example a CD (Ding, 2006, 255) or a computer hard drive containing the sonic material (Pestova, 2008, 2). The first attempts to electronically extend the timbral capacities of concert instruments took place within fixed-media-compositions; these works either consisted of natural sounds, or of artificial sonic material created by

²⁷ However, some classical electronic instruments, such as the analog synthesizers, are still very popular.

composers in their studios. During the early years of electronic music, composers had to write everything note by note in a creative process whose speed depended on whether they were working on “concrete” or “electronic music”. In the genre of concrete music the composers were working with recorded sounds, while in the latter category every sound, room, and reverberation was created individually, as the artificial sound itself lacked acoustic qualities. Pierre Schaeffer²⁸ and Karlheinz Stockhausen count as early developers of the field. Schaeffer composed numerous works of *musique concrète* in collaboration with Pierre Henry²⁹ in Paris³⁰ in the 1950’s, whereas Stockhausen was simultaneously dividing his time between electronic music explorations and instrumental compositions in Cologne³¹ (Griffiths, 1994, 147-149).

Fixed-media background systems were often used for the same purposes as the more flexible real-time solutions of today: to enlarge the sonic capabilities of the instrument and to change its timbre through various methods such as filtering, delaying, frequency shifting, or reverberation. However, fixed-media-compositions are not considered as super instrument works in the context of this discussion because they do not contain interaction between the performer and the electronic background. Instead of enhancing the performing experience, such a system can complicate it because of its lack of proactiveness. According to McNutt, in the worst case it may resemble a bad human accompanist who is “inconsiderate, inflexible, unresponsive and utterly deaf” (McNutt, 2003, 299). In such a situation most of the performer's energy and concentration are spent on following the electronic background and little is left for the sound quality and interpretation (Ibid.). Some performers, however, respond more positively to this kind of repertoire. According to Ding, “with acoustic instruments as a ‘live element’, music for instrumental performance and tape may offer the same degree of interaction (as the live electronic works) between players and audience, contributing to the excitement of its performance” (Ding, 2006, 256).

²⁸ His work “Symphonie pour un homme seul” was one of the first concert performances of electronic music (Griffiths, 1994, 147).

²⁹ Schaeffer also collaborated with Pierre Boulez and Jean Barraqué. Neither composer was convinced of the artistic results (Griffiths, 1994, 149).

³⁰ At the Radiodiffusion Française

³¹ At the Radiodiffusion studio, Cologne

Despite the problems related to fixed electronic systems, many important compositions are based on them. For example, Mario Davidovsky's experiments with acoustic instrument and tape, such as "Synchronisms No. 6" (1970, for piano and electronic sound), paved the way for the development of electroacoustic piano music. Other famous fixed-media piano works of the same decade include, for example, Luigi Nono's "...Sofferte la Onde Serene" (1976, written for pianist Maurizio Pollini) and Giacinto Scelsi's "Aitsi" (1974, for amplified piano). More recent composition examples that explored the extended sonic characteristics of piano in conjunction with fixed-media background include, for example, Christopher Bailey's "Balladei" (2005), Jonathan Harvey's "Tombeau de Messiaen" (1994), Alvin Lucier's "Nothing is Real" (1990), James Mobberley's "Into the Maelstrom" (1992), and Katharine Norman's *Trying to Translate* (1991), to mention just a few. Moreover, certain performers, such as pianist Philip Mead, flutists Elizabeth McNutt and Margaret Lancaster, clarinetists Gerald Errante and Esther Lamneck, and the violinist Mari Kimura have participated in the development of electroacoustic repertoire by regularly performing and commissioning new works from these composers (Ding, 2006, 255).

Many composers of the 21st century still experiment work with fixed media. Instead of working with actual tape, they can choose to use a fixed pre-set computer-based electronic background with similar roles, such as, for example, in the computer based background of Neil Rolnick's "Digits" (2010, for piano and computer). Some parameters of "Digit's" electronic system are fixed, whilst the pianist is mostly bound to follow the progression of the electronic part. Many works featuring a combination of acoustic instrument and fixed media background have been designed to support the listener's impression of increased instrumental capacities. For example, the electronic part of a work for piano and fixed media often contains previously recorded material produced on the original instrument and then processed by the composer. When played back together with the acoustic instrument, the end result might indeed transform material into a realm beyond that of regular acoustic sound. As convincing as this might be from the perspective of the listener, such an additional non-proactive system does not increase the performer's capabilities or playing techniques, which is why fixed media compositions have not been categorised as super instrument works within the

framework of this dissertation. Nevertheless, certain looping techniques can be used for such purposes in a live situation³².

Example 6: A “One Man Band” or a Performance on Multiple Instruments

As mentioned at the beginning of this chapter, this dissertation discusses the super instrument as a solution or a concept that may contain various instruments (keyboards, manuals, electronic solutions), but still be more than the sum of its parts. Defining such a phenomenon is complex. It seems reasonable to approach the problem from the role and function of the instrument within a musical performance, rather than concentrating on the instrument's mechanical characteristics. Instead of focusing on the instrument only, it may be worthwhile to focus on how the different parts and elements interact in each composition under concert performance conditions.

An illustrative example of this is found in the so-called one-man-bands that often use all of the performer's limbs to enable him or her to play a number of diverse instruments simultaneously. Such one-performer set-ups may appear in different music genres and, depending on how the different instrumental parts interact with each other, may well attain the level of super instruments. Electronic tools can also be used in a modern one-man-band setting. By using Wii Remotes, as well as the possibilities offered by the Microsoft's voice, gesture and movement recognition technology, the performing musicians can even adapt the roles of the dancers, conductors, or performance artists by “waving, wagging, gesticulating, or flailing their way through a performance” (Hayes, 2013, 3).

Some musicians within the pop, jazz, or rock music genres have been interested in combining different instruments within their shows. Pop musicians commonly concentrate on their main instrument on stage, instead of attempting to build up a multi-instrumental performance. In general, this contrast suggests a difference between a

³² Such include, for example, the tape loop technique. The system is based on live-recording of samples that are played back within the same performance, thereby enabling the performer to create a super instrument with several simultaneous layers. Such techniques are briefly discussed in chapter 4.

multi-instrumentalist³³, who has some proficiency in playing more than one instrument (or is leading a professional career with several instruments), and a musician who actually plays them within one performance and acquires extra capabilities this way. Many orchestral musicians can double on another instrument (e.g. clarinet and bass clarinet), yet they cannot be called super-instrumentalists, as they do not combine the capabilities of the two simultaneously, but merely play them separately within a concert performance when necessary.

Example 7: Independently Playing Instruments, Pianola/Piano Rolls, Disklavier, and Other Automatic Solutions

A pianola and a computer based MIDI- or algorithmically-controlled electronic piano (or a Disklavier) may seem rather similar at the first glance. However, the difference is tremendous. All these “pianos” can be programmed to play in a manner that would exceed the technical skills of any human pianist. However, whereas a pianola implicates a fixed pre-set system, a computer controlled piano can be programmed to do more versatile tasks: it can also be controlled in real-time, depending on the qualities of the electronic instrument as well as the imagination of the composer/programmer. If used together with a human performer, a computer controlled piano can form an important part of a super instrument performance³⁴. However, none of these instruments alone count as super instrument. Automatic systems (including sound installations or sound producing sculptures) only count as such if they contain an interactive live element. The most important defining element of a super instrument is not what it *is* but what *can be done* with it. A Disklavier or a synthesizer possess enormous possibilities, such as live recording, playback, transposing, doubling, reverberation, et cetera, but none of these electronic solutions should be counted as super instruments *per se* if their special capabilities are not being used as an integral part of a live compositional concept. To this extent they depend on whether the pattern of their usage conforms to categories two (the integral aspect) and three (the live aspect).

³³ The web dictionary Merriam Webster defines a multi-instrumentalist as “a musician who plays two or more instruments” (<http://www.merriam-webster.com/dictionary/multi-instrumentalist>. Accessed 31.1.2014) but this classification only refers to the existing skills of the musician, not to an actual performance combining all the instruments that the performer is able to play.

³⁴ See the discussion on Neuwirth's “Kloing!” or Machover's “Jeux Deux” in chapter three.

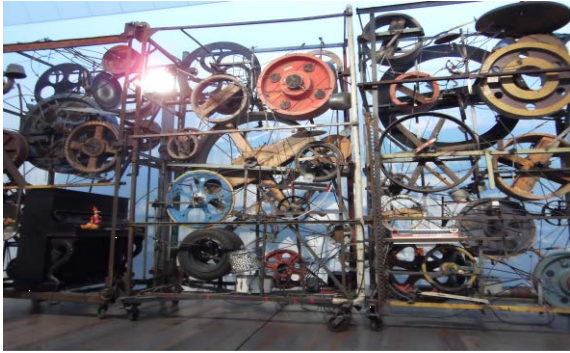


Figure 1: Jean Tinguely's sculpture "Meta-Harmonie II" (1978). The sounds produced by the sculpture occur in a predicted manner. In spite of the sound material being beyond the capabilities of a real performer, this sculpture cannot be classified as a super instrument because the system is not interactive. Photo by the author.

Example 8: A Speaker Orchestra/Super Orchestra

Modifying and supersizing a solo instrument has so far been the main theme of this thesis. But what if the focus is shifted away from one single instrument? What if the composer works on fortifying and alternating the capabilities of the whole orchestra instead of just multiplying the soloist's capabilities? The required compositional techniques and possible computer based solutions depend on the artistic goals of the composer. For example, in spite of its innovative use of music technology, Todd Machover's "Jeux Deux" is a work that mostly follows the traditional concept of a piano concerto. The composer emphasised the leading role of the soloist by adding new instrumental possibilities to the solo piano part by using his hyperscore software in conjunction with a Yamaha Disklavier. Finnish composer Uljas Pulkkis, however, has approached the essence of a concerto from a different viewpoint within his "1900-Concerto for Piano and Genelec Orchestra". In this work the capabilities of the orchestra have been extended, to the point that its whole concept and identity are challenged by the lack of players other than the soloist. Each instrumental line apart from the solo part was created electronically with the Vienna Symphonic library³⁵. The

³⁵ Various sample libraries such as the Vienna Symphonic Library are popular among the young composers of today, especially within the movie- and gaming industry. The possibilities that these sample libraries open up are vast. Orchestral music can be produced without actual collaboration with a real-life orchestra, while various spatial, rhythmical and acoustic alterations can be made by the composer alone. The sound components created on a sample library can be blended as a part of an acoustic performance, the new mix becoming a combination of sounds uniquely transcending the acoustic qualities of the

acoustic sound sources are replaced by speakers and the soloist functions as a conductor who, together with the sound technician, controls the volume, tempi, and tuning. Although completely electronic, the orchestra actively functions in accordance with the performer, reacting to the triggers of the soloist. According to the composer, this setting has many benefits compared to a traditional acoustic orchestra regarding tuning control and independence from acoustic circumstances (Pulkkis, 2013, 13). Pulkkis argues that even though he was attempting to stay close to the customs of regular orchestral performance, the technological solutions enabled certain techniques that could not have been attained by a normal orchestra. Moreover, he points out that he wanted to create an orchestra that would always play the same regardless of the acoustics of the concert hall (Pulkkis, 2013, 12).

This demonstrates that even if the technical tools used by different composers might be similar, the end result and the applied composition techniques vary. Even though both Karlheinz Essl and Uljas Pulkkis attempted to extend the instrumental possibilities - or the performance techniques of their works - by the means of realtime-based electronic solutions, their motivations for using them differ: whereas Essl prefers independent systems that are even in charge of certain artistic decisions “...by utilising algorithmic methods such as automatism, random operations, rule-based systems and autopoietic strategies” (Essl, 2006, 1), Pulkkis' purpose was to create a system that would work exactly the same way in all circumstances and that would always be controllable by the soloist/conductor (Pulkkis, 2013, 12). However, the pursuit of fixing the functions of the orchestra only apply to the acoustic qualities, as the orchestral background is working in realtime interaction with the performer.

Another function that sets Pulkkis' speaker orchestra apart from a standard one is the innovative use of tuning. As the composer puts it, his computer based system allows global changes of tuning even in the middle of the piece, which would hardly work with an acoustic symphony orchestra. Within this work the tuning shifts gradually from the equal temperament towards the natural one and then back (Pulkkis, 13, 13). However,

original instrument, in a manner reminiscent of Richard Wagner's "Mischklang" idea (H.P.Gasselseder, Re-Orchestrating Game Drama. The Immersive Experience of Dynamic Music in Video Games. (diss. Salzburg; Universität Salzburg. 2012.), 151)

one of the main merits of this work is the fact that the soloist alone is in charge of the orchestra, or, in other words, is an orchestra by him/herself, which makes this solution a super instrument.

Chapter 3

PERFORMANCE WITH LIVE ELECTRONICS

For the purposes of this thesis, electronic method refers to any kind of computer based super instrument solution, in which instrumental capabilities have been significantly extended with electronics. However, “electronic music is not one single genre but rather a nexus of numerous genres (Demers, 2010, 5)”, which is why it is impossible to take into account all the possible techniques used within the field. A plethora of electronic sound processing methods is available to composers looking to customize their own super instruments solutions for their compositions. This includes, for example, algorithmic composition techniques and real-time processing or manipulation of the sound material. As will be shown, composers often apply more than one technological solution within their electroacoustic super instrument works. This chapter is focused on a few composition examples and a selection of composition techniques. Because the evolution of the super instruments is connected to the general aesthetics and methods of sound processing, I have also found it necessary to include a brief historical overview of the development of electronic music.

3.1 A Brief Overview of the Development of Electronic Music and Sound Modification

The end of the World War II saw the influx of new movements in most artistic forms. This general change affected the music as well: for example, Edgard Varèse’s concept of “organized sound” was based on the new idea that sounds could be separated from conventional forms of expression and instrumentation (Demers, 2010, 8). Experimentation on timbral qualities and instrumental extensions became increasingly popular among the new generation of composers. Previously unimaginable use of unpitched sounds became part of the normal musical vocabulary, leaving behind the former concept in which,

according to Hanslick, “the musical sounds can be distinguished from those of nature by the fact that they involve fixed pitches” (Eduard Hanslick in Cook, 1990, 10).

Moreover, one of the most important features of the evolution of electronic music was the idea of music “opening up to all sounds”, as well as the development of interactive instruments (Chadabe, 1996, 41): the hyper- or super instruments can be considered as part of this line. The development of the synthesizer in the 1960’s also radically increased composers’ options, allowing them to write completely original music based on altogether new sonic aesthetics³⁶.

3.2 General Characteristics and Identities of the Super Instruments

In addition to being a tool for extending the instrument’s qualities within electroacoustic works, computer-generated processes also have a strong structural importance. In general, the behaviour of an electronic system should be regarded as an organic part of the composition, rather than as an external attachment to the compositional core structure.

The essence of a musical instrument can be infinitely transformed through different instrumental or technological solutions in the context of any super instrument composition. I have explored this within the electroacoustic MIDI piano compositions or improvisation performances that I have given together with composer/sound designer/music psychologist Hans-Peter Gasselseder. In these performances the instrument’s essence and sonic colour have been transformed into something completely electronic and artificial and the room qualities, acoustics, and reverberation have been modified in a manner that makes the sonic colour completely unrecognisable and unressembling to any kind of an acoustic instrument (see for example “For Those Who Don’t Understand” (2012) or “Improvisation” (2011)). Such drastic alterations of the acoustic and instrumental qualities inevitably affect the reception of a composition or a musical instrument. This leads to a situation in which performers and composers have to re-define their identities. The performer might need to learn new skills within the preparation process, whereas the composer has to adapt his or her composition

³⁶ The aesthetics of contemporary piano music were also strongly affected by John Cage, whose experimentations with prepared pianos uncovered new kind of timbres and instrumental techniques.

techniques to a non-traditional performance situation. Moreover, the listeners cannot rely on a ready-made performance tradition; in some cases they are even required to participate to the performance³⁷.

3.3 Functions

Exploring with electronics has been spurred on by the fact that 21st century composers do not have to secure access to high class professional studios in order to produce electronic music. Almost anyone³⁸ with a laptop can program the necessary functions for music electronics themselves, thanks to affordable and easily-accessible software such as Max/MSP, PureData, or with a variety of sequencers, for example, such as LogicPro, Cubase and many others, depending on the style and requirements of each composer. In addition to live processing, these programmes also allow for good communication between performer and sound technician. The music software and programmes are able to provide a variety of effects allowing changes to any parameter if necessary. In addition to computers, microphones, and speakers, computer-controlled instruments can also be used as an essential part of a composition or concert performance. With the help of music electronics, the composers can enhance the original capabilities of the instruments, as well as alter the natural qualities of sound and resonance. Moreover, it is possible to generate artificial sounds that cannot be played on any existing instrument³⁹ (Hynninen in Komppa, 2013, 47) and different partials of the sound spectrum can be emphasized or altered so that the actual sonic outcome becomes much richer than the original acoustic material. The acoustic situations (e.g. the acoustics of the room) are also important factors in determining the final outcome of a musical performance. With the help of algorithmic or convolution based systems, acoustic qualities can be simulated and modified so that even the sound of a concert room (be it either a real or simulated one) can be controlled by the composer.

³⁷ The author participated as a listener to a concert project by Stephen Montague in Devon, UK, in 2008. The audience was specifically masked in order to function as a part of the spectacle, which incorporated various theatrical and performative elements.

³⁸ However, computer programs are getting more and more complex, which is why high technological skills are essential.

³⁹ Although this has been possible for the electronic music composers since the early years of the genre, such techniques became widely accessible when the synthesiser came on the market (approximately in 1964).

3.4 Technologies and Techniques

The possibilities of human-computer interaction within musical performance have been researched by many composers based at different technology institutions⁴⁰. For example, physical modeling and artificial reality instruments⁴¹ have opened up new perspectives in music composition and performance (D. Young, P. Nunn, A. Vassiliev, 2006, 1). When it comes to imitating the qualities of acoustic instruments, musical synthesis based on physical modeling promises the best results (Smith, 1992, 74): “physical modeling synthesis runs a mathematical model of an actual acoustic instrument or complicated, imaginary, “pseudo-acoustic” system on a computer or DSP” (Paradiso, 1998, 1). Such techniques have also formed a part of the design of certain sample libraries. Although most of them (such as the Vienna Symphonic Library) use recorded sounds, some libraries⁴² are based on physical modeling. In general, the growing number of highly efficient music interfaces, as well as the performance and composition techniques featuring them, possess significant capabilities. The Hands of Waisvisz has manifested great virtuoso potential, and other controllers, such as, for example, Tarabella’s Imaginary Piano, Burtner’s MetaSax, Scavone’s Pipe, and the Hyper Flute of Palacio-Quintin offer extended sonic possibilities (D. Young, P. Nunn, A. Vassiliev, 2006, 1). Moreover, Machover’s previously mentioned hyper score software is an innovative example of making use of human-computer interaction in a concert situation. The main purpose of the software is to link the performer’s actions on their instrument to the realisation of musical parameters (Ibid.). Hyper instruments have also been explored by Fernando Rocha and Joseph Malloch⁴³, whose invention “Hyperkalimba” allows the performer to combine the use of traditional performance gestures of the kalimba thumb piano and the extended possibilities of electronic sound modification (Pestova, 2008, 9).

⁴⁰ Whereas the most important research and development in Europe is mainly concentrated in IRCAM, M.I.T. has been one of the leading developers of the field in the USA.

⁴¹ Augmented reality music interfaces have been investigated by Alessandrini, Billighurst, Kato, May, and Marrin, among others.

⁴² For example the Arturia Brass Library

⁴³ The research project took place at McGill University in 2007-08.

The hyperbow has been a research target of Machover and his research group since the middle of the 1980's. This special bow was originally meant to enrich the sonic capabilities of violin but was later extended to the cello, with a specially adapted version of the software developed for the purposes of their collaboration with the Royal Academy of Music⁴⁴. Even though the hyperbow was originally developed for the needs of professional performers, it can also be used as a tool of music education (Bell in Templeton, 2002, 1). The idea behind the innovation is to enrich and extend the sonic qualities of a normal violin or cello by gathering real-time data of a performance during which the movements of the performer are recorded, and then to use this information for producing special sound effects and timbre alterations that enhance the player's instrumental performance. Machover's own version of Paganini's Caprice No. 24 is an illustrative example of a hyperbow composition: the composer decided to work on that particular caprice because of its famous virtuoso characteristics that Machover and Bell (the latter of whom also performed the work) wanted to extend further in order to create a contemporary version of a virtuoso piece, to "show off on a violin" (Ibid.).

Hyper score software has also been used in piano music. Machover's work "Jeux Deux" for hyper piano and symphony orchestra combines it with a Yamaha Disklavier Grand. In this composition, the software extends the functions of a grand piano for example in terms of volume and instrumental capabilities, as well as transcends the pianist's technical possibilities. For instance, in various parts of the piece the pianist has to play simultaneous chords in multiple octave ranges, which one instrumentalist would not be able to achieve. Possibilities of playing other pre-recorded and previously programmed materials during the live performance were used as part of this particular composition's musical language. Although the electronic solutions applied in "Jeux Deux" indisputably increase the virtuoso qualities of the pianist, as well as the capacities of the piano itself in terms of instrumental techniques and sound design possibilities, its dynamic responsiveness is not clear. While a regular piano can offer a vast palette of resonances and dynamics, a MIDI instrument only has 128 resolution steps which

⁴⁴ Pieces for hyperbow were presented for the first time at the Royal Academy in 2005, and later at the NIME conference in 2006. The collaboration with the Royal Academy of Music has since continued; the author of this dissertation had an opportunity to attend to the hyperbow seminar and concert of Machover at the Royal Academy of Music in 2008.

actually makes its timbral range rather limited compared to that of an acoustic instrument.

3.5 Supersize the Piano: The Use of Electronic Extensions in Contemporary Piano Repertoire

Olga Neuwirth's "Kloing!" (2008) for computer controlled piano, live-video, and pianist is an illustrative example of the use of computer interaction. The composition combines different technologies in a versatile manner and challenges the idea of a solo performer being in ultimate control of his or her instrument. The work is realised on Bösendorfer CEUS grand piano, which is capable of creating up to 1000 velocity layers on each key. The artistic idea behind this work is a human's fight against a machine (Plessas, 2008, 4): the piano is played by the pianist and the computer simultaneously. The computer's role gradually increases in importance, and the rapid computer-generated movements of the piano keys give the impression of a natural force that cannot be controlled or tamed by any human intervention.

The technological part of "Kloing!" is based on the seismic data gathered in the Sumatran area during the seaquake that caused the ztsunami disaster on the 26th of December 2004. The data was transformed into an audible form with the help of mathematical modeling and then converted into rhythms and pitch material by using a specific computer program (Plessas, 2008, 1-3). The composition starts with parts from classical virtuoso piano repertoire: excerpts from a few well known pieces (such as, among others, Liszt's "La Campanella" and Chopin's "Raindrops" prelude) are played with a distorted player-piano sound which was constructed by recording old and barely functioning instruments. The material based on the seismic data is introduced gradually until it takes over the piano keyboard: at the end there is no space for the pianist to play. Video material is projected onto the screen during the performance, the visual element giving the performance a theatrical and dramatical touch, which underlines the super powers of the piano, as the film shows the exaggeratingly superhuman movements of the keys. Showing video clips of cartoon characters Tom and Jerry playing an

unpredictably reacting piano also brings lighter and humorous characteristics to the performance.

3.6 Indeterminacy in Music

“In 1974 John Cage was asked: - Why doesn't your music have any structure? Cage replied: - My music is a process. Like the weather (Chadabe, 1996, 43).”⁴⁵

Classical music performers of the 21st century have gotten used to a performance tradition that encourages (and often also requires) them to play everything exactly as indicated on the score. Homogeneous performance practices are systematically advocated by various institutions of music education as well as the recording industry. In such a climate there seems to be very little room for improvisation or interpretation, besides on the very surface⁴⁶. However, treating compositions as closed entities is a relatively new phenomenon⁴⁷. The idea of a composer as a genius who alone is in charge of the artistic contents of their work was born in the Romantic era, which affected the way composers constructed their works and how the musicians started to play and practice them. A classical music composition is still generally regarded as a masterwork that cannot be modified or challenged. An entirely notated piece of music is considered perfect and the performer's task is just to play it as authentically as possible. In this way, the concept of a conventional composition is closer to a fixed object rather than a collection of freely flowing musical events. However, Chadabe underlines the importance of changing this attitude. According to him, one of the most significant steps in the development of contemporary music was the shift of emphasis from compositions being seen as “fixed objects” to composition as a living “process” (Chadabe, 1996, 43). This allowed the composers and performers to discover new modes of expression.

The preference of “process” over “object” (Essl, 1994, 1) can also be identified in the increasing interest towards algorithmic composition techniques that started to flourish in

⁴⁵ Chadabe 1996, 43-44. The question was asked by someone in the audience of the HPSCHD forum at the Brooklyn Academy of Music in 1974. Chadabe was the production's artistic director and was on stage when the encounter took place.

⁴⁶ For example, aspects of ornamentation, detailed articulation, or pedaling.

⁴⁷ Baroque and Classical composers even wrote arias for insertion into operas by other composers and it was common that the cadenza parts of concerto works were at least partly improvised. Also the use of figured bass in the Baroque era provided the performers considerable interpretational freedom.

the genre of electronic music towards the end of the 20th century, simultaneously with the development of highly competent computer programs, such as Max/MSP, and, of course, of faster computers that enabled real-time computer generated processes to be put into practice in musical compositions. Algorithmic compositional techniques in contemporary music are connected to live recording and real-time processing of the gathered data. Essl calls them an “inspirational machine” that can be regarded as a powerful tool, with which to expand our musical experience (Essl, 2006, 1). Other composers, such as Volkmar Klien, frequently apply algorithms in their electronic compositions and sound installations, whilst a number of composers, such as, for example, Georg Friedrich Haas, have adopted a relatively critical approach towards them (Haas, 2013). Depending how such techniques are being applied in the context of each composition, they can provide an otherwise inaccessible variety of sonic, rhythmical, and instrumental possibilities.

3.6.1 The Special Characteristics of Algorithmic Composition

The idea of setting a rule to which the rest of the music can be generated, existed in its basic form in the early Medieval music⁴⁸, with the concept of the organum. The principle was first presented by Hucbald of St Amande, who demonstrated how to improvise an additional voice to a given Gregorian chant. St Amande’s instructions can be considered as a first step on the path towards the development of the canon, a word which, in fact, means “rule” in Greek (kanon=rule) (Essl, 2006, 2). “Musikalische Würfelspiele” (or musical dice games) can be seen as early manifestations of algorithmic composition techniques (M. Edwards, 2011, 59). Musical dice games were especially popular among the composers of the late 18th and early 19th century⁴⁹. Such works are based on precomposed excerpts that the player(s) put in order by throwing dice, thus generating a musical composition.

⁴⁸ Other historical music forms, such as the isorhythmic motet of the 13th, 14th, and 15th centuries, also enabled the realisation of musical material in basis of compressed notational information.

⁴⁹ Many games of this sort were developed at the time. These include, for example, Mozart’s “Musikalisches Würfelspiel” and C.P.E Bach’s “Einfall einen doppelten Contrapunct in der Octave von sechs Tacten zu machen ohne die Regeln davon zu wissen“.

From the composers' perspective, the issue is the extent of detailed control one wishes to retain over the final sonic outcome, given that the process itself usually plays a more important role than than a notated composition in this situation. As Karlheinz Essl puts it, a composer has to give away a certain amount of control but in return the system "enables one to gain new dimensions that expand investigation beyond a limited personal horizon" (Essl, 2006, 1). The purposes and possibilities of conventional and algorithmic composition techniques differ. The latter concept is based on the idea of flexibility, whereas a thoroughly notated standard repertoire composition is usually based on a fixed form that ideally should remain the same in each performance, unless otherwise stated by the composer. The primary characteristic of algorithmic composition techniques resides in the fact that most of the actual composing work has been done at the programming stage, as the algorithm is in fact a key or code to the entire work. In such compositions the system controls the processes (and thus the compositional structure) that formulate the detailed sonic surface differently in every performance. This brings an additional layer to the formation of a musical composition and its sonic manifestation in a concert performance. Traditionally the musical material is produced by the composer and interpreted by the performer; electroacoustic algorithmic compositions, however, require a computer-based interface that also participates to the creation of the actual musical work. Such works combine the technical excellency of the computer and expressive (and technical) competency of the human imagination and intelligence.

3.6.2 Algorithmic Composition Techniques as a Part of a Performance

"It was so unpredictable, it was just wonderful!" – David Tudor,⁵⁰ on the performance of his work "Untitled"

Examples of algorithmic composers:

Rene-Louis Baron (FR), Pierre Barbaud (FR), Warren Burt (AU/USA), David Cope (USA), Nick Didkovsky (USA), R. Luke Dubois (USA), Janet Dunbar (USA), David A. Jaffe (USA), Volkmar Klien (AT), Gottfried Michael Koenig (DE), Sergio Luge (MEX/ES), Max Mathews (USA), Eduardo Reck Miranda (BR), Hans Mittendorf (DE), Dafna Naphtali (USA), Godfried-Willem Raes (BE), Dirk Reith (DE), Marc Sabat (CA/DE), William Susman (USA), Laurie Spiegel (USA), Armands Strazds (LT), Yūji Takahashi (JP), Rodney Waschka II (USA), Iannis Xenakis (GR)

Automatising composition has long been of interest to various composers. Barbaud (1911-1990) regarded himself as the inventor of algorithmic music (Barbaud, 1960, 92), while automatic musical composition was first patented in Paris by Rene-Louis Baron in 1998. Lejaren Hiller (1924-1994) is often regarded as one of the pioneers of computer controlled algorithmic composition (M. Edwards, 2011, 61). Another important contributor to the field was Max Mathews (1926-2011) who participated in the designing process of the Max/MSP⁵¹ program and after whom the software is partially named. However, the best known composer in the field was undoubtedly Iannis Xenakis (1922-2001), who mentioned algorithmic composition techniques already in 1957, and whose work GENDY3 (1991) can be considered as a prototype of "a purely algorithmic composition" (P. Hoffmann, 2002, 121). The automatization of the compositional processes within his GENDYN-program happens on "the 'atom' of digital sound, the sample ('micro-composition')" (P. Hoffmann, 2002, 122). GENDYN generates the micro- and macro- levels of the composition according to the composer's input (Hoffmann in Georgaki, 2005, 3). Xenakis himself called the process "dynamic stochastic synthesis" (Xenakis, 1992, 289-293), which eventually formed the basis of granular synthesis that has been since been a point of interest for numerous composers and researchers (Georgaki, 2005, 3). "The idea behind the GENDYN program is that free, autonomous evolution of the music itself takes the place of the micro-formal choices

⁵⁰ D. Tudor in Chadabe, 1996, 44.

⁵¹ The program was developed by Miller Puckette.

usually made by the composer” (Gérard and Rebelo in Georgaki, 2005, 3). In addition to his electronic compositions, the composer also used the same techniques for some of his acoustic works.

Although there has already been considerable amount of research in this particular area, the development of algorithmic music is an on-going process. Whereas some composers exclusively concentrate on their artistic work, others also actively participate in the development of new computer softwares and systems. For example, Marc Sabat is currently working on a self-tuning computer algorithm “micromaelodeon”, David Cape has designed the EMI software (“Experiments in Musical Intelligence”), and Godfried-Willem Raes has created the algorithmic music programming language (<GMT>). Karlheinz Essl has created several algorithmic computer programs, for example “Seelewaschen” (2003-2006), “More or Less” (1999-2007), and “Real Time Composition Library” (1992-2014), the latter of which some of his compositions (for example “Sequitur V”) are partly based on.

Many composers create new computer programs to address the needs of their specific composition projects, which in most cases can be seen as an integral part of their artistic expression that cannot be distinguished from the rest of their composing work. Karlheinz Essl’s “Lexicon Sonate⁵²”, is based on a specifically designed computer program, which “is an infinite music installation that can run on a computer for years without repeating itself. It can also be used as a computer instrument for live performances” (Essl, 1992, 1).

The use of algorithmic composition techniques occasionally tempts the composers to favour electronic solutions free from human performers. For example, Hans Mittendorf’s “Algorithmic Composition for two Virtual Pianos” (2010) works well within a concert setting: the end result sounds musically meaningful because the precisely timed interactions between the computerised processes generate clearly recognisable motifs. Gary Lee Nelson’s “Fractal Mountains” for Yamaha TX816 and a pair of EMU Proteus/1 synthesizers controlled by a Macintosh computer and a MIDI

⁵²The work can be listened in the following address: <http://www.essl.at/works/Lexikon-Sonate.html>

wind controller is also an independent algorithmic entity. The same composition techniques, however, have also been used in conjunction with acoustic instruments and live performers: such works include, for example, Gottfried Michael Koenig's "Übung" for solo piano (1969/70) and Gary Lee Nelson's "Summer Song" (1991) for solo flute. The use of a live performer depends on the artistic and structural demands of the musical composition.



Figure 2: Karlheinz Essl performing "Lexikon-Sonate" on a Bösendorfer CEUS computer piano at Bösendorfersaal, Vienna (12 Dec 2008). A similar instrument was also used by Olga Neuwirth in her work "Kloing!". Picture by Wladimir Fried (2008)

Composers cite different reasons for applying generative music processes. For example, Laurie Spiegel comments on her compositional thinking: "I automate what ever can be automated to be freer to focus on those aspects of music that can't be automated" (E. Hinkle-Turner, 2006, 241). Moreover, in addition to contemporary composers who mainly present their work in concert halls, there are experimental musicians, such as Sergio Luque, who participate in experimental computer music bands and use these techniques as a part of the aesthetical language of their groups.

3.7 Karlheinz Essl: “Sequitur V” for Toy Piano and Electronics

The toy piano has turned out to be a suitable instrument to be used in conjunction with electronic solutions. Its limited characteristics provide the composers a *tabula rasa* to fill with the results of their own musical imagination. It is hardly a coincidence that Karlheinz Essl has written many of his algorithm based works for this particular keyboard instrument (for example, “WebernSpielWek” (2005/2012), “Listen Thing” (2008), “Whatever Shall Be” (2010), “Under Wood” (2012), and “Patchinko” (2013)). His works transform the toy piano into an electro-acoustic “super instrument” by multiplying its instrumental range, bringing in otherwise non-existing dynamics and reverb, as well as electronically doubling the instrument to enable the player to perform a solo duet.

“Sequitur V” is a composition belonging to Karlheinz Essl’s long term “Sequitur” project, in the context of which he has written algorithmic pieces for various instruments (for example electric guitar and African Kalimba). The “Sequitur” serie is Essl’s response to Luciano Berio’s “Sequenze”: the composer’s aim was “to attempt to write a series of pieces which take advantage of the idiosyncratic instrumental possibilities – and confront them with a realtime sound processing environment that has its own secret life” (Essl, 2008, 1). The live electronic parts of the “Sequiturs” all use the “Sequitur-Generator” program designed by the composer, as each work of the serie uses its own version of it (Essl, 2008-2010, 1).

The acoustic and instrumental qualities of the toy piano have been extended within this composition with the help of real-time sound processing. However, the original timbre of the instrument (and thus the identity of the concert instrument) does not change in this work as radically as in “Sequitur XIII”: although the instrument’s existing capabilities have been enhanced, the original sonic colour stays recognisable at all times. On the other hand, the compositional identities of “Sequitur V” and “Sequitur XIII” are quite close, as they share the same explorative purpose, that is to extend the harmonic, technical, rhythmical, and structural qualities of the original concert instruments (Essl, 2013). Both works are based on computer-generated micro canons

that form a complex and active compositional organism which works in real-time, based on the gathered sonic data.

Composers have developed various ways of controlling their material through MIDI- or other computer-based devices. For example, Nelson refers to a system that “makes no sound by itself but rather reflects the character of the synthesizer that it controls” (G. L. Nelson, 1993, 1). The electronic part of “Sequitur V” is exclusively based on the sounds produced by the performer on the instrument, as the system itself does not make any sounds nor contain any kind of samples or pre-recorded material. The algorithms are used in “Sequitur V” to run the sound modification processes triggered by performer using the space bar of the Macintosh computer or the foot pedal. Moreover, because a toy piano itself does not really have a proper range of dynamics, those qualities are also generated by the electronic system and controlled either by the sound technician or the performer.

The sonic material of the electronic part is collected through constant live recording obtained by attaching a contact microphone on top of the instrument. In addition to the artificial dynamics, the selection of electronic functions of “Sequitur V” contains various other effects that help to transcend the natural limitations of the toy piano. Such include, for example, distorting and modifying the instrumental timbre, adding reverb and applying delays, as well as constructing different kind of rhythmical structures and processes. The algorithms are used to generate an extensive amount of electronically processed canons that interact with the recorded sound material produced by the performer.

FX Parameter Changes in Sequitur V (Karlheinz Essl)

	detune (detune) %	flanger (flange) %	ring modulator (rmod) %	comb filter (comb) %	reverb (rev) %	tremolo (trem) %	Relative SPEED of Parameter Change
1	0	0	0	0	5	0	-
2	0	0	0	0	5	45	slow
3	0	85	0	0	30	0	moderately fast
4	0	0	60	0	5	0	slow
5	0	0	0	0	5	55	slow
6	0	0	0	65	50	0	slow
7	0	50	0	0	5	0	moderately fast
8	20	0	0	0	5	0	slow
9	0	0	65	0	5	80	slow
10	0	0	0	0	5	0	fast
11	0	50	0	0	5	0	moderately fast
12	0	35	70	0	5	0	moderately fast
13	0	20	50	45	5	50	slow
14	0	0	30	0	5	40	slow
15	20	0	0	0	5	30	slow

Figure 3: The list of parameter changes (estimated values) of each computer-generated passage (1-17).

“Sequitur V” consists of 17 different computer-based processes that have been designed to reflect the corresponding acoustic material throughout the piece. The electronic system is a cumulative process: all the passages are related to each other rather than being separated. The phases overlap and affect one another and the musical material is in constant transition. As shown by the diagram above, the design of each phase is unique: the passages do not necessarily differ from each other radically, but form distinct mixes of their shared functions. Each passage emphasises different effects.

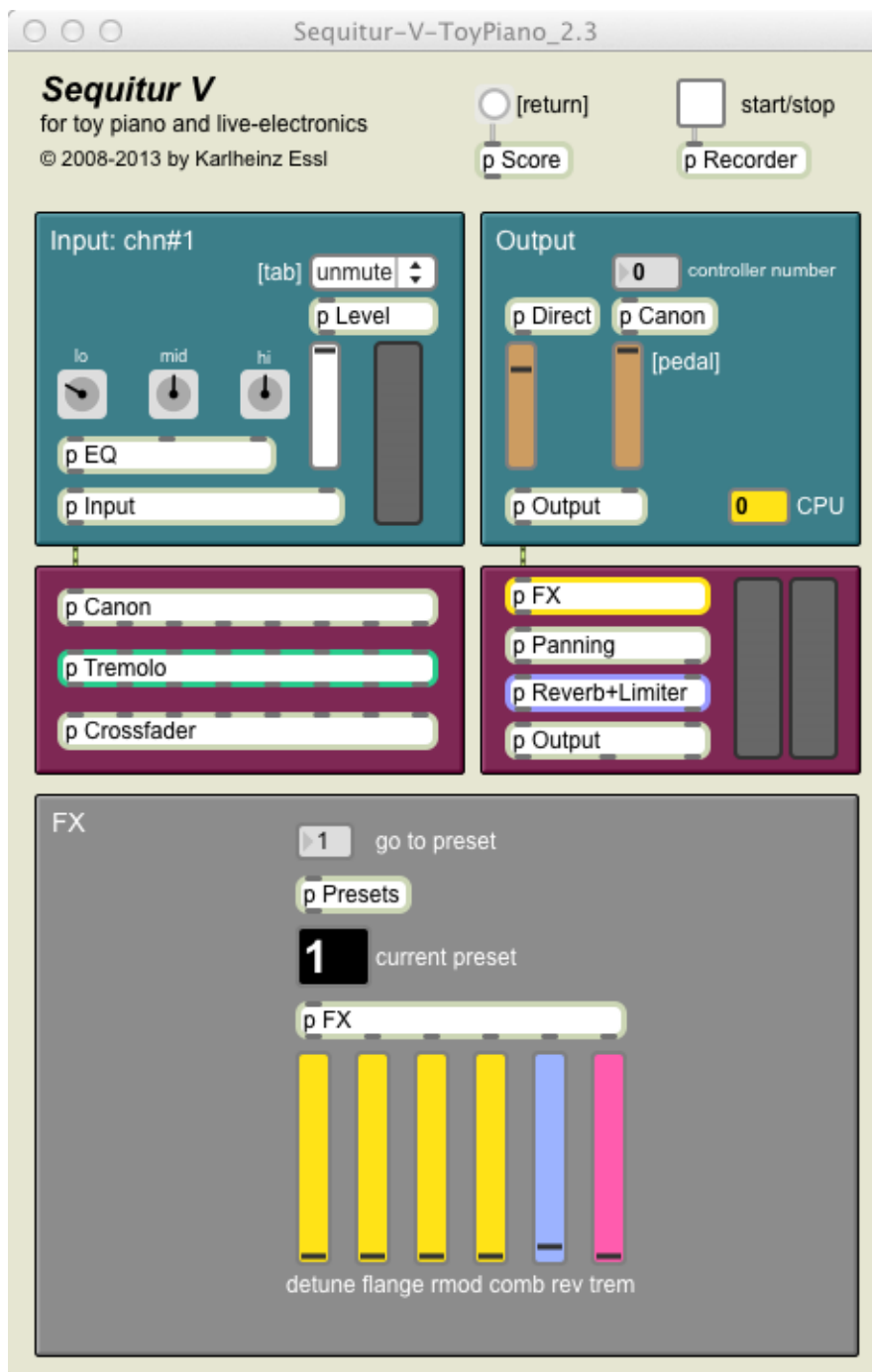


Figure 4: The real-time based player of “Sequitur V”

3.7.1 Performing “Sequitur V”

The toy piano is nowadays a secondary instrument for some classically trained pianists specialising in contemporary music. I was not aware of its possibilities (or of the toy piano repertoire in general) until I had a chance to practise and perform Essl’s “Sequitur

V”. The collaboration started during my composition lessons with Essl when I was studying electroacoustic composition at Universität für Musik und darstellende Kunst Wien. To illustrate his composition techniques, Essl gave me the opportunity to rehearse “Sequitur V” at his studio and gave me the score, which I took home to practise the toy piano part. My first impression was that the instrumental part seemed straightforward⁵³. However, when I played the piece for the first time, it became obvious that the work would require much practice. I rehearsed “Sequitur V” a number of times, with the first two or three mostly spent on familiarising myself with the interactive computer generated part. I gradually started to understand the reactions of the electronic system and managed to adapt my performance techniques to it. “Sequitur V” has since become a fixed part of my repertoire and I have played it numerous times at different concert venues.

The first version of the piece did not require the performer to observe the dynamics of the electronic part. The composer has since revised his composition: the dynamics of the electronic system are now determined within the current version, which means that the toy pianist needs to use a MIDI pedal for controlling them⁵⁴. Alternatively the work can be performed with an additional musician (sound technician). Most of the functions of the electronic system are not directly shown on the score. Rather than relying on notations, I had to discover a way of playing that combined improvisation with traditional classical music performance. Finding the right balance between playing/performing and waiting/listening is one of the challenges of the work. The electronic “solos” (played by the computer) resemble the orchestral interludes of a concerto. Rather than just waiting for them to pass, the performer has to actively listen to them in order to know how the musical situation is developing. Such passages also bear structural importance. Playing “Sequitur V” could be compared to a situation in which one dances with one’s own reflection in the mirror: the electronic background is

⁵³ The seemingly uncomplicated acoustic solo parts are a trademark of Essl’s compositions. However, there seems to be a practical reason for this: because of the complexity of his electronic processes, the composer wants the performer to invest all his or her attention on the interaction with them, rather than focusing on instrumental difficulties.

⁵⁴ This of course makes the piece more difficult to play, as the performer has two parallel sets of dynamics to control.

not an external accompaniment but a real-time system which reacts to the performer's every movement with a short delay.

3.7.2 The Timing in “Sequitur V”

“Sequitur V” has two contrasting characteristics: while the algorithm controlled electronic part is unpredictable, the instrumental part is thoroughly notated and has to be played precisely. The performer needs to learn how to combine these two aspects of the work. The timing of the piece is left almost entirely up to the performer; no click track or other time controllers are used and, as mentioned, the performer deciding when to proceed to the next passage. Although it is necessary to count the exact durations of some of the breaks, the toy pianist should primarily base the interpretative decisions on each musical situation, i.e. depending on whether the phrase is closing or if, on the contrary, it is emerging from the general sound mass. Sufficient practice with the electronic player gradually makes it easier to approximately estimate the the length suitable for each passage. The lack of time controllers is one of the benefits of this work: rather than having to react to a click track, the performer can focus on playing the instrument, which increases his or her energy and presence. It is easier to concentrate on sound quality and instrumental techniques.

The electronic processes are marked on the score simply with numbers from one to seventeen, which indicate when to move forward to the next passage. Instead of indicating the exact time codes for the key points of the work, the composer has marked their starting points on top of different breaks or fermata symbols. These are not meant to be regular silent breaks but indications for the toy pianist to stop playing and to concentrate on listening to the computer-generated material.

During the rehearsing process of “Sequitur V” I developed the following system of decision making regarding the timing of different passages. The comments are based on my own subjective performing experiences.

1. The electronic system starts: it should be switched on a moment before the performer starts to play (figure 5).



Figure 5: bar 1. The electronic system starts.

2. The beginning of the second passage is placed between two different textures. The performer should make a short break before continuing to the next phase. However, one should not wait until the canons have faded out. Bar 21 emerges from the depths of the electronic system (Figure 6).

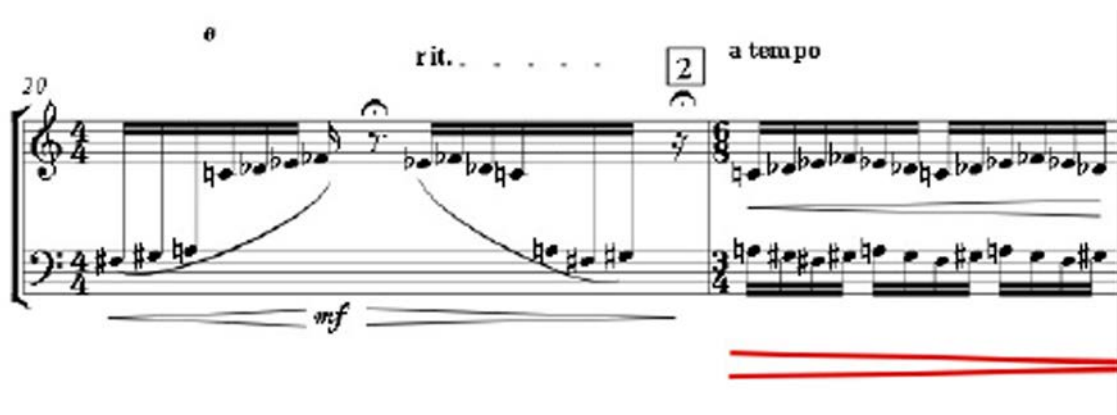


Figure 6: bars 20-21. The beginning of the second passage is placed between two different textures.

3. The transition between passages two and three is longer than the previous ones. Because there has been a long crescendo into *ff*, the development of the electronic material needs more time. The duration of the break has been notated precisely: the performer does not need to estimate the timing (Figure 7).



Figure 7: bars 27-29. The transition between passages two and three takes place in bar 28.

4. The fourth passage calms the music down. The break is notated accurately (Figure 8).

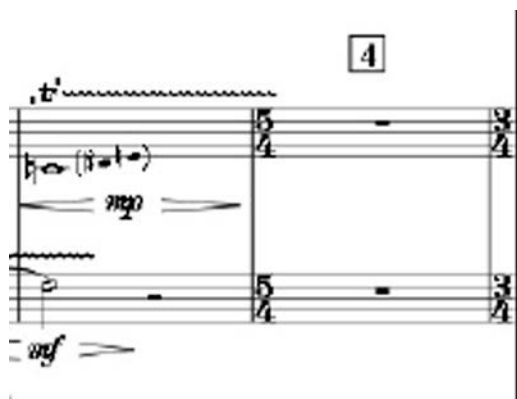


Figure 8: bars 31-32. The fourth passage begins in bar 32.

5. Phase five connects a closing phrase (bars 33-37) and the beginning of a new one.

The performer needs wait until the reverb of bar 36 quietens down (Figure 9)

a tempo (♩=72)

rit. molto

5

The musical score for Figure 9 consists of two staves. The top staff begins with a dynamic marking of *sf* (sforzando) and a hairpin that tapers to *pp* (pianissimo). The bottom staff also begins with a dynamic marking of *sf* and tapers to *pp*. Above the staves, the tempo changes from *rit. molto* to *a tempo* (♩=72). A box with the number 5 is positioned above the second measure of the *a tempo* section. The score is divided into three measures with time signatures of 7/4, 3/4, and 6/8.

Figure 9: bars 33-37. Connecting a closing phrase and the beginning of a new one.

6. The sixth passage reduces the volume and pitch material of the previous process. A new texture consisting of repetitions emerges. The break should be relatively short, which is why the composer has indicated its exact duration (Figure 10).

6

The musical score for Figure 10 shows a single staff with three measures. The first measure has a dynamic marking of *p* (piano) and a hairpin that tapers to *pp*. The second measure has a dynamic marking of *pp*. The third measure has a dynamic marking of *pp* that tapers to *p*. The time signatures for the three measures are 2/4, 3/4, and 4/4. Below the staff, there is a red hairpin that tapers from left to right, ending in a small circle.

Figure 10: bars 45-47. reduction of the volume and pitch material of the previous process (bar 46).

7. The seventh passage connects the previous rhythmical texture (repetitions on one pitch) and more melodic material. Some time should be allowed for the reverberation in bar 51 (Figure 11).

Figure 13: bars 74-77. The break between passages eight and nine should be rather short on bar 75.

10. Phase ten is similar to the third passage: the break between bars 84 and 86 fortifies the preceding crescendo. The performer should allow the electronic system enough time to ring (Figure 14).

Figure 14: bars 84-86. The performer should allow the electronic system enough time to ring in bar 85.

11. The eleventh phase connects two phrases related to each other; the duration of the break has been notated precisely (Figure 15).



Figure 15: bars 88-90. The eleventh phase connects two related phrases on bar 89.

12. The computer generated process continues the previous phrase and brings the music forward. Similarly to the passage 11, the break should last exactly four beats (Figure 16).



Figure 16: bars 92-94. The break should last exactly four beats (bar 93).

13. The computer generated process helps speed up tempo and volume. The break should have an exact duration of four beats (Figure 17).



Figure 17: bars 96-98. Speeding up the tempo and volume.

14. Unlike the others, this process does not start during a break. It forms an external dynamic layer that supports the subsequent dramatic passage (Figure 18).

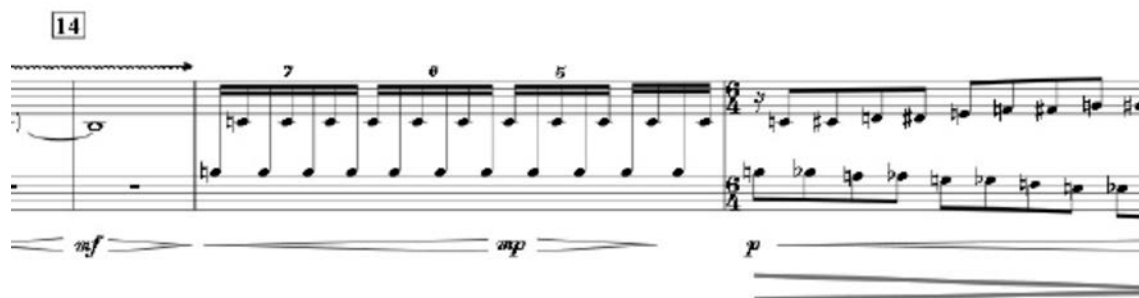


Figure 18: bars 103-106. The electronic part forms an external dynamic layer that supports the subsequent dramatic passage.

15. The performer should clearly communicate an end of a phrase in bar 109, which is why the break can be sustained a bit longer (Figure 19).



Figure 19: bar 109. The performer should clearly communicate the phrase ending.

16. Passage 16 starts in the middle of the phrase: it helps build the polyphonic situation. The toy pianist should keep on playing and not react to it (Figure 20).

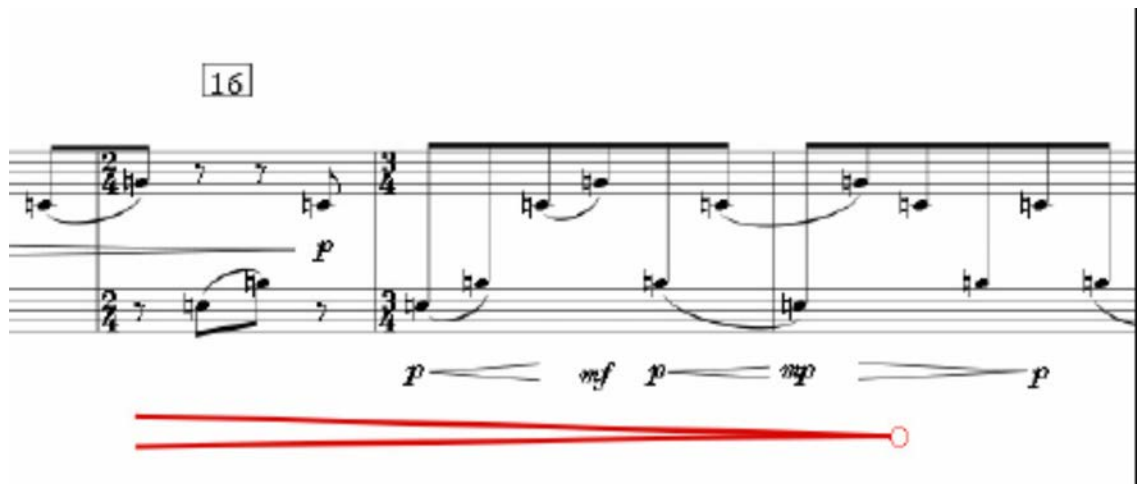


Figure 20: bars 119-121. Passage 16 starts in the middle of the phrase (on bar 119).

17. This process lasts until the very end of the piece: the electronic system constructs rhythmic micro canons around one single pitch and fortifies the dynamic growth. The electronic part should be faded out towards the end of the piece, after which the performer plays the final tone in ffff (Figure 21).



Figure 21: bars 124-128. The beginning of the coda.

3.7.3 Notation

Excluding the dynamic markings and the plain numbers indicating the triggering points, the composer has not notated anything related to the electronic part. Although the score does not reflect or communicate the complex overall structure of the piece, this seems to be an efficient solution. The functions of the real-time player would be beyond the grasp of traditional notation because of their high complexity and unpredictable characteristics, as the piece consists of processes rather than independent effects.

3.7.4 Toy Piano as a Super Instrument in “Sequitur V”

The specific instrumental characteristics of the toy piano attract some composers eager to re-define the instrument’s identity to accord with their own ideas. It can be a convenient choice within a compositional setting in which the electronics also dictate the functions of the acoustic instrument. A growing number of composers have participated in expanding the repertoire for this miniature instrument⁵⁵ and several performers have dedicated themselves to it. One of the first (and most significant) toy piano composers was John Cage who used to collaborate with Margaret Leng Tan (born in 1945), who still frequently performs his toy piano works. Other performers of the

⁵⁵ These include, for example, Lou Bunk, Derek Hurst, Jorrit Dijkstra, Yu Oda, Andrián Pertout, Monica Pearce, and Carlos D. Perales, to mention a few.

next generation include, for example, Phyllis Chen, Isabel Ettenauer, Emil Holmström, Pascal Meyer, Victor Trescolí Sanz, and Xenia Pestova.

Toy piano is a concert instrument on its own right. Despite the visual similarities between a regular piano and a toy piano, they are significantly different. A toy piano is not just a limited version of the normal piano: it has its own characteristics, repertoire, and playing techniques. The smaller size of the keys requires the performer to apply different kind of a hand position and fingering and, moreover, the timbre is very different from a regular piano (Pestova, 2014). In addition, instead of sitting on a piano chair, the performer usually sits on the floor next to their instrument (in many cases also controlling an electronic system). The aspects of tuning and resonance are unique. A normal piano is usually carefully tuned, whereas almost nobody tunes their toy pianos (Ibid.), which causes interesting and unpredictable overtone situations. Every toy piano has its own characteristics of sound, which is usually taken into account in the compositions written for this particular instrument.

When the toy piano was invented by Albert Schoenhut, it was originally produced as an instrument for children, an identity which remains in the minds of the concert audience. Being a miniature keyboard instrument with a range of either two or three octaves (a standard Schoenhut toy grand piano usually has 37 keys), and, metal plates instead of strings, the toy piano is of course limited in its technical and sonic characteristics. Unlike the regular piano, the toy piano does not provide a vast palette of dynamics. Moreover, playing large chords or fast repetitions do not usually fit well to the natural capabilities of the instrument.

As this work by Essl shows, it is possible to transform the toy piano into a concert instrument by using music electronics. “Sequitur V’s” algorithmic system forms a complex and interactive compositional organism. The end result is a partly independent sonic machinery, and partly controlled by the performer/sound technician. The kaleidoscope of sounds, rhythms, reverberations, and delays of this piece has very little to do with the sonic capabilities or limitations of the original instrument. The computer

generated part bears an equal importance to the instrumental line by forming a “second instrument” which allows the toy piano performer to play a duet with themselves.

3.8 Karlheinz Essl: “Sequitur XIII”

Karlheinz Essl's “Sequitur XIII” (2009/2013) for extended piano and live electronics is an innovative work in which the piano has been transformed into a super instrument thanks to a computer-based algorithmic system. Turning the relatively simple instrumental material into an orchestral entity through various real-time harmonic and spectral alterations, the piece multiplies the functions of the original instruments by recording the musicians' performance and playing it together with its modified version. The work shares many features with “Sequitur V”, most of them on the aesthetical as well as the technological level. As with “Sequitur V”, the electronic player of “Sequitur XIII” is a real-time system that reacts to the piano part without producing any sounds by itself. Its main purpose is to enhance and reflect the collected sonic data with the help of two high-quality cardioid microphones, as the fine and monophonic piano texture becomes a vast and polyphonic entity.

Different partials and resonances are constantly emphasised with the help of the electronic system, which creates a unique sonic atmosphere. The electronic system has two different dynamic levels: the input into the programme (marked on the score in green colour) and the output from the programme (marked in red colour). By controlling the input level, it is possible - for instance - to send only the resonance of the sound to the Sequitur Generator⁵⁶. The inherent canonic principle is concealed, as one does not hear the characteristic loud attack but only the soft resonances, which creates an effect that resembles an echo (Essl⁵⁷, 2014).

⁵⁶ The specific computer program designed for “Sequitur XIII”.

⁵⁷ An email conversation between the author and the composer, 6.8.2014.



Figure 22: bars 1-2. The input and output levels of the computer program are indicated on the score with green and red colours. As seen in bar one, only the resonances are played through the speakers, which disguises the starting points of the canons.

3.8.1 “Sequitur XIII”: Creating a Super Instrument with the Help of Technology

The super instrument qualities of the work can be heard most clearly in its versatility of timbres and resonances. Although most of the piano part is thinly scored, the overall harmonic and rhythmical world of the composition sounds rich and full. As stated by the composer himself, “the virtuosity of this piece is not found in the polyphony of the voices, but in the polyphony of the structural components which – by interacting with each other – form a common “sound” together” (Essl, 2009, 3).

The composer uses the EBow to emphasise the key points of the overtone based material and to sustain certain harmonies for a longer period of time. The piece is based on three different harmonic scales based on odd-numbered overtone series that are anchored together towards the harmonic center (middle “C”) by the use of EBow (Essl, 2009, 1).



Figure 23: The overtone series used by Essl in “Sequitur XIII”

The harmonic world of “Sequitur XIII” is rather chromatic. The use of three different overtone scales at the same time allows sharp dissonant textures. The pitch material is exclusively based on the following 22-tone scale:



Figure 24: The overtone scale of Sequitur XIII

Although the notated score is full of space, freedom and rests, the overall sonic development is constantly evolving. The musical tension is constructed between the pianist’s actions on the keyboard and the electronically-produced material controlled by the sound technician and played through the speakers. Both parts are knitted together closely, making it impossible to aurally distinguish between the electronic and acoustic components.

3.8.2 “Sequitur XIII” from the Performer’s Perspective

The rehearsing process of “Sequitur XIII” was different from that of “Sequitur V”: first of all, when I commenced to practise “Sequitur XIII” I had already gathered a fair

amount of experience in performing electroacoustic works, which was not the case when I first learned “Sequitur V”. Despite its extensive use of extended techniques, “Sequitur XIII” is a work for my main instrument. I did not need to adjust to a completely new instrument as with “Sequitur V”. Having been a member of a contemporary music ensemble for years, I was also familiar with different extended techniques and instrumental preparations, which made it easier to master the technical requirements of this particular composition. After rehearsing and performing “Sequitur V” I had also become more familiar with Essl’s aesthetics and composition techniques, which helped me better understand the role and functions of the electronic part, as well as the notation of the piece. Moreover, “Sequitur XIII” was commissioned by pianist Tzenka Dianova, whose recording of the piece is publicly available⁵⁸. Watching and listening to her performance quickened my own learning process.

Extended techniques and preparations form an important part of the pianist’s expression within this particular work. Rather than merely changing the timbre, they have been used in order to manipulate the harmonic structure. This responds acoustically to the functions of the electronics (picking up harmonic partials and resonances). The performer is often required to play harmonics, which she or he produces by touching the string on the corresponding spot and then hitting the key with the other hand. The composer recommends that such places should be marked with a chalk⁵⁹ in order to make it easier to find them: I have also myself found this rather useful.

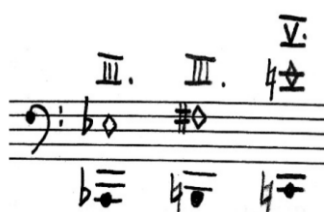


Figure 25: This image demonstrates which keys to hit (the lower line) in order to attain the required flageolets.

Before commencing to play the work one is supposed to mute the three lowest and highest piano strings with rubber wedges. This way a completely muffled sound is

⁵⁸ A video recording of the performance is available at <http://www.essl.at/works/sequitur/sequitur-13.html> (accessed 5.9.2014)

⁵⁹ However, crayon/china marker might work as well, as it does not crumb.

acquired, which is essential in order to play the rhythmical and percussive passages in a correct way.



Figure 26: The muted keys produce a rhythmical and percussive effect. The electronic system elaborates the texture with added polyphony (bars 17-22).

Other technical specialities of “Sequitur XIII” are the use of EBow and fishing wire (or a single hair from a violin bow): learning to intercorporate these implements to the musical performance requires some practice. The performer should place the wire around Contra-A flat and Great-A natural, after which he or she can control the resulting “drone” sound by adjusting the pressure and speed of bowing (Essl, 2009, 3).



Figure 27: The “drone” sound: the performer plays the piano strings with a fishing wire (bars 67-69).

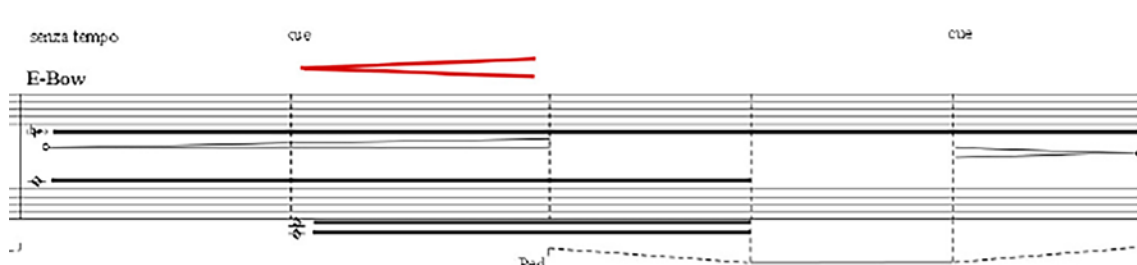


Figure 28: Notation of the use of EBow in bar 51. The device should be placed on the strings of the middle C.

As is the case with “Sequitur V”, the most important musical events of this composition do not take place in the acoustically performed piano part, but in the electronic line

which reflects it. Both works require a performer who is comfortable with playing together with a real-time based electronic background. “Sequitur XIII” requires a lot of natural musicianship and willingness to improvise, as one cannot find all the important information from the score, which is typical of Essl’s compositions. The pianist is supposed to listen to the reactions of the electronic real-time modifications of the electronic player in exactly the same way as, for example, in “Sequitur V⁶⁰”. “Sequitur XIII” is a duo work: Essl treats the sound technician as another performer rather than an assistant of the soloist. The sonic outcome relies mostly on the functions of the electronics rather than the reactions of the acoustic performer, as the sound technician is in charge of determining “Sequitur XIII”’s time structure, dynamics, and key points of harmony. Thus, in my experience, good communication between pianist and sound technician is essential in this situation.

Figure 29: bars 30-37. The numbers in boxes (2 and 4) show the performer the approximate time to move to the next passage, which, however, at the end mainly depends on the behaviour of the computer generated material.

3.8.3 The Listeners’ Perspective

The different textures played by the pianist and the sound technician give the impression of a super pianist or an electroacoustic ensemble formed by a single

⁶⁰ It is possible to perform “Sequitur V” with or without a sound technician.

performer.⁶¹ In addition to playing the instrument, the pianist is also in charge of different implements and preparations, which has a strong visual and dramatic impact on the listeners' experience. The different sonic colours result from the combined use of acoustic instrument, electronic manipulation, and extended techniques. "Sequitur XIII" is an atmospheric piece: according to my own experience some of the sonic colours even seem to relate to the aesthetics of film music (especially within the horror movie genre), which is not surprising, considering that Essl has also composed several soundtracks for visual media.

3.9 Kallionpää: "Zusammenbindenbinden.Winden? –Hommage a Schumann"

This work was constructed around a computer generated system that extends the sonic image of a solo piano. The purposes of writing this algorithm-controlled composition were to, firstly, multiply the capabilities of a regular piano, secondly, emphasise and colour the bass line with the ring modulator, and thirdly, use the electronic system as a provider of micro dynamics and constantly alter rhythmic and harmonic situations unachievable by a normal piano with one performer.

In the context of "Zusammenbinden? Winden. –Hommage a Schumann", the acoustic instrument is transformed into an orchestra that deals with several microscopic sonic processes. The algorithmic composition techniques are used to augment the essence of a regular piano towards the idea of a super instrument with spectrally-altered characteristics. The computer generated processes of "Zusammenbinden? Winden. –Hommage a Schumann" form the foundation of the work and, similarly to Essl's "Sequiturs V" and "XIII", this work also requires a custom made real-time player. However, while Essl typically uses live recording as a part of his musical expression, "Zusammenbindenbinden.Winden? –Hommage a Schumann" does not deploy real-time processing of the recorded material, although the computer generated process itself is a live system.

⁶¹ This is, however, only the listener's impression. As stated before, the roles of the pianist and the sound technician are equally important and most of the sonic texture is actually generated by the computer.

The electronic systems form part of the development of the identity of the composition itself, as well as providing the means for the alteration and formation of new kinds of instrumental identities. The philosophical thinking behind “Zusammenbindenbinden.Winden? –Hommage a Schumann” has been significantly influenced by Essl as, unlike most of my other compositions, this one adapts his idea of relinquishing a certain degree of control in order to gain more freedom of artistic expression. The work also differs from my other compositions in terms of harmonies and general structures: whereas my previous works have usually been based on harmonic progressions aiming at maximal chromaticism, “Zusammenbindenbinden.Winden? –Hommage a Schumann” mainly relies on a diatonic and stable harmonic background. Rather than constructing a clear dramatic formula with a beginning, development, and climax, I decided to develop a surface which moves independently and exhibits the same musical material from different angles like a prism.

3.9.1 Composing “Zusammenbindenbinden.Winden? –Hommage a Schumann”

Composing “Zusammenbindenbinden.Winden? –Hommage a Schumann” was different from my previous experiences in composition in terms of techniques, technology, and aesthetics. It was one of my first electroacoustic experiments and my first attempt to use Max/MSP program. I had previously composed a work for organ and electronics (“Dialogo” (2008)), which was built on the LogicPro program. Yet the aesthetical ideas of these two works could not have been farther apart. When composing “Dialogo” I controlled my material at all times: the electronic part was first recorded with the organ of the Dutch church in London and then carefully modified in a studio environment. Unlike that of “Zusammenbindenbinden.Winden? –Hommage a Schumann”, the computer generated part of “Dialogo” is a fixed background. Even though a performer of “Dialogo” has a lot of room for interpretation (their part being mostly based on spatial notation), the electronic part itself does not allow much flexibility because the recorded and processed samples have to be triggered within certain time frames.

With “Zusammenbindenbinden.Winden? –Hommage a Schumann” I was, for the first time, experimenting with Essl’s idea of a self-running, algorithm-based, electronic

system as the foundation of the composition. I had to abandon the support provided by my normal pre-structured harmonic and rhythmical “map”⁶² and trust the computer-controlled system. Writing an artistically coherent algorithm-based musical composition requires even more planning and pre-setting than a more conventionally constructed thoroughly notated piece. As Klien and colleagues suggest, setting up a generative music system does not automatically guarantee an aesthetically meaningful musical artwork because “not everything that works mathematically is bound to work on an aural level and that this is not only a question of complexity or lack thereof.” (V. Klien et al., 2010, 1). Pierre Boulez and Milton Babbitt have explored mathematical concepts in conjunction with their artistic work and writings. Boulez has been an advocate and developer of total/integral serialism, whereas Babbitt is widely known for inventing the interval set theory. Although serialism was an essential part of Boulez’s compositional techniques, he has nowadays distanced himself from its most rigid form⁶³.

Mathematical constructs can serve well as part of the compositional design, but they cannot alone replace the creative input of a human composer⁶⁴. I was aware of the problems of using a mathematical system as a composition technique, which is partly why I decided to compose a piece that would be relatively simple in terms of its harmonic structure: the complexity of the music lies in the functions of the electronic system. The harmonic focus stays in “G” at all times. Instead of containing strong and expressive musical gestures, the piece crystallises around the tiny movements of the computer generated materials.

The impression of a wavy and moving musical surface is mostly achieved by the absence of proper modulations or harmonic changes. The whole electronic background is based on the same music fragment that changes shape but is never transformed into something fundamentally different. The motif has been extracted from Robert Schumann’s “Spanisches Liederbuch” and it is present throughout the piece.

⁶² I usually make a generic graphical score and a structural map before starting to compose a new work.

⁶³ One of these compositions is “Le marteau sans maître”. Although still strongly influenced by serialism, the composer has incorporated elements of jazz and the use of non-Western musical instruments.

⁶⁴ An example is the Finnish composer Einojuhani Rautavaara, (belonging to the same generation with Boulez), who participated to the original Darmstadter Ferienkurse in the 1950’s and became interested in serialism. Although he used it for a while as a part of his compositional vocabulary, he eventually rejected the technique. His current works are based on musical drama and free tonality rather than any kind of a fixed mathematical formula.

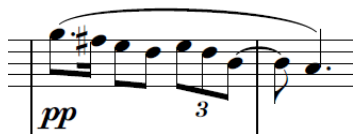


Figure 30: The main motif of “Zusammenbindenbinden.Winden? –Hommage a Schumann”

As with many other compositions within the genre of algorithmic music, the electronic system is the main component of this work, which is why I decided to concentrate on it first. The main motif was recorded at the studio, after which I designed an electronic player that would constantly modify it by different time-stretch canons and slight microtonal tensions. During the process I had to decide how the electronic and acoustic aspects of the piece would relate to each other: should the electronic background function as an accompaniment (and the acoustic part as a solo) or should the two lines merge together? I opted for the latter alternative because I wanted to explore how to transform a grand piano and a computer into one organic and seamlessly-functioning entity.

My performer and composer identities have perhaps never before overlapped in the same manner as within this project: when composing the piece I was fully aware that I was to perform it in public at Musikverein Wien at short notice. My intention was to compose a piece that would best suit to my own particular pianistic qualities, which I took into account when writing the instrumental part.

3.9.2 The Performer’s Perspective

Although the electronic system of “Zusammenbindenbinden.Winden? –Hommage a Schumann” is “alive” and its different components interact with each other, the system only processes pre-recorded sonic data which reflects the harmonic and motivic contents of the piece. The sound technician uses the ring modulator on the amplified live piano in a slow tempo, which emphasises and embellishes a pitch group based on the main motif: this forms a subtle cantus firmus for the entire duration of the composition. Similarly to Stockhausen’s “Mantra”, “Zusammenbindenbinden.Winden? –Hommage a Schumann” is based on a core motif from which the entire composition is

derived. The motif also defines the pitches to which the ring modulator should be applied.

The stereo speakers should be placed next to the piano, pointing towards the audience. Achieving the right balance between the electronic and acoustic parts was my main concern during the rehearsing process. However, by analysing the recording of the performance I found that morphing the two components together had succeeded. The electronic system runs on its own and the performer does not need to trigger it: he or she is solely in charge of dynamics, which can be controlled with the foot pedal. Other effects (such as the ring modulator) should be controlled by the sound technician. Even if the computer-based player does not react to the actions of the human performer, the human performer has to take the functions of the player into account. The pianist has to listen to the development of the electronic material and to adjust their performance techniques and choices of tempi and dynamics accordingly.

Although the score of this composition does not contain any spatial notation, a certain flexibility regarding the musical form has been given for the performer. The pianist can decide within a live performance for how long time he or she wants to listen to the player, and with the help of the foot pedal, can control when the piano part becomes dominant. A classically trained pianist is usually not used to deciding about the flexible duration of the piece, which is something that must be practised during the rehearsal process. When practising and performing this piece, I noticed that the pianist's stress levels influence the length of the listening passages (i.e. when just the electronic part is on and piano stays quiet), which naturally affects the overall duration and proportions of the piece. After realising this I consciously attempted to prolong such passages. Rehearsing “Zusammenbindenbinden.Winden? –Hommage a Schumann” felt rather similar to learning Karlheinz Essl’s “Sequiturs”. Because the piece is based on a real-time system, one cannot mentally practise it just by reading the score: instead, one has to play with the electronics and gradually familiarise oneself with the interaction between the different components of the work. The notation of the instrumental part cannot comprehensively indicate what is going on in the entire process: the score should mainly be treated as an instruction for the performer, rather than a complete and analytical description of the composition.

(Improvise freely with the ring modulator until the end of the work)

56

Pno.

mp *pp* *mp* *pp* *mp* *pp*

Ped.
(Ring modulator)

pp *mp* *pp* *mp*

(Ring modulator)

mp *mp*

Figure 31: The ring modulator emphasises the motifs of the piano part in a very slow tempo. It only affects the amplified live piano. Excerpt from the score, bars 56-58

16

Pno.

P.S.

The performer can define the duration of this passage

Time stretch canon

mf

Figure 32: The performer decides the duration of certain passages. Excerpt from the score, bars 16-18. The breaks within the acoustic piano part get gradually longer towards the end of the piece. The pianist should remember to allow enough time for the “solos” of the electronic part.

Although “Zusammenbindenbinden. Winden? –Hommage a Schumann” might not considerably differ from a traditional classical music piano work in terms of instrumental techniques, the sonic outcome clearly differs from a regular piano piece. As mentioned, the structure of the composition does not rely on traditional concepts of musical development, but is merely a surface or sound cloud with occasional motivic outbursts instead. The performer’s challenges in this composition lie more in the musical interpretation than in the field of instrumental techniques. The pianist has to

deal with a floating and flexible musical form, as the compositional identity of “Zusammenbindenbinden.Winden? –Hommage a Schumann” resembles more an interactive sound sculpture than a composition with more definitely defined temporal parameters.

3.9.3 The Listener’s Perspective

In spite of the seeming lack of communication between the piano part and the electronic line, the algorithmic system forms a versatile harmonic and rhythmic environment for the acoustic piano texture. Because the electronic player processes a pre-recorded excerpt taken from the actual piano part, it reflects the musical material in a manner that does not allow the listeners to aurally separate the acoustic and electronic segments from each other.

In addition to the ring modulator, the music only contains one timbre (piano) which comes either from the speakers or the concert instrument, the sonic colour of the piano is never radically altered. However, while the variation of timbres is limited, the multitude of simultaneous processes gives the impression of a complex labyrinth of sounds. The essence of this phenomenon could be seen as the sonic counterpart to an image reflected through infinite mirrors. The indeterminate processing of the sound material enables harmonic and rhythmic situations that could not be done within acoustic setting.

Chapter 4

PERFORMANCE WITH MULTIPLE INSTRUMENTS

Examples of Multiple Instrument Composers

- Popular/world/jazz/fusion music: Tori Amos (USA), Esteban Antonio, Matthew Bellamy (Muse) (UK), Elliott Cheng (UK), George Duke (USA), Liam Finn (NZ), Todd Green (USA), John Paul Jones (Led Zeppelin) (UK), Mike Oldfield (UK), Gerald Peter (AT), Steve Puto (CA), Elliott Sharp (USA)
- Contemporary classical or experimental concert music: Diana Burrell (UK), Gavin Bryars (UK), John Cage (USA), Karlheinz Essl (AT), Ge Gan-ru (CN), Georg Friedrich Haas (AT), Seth Josel (USA/DE), Guy Klucevsek (USA), Phil Niblock (USA), Linsey Pollack (AU), James Tenney (USA), Toby Twining (USA), Lois V. Vierk (USA), Xo Xinh (VN)

One of the main hypotheses of this discussion is, that “a super instrument” (or a composition for it) should be defined as an entity in which all the instrumental lines or computer generated features form an organic unity instead of forming separate identities. With the categorisation of “performance with multiple instruments” I here refer to compositions in which the performer is supposed to play at least two different instruments simultaneously, or to a situation in which the performers create a super instrument together with several identical instruments (see for example Steve Reich’s “Six Pianos”). My own compositions discussed in this chapter are multi-keyboard works. Jeff Brown’s piece “Love and Hydrogen” has been selected for this discussion in order to showcase the performative challenges of a combination of piano, toy piano, and voice together with the use of instrumental preparations, microtones, and extended techniques.

In general, using multiple instruments should be a way of introducing additional performative qualities. An audience consisting of professional musicians tends to react negatively to a performance in which the musical material originally composed for one instrument is just shared between two without a proper reason. For example, pianist Josh Wright's solo performance of Liszt's “Campanella” on two pianos was criticised in the pianists' discussion forums because the professional audience failed to understand the motivation behind the change⁶⁵. Playing a regular solo piano work in this way might serve as a visual effect on a live setting but does not otherwise make any difference from the listener's perspective.

On the basis of the information gained through my practical artistic work, I argue that the simultaneous presence of multiple instruments can transcend the performing experience and extend the capabilities of a concert instrument (in terms of sonic range, rhythmical possibilities, and instrumental techniques for example). Combining different instruments also opens possibilities in terms of tuning and harmony, like in “Love and Hydrogen”, in which the microtonal harmonies and melodic progressions have an important role in building the tension and structuring the piece. The presence of two

⁶⁵ See for example the discussion on “piano street” internet forum: <http://www.pianostreet.com/smf/index.php?topic=45858.0> (accessed 9.6.2014)

keyboards within my “Toccatà” allows the performer to play rhythmically overlapping figurations within the same register simultaneously.

The instrumentation of a piece dictates the kind of techniques the performer should apply, and how they should treat the music structurally, in terms of intonation, or of listening and correlating its different components. The aspects of performative physicality and intellectual perception of the music, as well as the unique characteristics of the instrument(s), have to be taken into account in the context of each multi-instrument work. Multiple instrument performances appear in all music genres (which can also overlap) and every composer and performer has their own approach. The identities and roles of a composer, performer, sound designer, and instrument builder frequently merge. The musical instruments themselves are sometimes built according to the specific needs and instrumental skills of a particular performer and such a solution can allow for multiple tunings and rapid changes between the different instruments, which can also be played simultaneously.

4.1 Multi-Instrument Performance in Popular, World, and Jazz Music

The choices of composition techniques and technologies often depend on the musical style and genre. Where the classical musician usually needs elaborate electronic systems and performance techniques, the popular music artists might use looping systems or techniques of multi-tracked recording to build up their one-man-ensembles. Multi-instrumentalist Todd Green’s complex and skillful Persian style improvisations on folklore instruments are thus based on such techniques (especially on the previously mentioned tape loop technique), which enables him to switch between instruments during the same performance. The different recorded layers⁶⁶ of his instrumental live performance form the sound scape of an ensemble: at the end all the instrumental lines are present at the same time. The same method has also been used by other pop or jazz musicians (for example Liam Finn and Elliott Cheng).

⁶⁶ All the lines are recorded on stage, Green does not use any samples or pre-recorded material.

Multi-instrument artists often customize their instruments: country musician Steve Puto has an instrument that combines a guitar, bass, banjo, mandolin, fiddle necks and a harmonica. The extended technical possibilities provided by multi-neck guitars have been widely explored in rock, jazz, and pop music. Composer and performer Elliott Sharp has thus given convincing super instrument performances on his double-neck instrument. Sharp combines the simultaneous play of the two guitar necks to samples and other electronically generated materials. The composer and guitarist Esteban Antonio performs on his self-designed hybrid instrument the Ha Shem, a 17-string concert harp guitar which can also be played with a bow. The instrument has three necks with different features (bass strings, guitar strings, and a bowed area). The structure of this instrument allows Antonio to produce various instrumental lines at the same time.

One of the most famous popular music multi-instrumentalists and composers is Mike Oldfield, whose project “Tubular Bells” is structured around the leading figure’s multi-instrumental skills. Moreover, Tori Amos uses multi-instrumentalism as a part of her shows by playing two keyboards or pianos simultaneously (for example in her songs “Bells for Her” and “Bouncing off Clouds”). The same has also been done by some jazz and rock music performers/composers such as George Duke, an influential jazz pianist, who used to play more than one keyboard during his performances, or Austrian rock musician Gerald Peter (Circle of Illusion), who uses the extended possibilities of two keyboards within his symphonic rock pieces. Although different in terms of genre, aesthetics, and techniques, all the multi-instrument explorations presented seem to share the same purpose of inventing new instrumental solutions that extend the individual performer’s expressive possibilities.

4.2 Examples of Multi-Instrument Compositions

Super instrument works that combine more than one musical instrument (for solo performer) are usually composed for a specific performer. For example, Diana Burrell’s “One-Man-Band” was commissioned by Mark Knoop who also premiered the work at the 'Rational Rec' festival in 2008. The same performer plays the accordion, piano, and

percussion at the same time, and all the parts are approximately as difficult and significant. As can be heard in the video recording⁶⁷, the versatility of the technical challenges within different instrumental lines occasionally takes its toll on the concentration of the performer, in addition to which changing between the instruments can sometimes be impractical. This is a rather typical problem within multiple-instrument performances, which I also noticed myself, especially when rehearsing Jeff Brown's "Love and Hydrogen".

These unusual instrumental combinations also have some drawbacks from the composer's perspective: multi-instrument works are generally not performed very often due to the lack of instrumentalists able to play them. In many cases the composers perform their own works themselves: this is the case for my "Trinity Mania" and Xo Xinh's "Hallucination" (for prepared piano, Vietnamese 16-string zither, and live electronics). The latter work combines the oriental timbre of the zither, electronic live processing, and the refined sonic colours of the piano into one unity. The unusual instrumentation of the piece indicates that, similarly to "Trinity Mania", "Hallucination" appears to have been written for the composer himself instead of an external performer.

The simultaneous use of several instruments opens up new harmonic possibilities. It can be difficult to change the tuning system in the middle of a performance, but it becomes possible with the help of electronic solutions or alternatively by combining two or more differently tuned acoustic instruments. Georg Friedrich Haas' use of multiple pianos or keyboards is mainly motivated by the possibilities of microtonal tuning. This is the case, for example, in his two-piano work "Drei Hommages für einen Pianisten und Zwei im Abstand eines Vierteltons Gestimmte Klaviere" (1985). My work "Celestifilia" has been arranged for two different keyboard instruments (piano, electric piano) for the same reason.

The use of multiple instruments within a solo performance provides many dramatic and theatrical elements, which some composers have also explored in conjunction with toy instruments. Ge Gan Ru's "Wrong, Wrong, Wrong!" (a melodrama for voice and toy

⁶⁷ Mark Knoop's performance of the piece can be watched at <http://www.youtube.com/watch?v=Al6XuI7Xz80> (accessed 22.6.2014)

ensemble, 2006) uses the performer's capabilities in a versatile manner: one performer is not only in charge of the voice line, but also of the whole ensemble part at the same time. Guy Klucevsek's arrangement "Sweet Chinoiserie" (2008) also explores the dramatic potential of a solo performer with a toy ensemble. The work was originally composed for toy piano artist Margaret Leng Tan, who is a flexible performer: the piece requires the toy pianist to play various combinations of toy pianos, accordion, melodica, and toy percussion within the same performance. Although using toy instruments, both works are serious and complex concert pieces.

Linsey Pollack has explored custom-made hybrid instruments in a musical theatre setting in his humoristic show "Cycology", in which he uses his very own super instrument made by combining non-music-related implements to traditional instruments. The composer plays all the instrumental lines by himself as he has taken on the multifaceted identities of instrument builder, performer, and composer. As with the dramatic compositions of Ge Gan-Ru and Klucevsek, the visual aspects create an additional impact on the audience's reception of this work.

4.3 Multiple Identical Instruments as One Super Instrument

A number of interesting alterations in tuning, layering, and instrumental techniques can be achieved by combining identical instruments into an ensemble. The similar capabilities and timbres create a super instrument which multiplies the possibilities of a solo instrument, yet give the listeners the impression of one united sonic surface. Some composers use this kind of instrumentation to their full potential: Lois V. Vierk's compositions "Go Guitars"⁶⁸ (for five electric guitars), "Cirrus" (for six trumpets), and "Simoom" (for eight cellos) combine the possibilities of microtonal tuning with the homogeneousness of the instrumental colours; James Tenney's "Septet" (for six electric guitars and electric bass) explores overtones in conjunction with a group of guitars that acts and sounds as one.

⁶⁸ Guitarist and composer Seth Josel produced a recording of "Go Guitars" in which he takes the multi-instrument performance to its furthest extent by playing all the instrumental lines himself. (S. Josel, *Go Guitars*. USA: OODiscs – OO36. 1998.)

Steve Reich's "Piano Phase" (for two pianos (1967) features a different take on multiple instrument composition: instead of experimenting with tuning, its focus lies in the nuanced rhythmical shifting between the two identical piano parts. The piece is usually played by two pianists but certain instrumentalists have also performed it alone. On top of the gradual change of the rhythm, the instrumentation also enables the use of otherwise impossible overlapping materials.

4.3.1 Performance Case Study: Steve Reich's "Six Pianos" (1973)

Instead of being based on a fixed dramatic musical formula, "Six Pianos" is a process that is gradually built up by evolving rhythmical fragments within an extensive time span. The main motif (at the piano parts 4 and 5) is split into short fragments, each usually repeated 6-10 times. The motif is elaborated throughout the piece, until it is revealed as a whole at the end of the composition. The ostinato patterns of the pianos 1, 2, 3, and 6 accompany the pianos 4 and 5 at all times: this forms a harmonic background on which the constant rhythmical changes are reflected.

Player 1
 Player 2
 Player 3
 Player 4
 Player 5
 Player 6

Figure 33: Bar one: pianists 1, 2, 3, and 6 commence the piece with an ostinato pattern that continues to accompany the rhythmic development of the pianos 4 and 5. The role of each pianist remains the same throughout the performance.

Figure 34: Bar three: pianists 4 and 5 begin to play in unison after listening to the repeated unison ostinato pattern of the pianos 1, 2, 3, and 6 for 6-10 times (see previous example). Pianos 4 and 5 are in charge of the rhythmic elaboration throughout the whole composition. The rhythmic cells are gradually elaborated into a full motif.

Figure 35: Bars 10-12: the main motif is introduced as a whole at the very end of the piece. Pianos 1-3 continue to play their original ostinato accompaniment.

The harmonic structure of the piece supports its procedural characteristics: there are no melodies or traditional harmonic functions between the chords. Instead, the harmonic system forms a general soundscape. The interest of the piece lies in the rhythmical development of the music, as there are no considerable changes of register: the piano parts have been orchestrated within a relatively narrow instrumental range, which helps to create a harmonic surface from which the motivic elaboration stems out.

The dynamic changes and rhythmical shifts are carried out based on the interaction between the two different groups of pianists: **A.** pianists 4 and 5 (rhythmic elaboration) and **B.** pianists 1, 2, 3, and 6 (accompaniment). Reich’s approach to “Six Pianos” remains closer to the conventions of orchestral music than traditional piano literature: instead of relying on individual pianists (for example, in terms of controlling the dynamics), the piece is focused on the overall work of the ensemble. All of the musical events and processes involve at least two pianists.

4.3.2 The Performer's Perspective

Pianists are often granted the leading role within an ensemble performance: even when playing in a symphonic orchestra (orchestral piano/celesta), the piano part usually stands out from the general sonic surface⁶⁹. Independency and leader characteristics thus belong to the pianists' natural performer identities. However, the performers of "Six Pianos" must change their approach, giving up the identity of a soloist and developing a new one as a member of an ensemble consisting of equally important identical instruments.

I was a member of six-pianos-ensemble "Piano Now" for several years (2002-2009). During that time the ensemble gave various concerts with different combinations of pianists, as well as performances that would engage the entire group. One of them took place at the "Clapping Music" festival in Helsinki in 2006: "Piano Now" was offered an opportunity to play Reich's "Six Pianos" as part of the festival program. We started the rehearsals a two weeks before the performance.

One of the most important things that I learned during the rehearsing process of "Six Pianos" was that a flawless ability to hear and understand the musical process as a whole is essential to perform this work: it is not enough to only concentrate on one's own instrumental line. I was playing piano 3, which is one of the pianos in charge of the accompanying ostinato passages. The part was not particularly challenging in terms of technique; instead communicating and interacting musically with the other pianists proved to be one of the most complex aspects of the piece.

All the piano parts sound very similar, which makes it difficult to hear the other pianists. This has an impact on the general structure of the piece, as the links to successive passages must happen in dialogue with the other players. Our group adopted an additional communication system in order to help the musicians keep track of the

⁶⁹ However, there are many compositions in which the piano does not play a leading role, despite being included in the instrumentation. These include "Lulu" by Alban Berg (excluding the piano's prominent role at the beginning) and Benjamin Britten's "Sinfonia da Requiem", as well as numerous other examples of classical or film music works. In any case, a pianist needs to be able to work without the support of their own instrumental section, which is why very advanced soloist skills are always required.

musical process. Each pianist wore a hat of different colour: a greeting gesture, by lifting the hat, advertised each musician's readiness to move on to the next musical passage. This system was used within the performance and proved to be effective. However, shortcomings still appeared in the concert setting, as some pianists were partly unable to follow the process, which resulted in them not playing all the materials of their parts. This was possibly caused by the group's lack of performing experience of minimal music, acoustic problems, and the exaggerated flexibility regarding the amount of repetitions. Although "Six Pianos" is based on a partly improvisatory concept (Reich's score only approximately indicates how many times each bar should be repeated), we found that agreeing on the exact number of the repetitions beforehand remains important. Unless the group is very experienced in performing this kind of repertoire, attempting to maintain the composer's original improvisational approach can not only be impractical, but can also inhibit the performing experience. Although pianos 4 and 5 always play in unison to make the rhythmical development (and thus also the structure of the piece) more audible and clear, considerable effort in terms of articulation is required from the two leading pianists (as well as the rest of the group): this facilitates the rest of the musicians to keep track of the music.

4.3.3 The Listener's Perspective

The different instrumental lines of this composition are orchestrated approximately within the middle octave ranges of the piano. This helps to form a super piano with the capabilities of creating thick harmonic soundmasses in which detailed rhythmical elaboration takes place. The simultaneous presence of six pianos creates a rich and full musical process and offers layering possibilities that would not be attainable in the context of a solo piano performance. Different groups of pianists have their own sets of dynamics: passages merge and then again blend back to the harmonic texture. The combined instrumental capabilities also increase the volume, which results to a mellow sonic outcome.

The ear adjusts to the procedural characteristics of the music, and a trance-like state is achieved (which is typical in the context of Steve Reich's compositions. For example,

“Six Marimbas”, “Piano Phase” and “Drumming” have a similar effect on the listening experience), as the listener concentrates on the constant flow of the rhythm. Because there are relatively few harmonic changes, the importance of each is highlighted.

4.4 Jeff Brown: “Love and Hydrogen” (2013)

After creating the multi-instrument composition “Love and Hydrogen” (for piano, toy piano, vocal part, percussion, and saxophone), this composer wrote a chamber opera of the same name, based on the material introduced within this work. “Love and Hydrogen” served as a compositional study that anticipated the larger scale work. Brown first experimented with his material within a multi-instrument setting before translating it to a larger ensemble. Moreover, he used the doppler effect (realised with four electronic pendulums)⁷⁰ for the first time within this project: the composer has since then continued exploring it within many of his other works.

The keyboard and vocal parts of “Love and Hydrogen” were specifically designed for my personal set of instrumental skills: Brown 's composition was created specifically for one performer able to unite the identities of a vocalist, pianist, and toy pianist. A randomly selected classically trained pianist would not necessarily be able to perform the work: in order to sing the vocal part with the required dynamics and sound quality, the pianist/singer needs a deep knowledge of voice production in addition to her⁷¹ keyboard skills. The range of the soprano part is relatively wide, on top of which the performer needs to have the ability to sing microtones. Dealing with all the instrumental tasks simultaneously requires a certain level of practice that might not be acquirable during a normal preparation time for an individual concert project.

⁷⁰ The pendulums are constructed of small loudspeakers and MP players attached to a string.

⁷¹ The instrumentalist needs to be female, as the vocal part is intended for a professional level soprano.



Figure 36: Excerpt from the bar 49: the vocal performer needs to possess good sound quality and a wide range of dynamics.

My argument on the co-dependency of the instrumental lines within a super instrument composition can be verified by examining the vocal part of the piece. Although it is challenging and requires strong technical abilities, it is clearly not important enough to stand on its own right as an actual soprano solo. Instead, it is functioning as a complementary element of the general instrumentation, mainly serving timbral and harmonic purposes. It should not be confused with an effect, as it has an essential and equally important input to the sonic outcome and compositional structure as the other parts. Various instrumental lines merely support each other rather than elaborate on their own in a long run within the context of this work. The work consists of various instrumental lines and even requires several performers, Brown's purpose was to create a singular homogeneous musical object rather than a regular chamber music work from which different timbres would stand out. The parts are designed to merge together seamlessly.

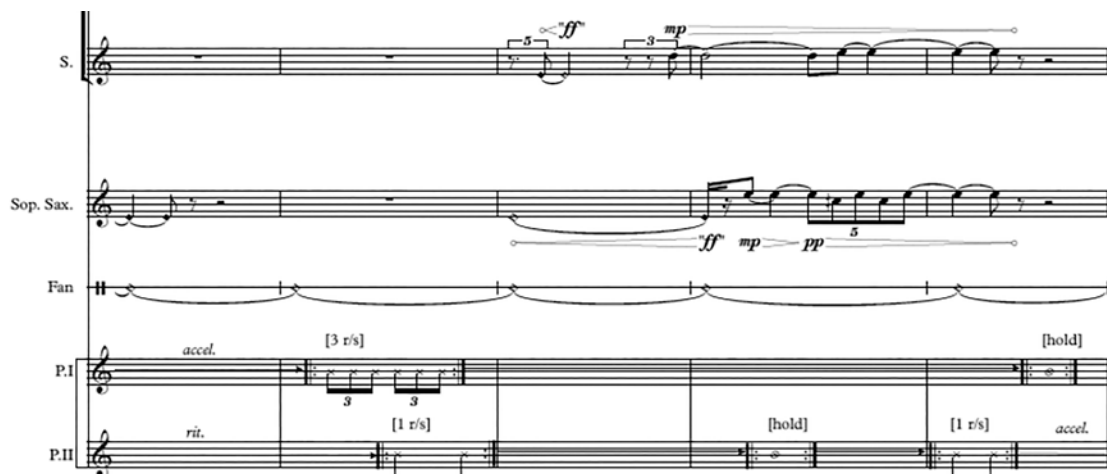


Figure 37: This excerpt showcases the characteristics of the vocal line. It should be regarded as a complementary instrumental element rather than an actual solo part.

4.4.1 Functions

With equal temperament considered as the unchallenged foundation of a classical music education, as well as being a basic assumption in discussions of traditional acoustic instruments, it is unsurprising that playing or singing micro intervals sets special challenges for the performing musician (Komppa, 2013, 46, my translation). “Love and Hydrogen” combines a microtonal tuning system to use of extended techniques, starting from the pianist’s microtonal singing and performance on a piano that has been tuned $\frac{1}{4}$ tone lower. The composer’s aim was to create a general sound rather than maintaining the original separate instrumental identities. The mix of different instrumental timbres and extended techniques (such as, for example, playing saxophone into a fan) together with the doppler effect created by the four electronic pendulums results into a new kind of a joint sounding quality.

4.4.2 Performing “Love and Hydrogen”

Brown had previously heard me play a multi-instrument performance at the premiere of “Trinity Mania” and was also familiar with my activities as a toy pianist and toy piano composer. Moreover, we had already collaborated as a chamber music duo (flute and piano), which familiarised him with my rehearsing techniques and repertoire, as well as my instrumental skills. In addition to standard repertoire pieces, we performed numerous experimental compositions with different combinations of instruments and extended techniques, which might have encouraged him to write this extremely complicated and innovative work for me. Brown consulted me about the instrumental qualities of the toy piano before composing “Love and Hydrogen”, we discussed the basic characteristics of the instrument, as well as the possible effects that could be used.

The first step of the rehearsal process was to find the optimal position of the instruments. I required a set-up that would allow me to switch quickly between the instruments, as well as play them at the same time when necessary. I chose to place the toy piano on a chair on my right hand side, facing diagonally towards the piano; this

made access to each instrument possible, which also helped me minimise the tension within my upper body, an important aspect for the singing techniques.

Classical singing was my secondary instrument during my music studies on the basic and conservatory level. However, I had not actively performed as a vocalist for many years, which raised a need for additional training. In order to refresh my technique, I started to do regular vocal exercises⁷² a few weeks before the concert. These included breathing exercises and singing arpeggios within the range of g-e3. The vocal part contains lots of microtones, which I practiced by playing equally tempered pitches on a regular piano, before reflecting the tuning of the vocal line.

I practiced the piano and toy piano lines simultaneously (at first excluding the vocal part). I only combined all three lines once I felt confident enough with the instrumental techniques. However, I did not have a microtonally tuned piano at my disposal (I was only able to practise on it a few days before the performance), which made it hard for me to grasp the correct balance between different parts. All the piece's instrumental lines are complex and demanding.

Because the composer and the rest of the musicians were based in Switzerland (the premiere took place at the Basel music academy) and myself in the UK, the rehearsals could only begin a few days before the performance. It became clear that some changes had to be made to the score, partly because neither I nor the composer had had a chance to put the whole ensemble together to test different instrumental alternatives. The changes were mainly slight adjustments to the extended techniques and balance between the toy piano and the regular piano; for example, the composer was not always satisfied with the combined sound of the two instruments in certain octave ranges.

⁷² Similar kind of exercises belong to the education of classical singers everywhere in the world. However, as this thesis does not deal with vocal music, a detailed analysis would not fit to the context of this discussion.

14

Toy Pno.

Pno.

63

ff *ppp* *ff*

senza ped. *una corda* *senza ped.*

Figure 38: The composer did not like the combination of timbres in bar 64, which is why he decided that both parts should be played on a regular piano.

In order to achieve the instrumental combination, click track, conductor, and the interaction with the saxophone part, I first rehearsed the work with just the composer/conductor, as well as the other soloist (saxophonist), whose part is closely knitted together with the lines played by the keyboardist. Together, these control the dramatic development of the composition, whereas the electronic pendulums take care of the harmonic environment. The pendulums create a beautiful and fragile, harmonically shifting background that resembles the sound of a small string ensemble. However, keeping on track with their functions (or the beats in general) is not simple, which is why the composer applied a click track and also conducted the premiere.

Figure 39 is a musical score for a chamber ensemble. It includes parts for Piano (Pno.), Soprano (S.), Soprano Saxophone (Sop. Sax.), Fanfare (Fan.), Piano I (P.I.), and Piano II (P.II). The score is in 4/4 time. The piano part features a complex rhythmic pattern with dynamic markings of *ff* and *PPP*. The vocal part is marked *PPP* and includes the instruction "sing any vowel throughout". The P.II part includes the instruction "[100%, 90°]" and "(sine waves)". The P.I part includes the instruction "(dim.)".

Figure 39: This score example illustrates Brown’s delicate handling of rhythmic and harmonic situations: the vocal part and the resonances of the piano reflect the functions of the pendulums. Although the passage should sound free and flowing, a conductor and/or click track is required.

Coordination between the different functions of the instruments is the hardest aspect of this piece; it is especially challenging to combine parallel effects and sets of dynamics within separate parts. The examples below illustrate such situations:

Figure 40 is a musical score for three parts: Toy Piano (Toy Pno.), Piano (Pno.), and Soprano (S.). The score is in 4/4 time. The Toy Pno. part starts at bar 24 and includes dynamic markings of *pp* and *ppp*. The Pno. part includes dynamic markings of *f*, *mp*, and *ff*, and the instruction "una corda". The S. part includes dynamic markings of *mp*, *ppp*, *f*, and *mf*.

Figure 40: Bars 24-26: The pianist becomes a “super pianist” who is in control of the piano and toy piano when simultaneously singing microtones. Adjusting the different levels of dynamics within the three instrumental lines is challenging. All the parts shown in this score example should be performed by the keyboard player alone.

The image shows a musical score for three parts: Toy Pno., Pno., and S. (Singer). The Toy Pno. part is written in a treble clef and features a complex, rhythmic melody with dynamics ranging from *ppp* to *ff*. The Pno. part is written in a grand staff (treble and bass clefs) and includes a 7-measure rest at the beginning, followed by a complex accompaniment with dynamics like *mf* and *f*. The S. part is written in a bass clef and features a simple, melodic line with dynamics like *mf* and *f*. The score includes various performance instructions such as *una corda*, *senza ped.*, and *senza ped.*, as well as fingerings and articulation marks.

Figure 41: Switching between different instruments in a flexible manner is the key challenge of Brown’s composition.

4.4.3 Concluding Remarks, “Love and Hydrogen”

The discussion of Jeff Brown’s “Love and Hydrogen” for piano, toy piano, voice, saxophone and electronic pendulums (two performers) has been carried out from the pianist’s perspective. Brown’s work pushes the limits of a single performer by attempting to combine three different musical identities (pianist, toy pianist, singer) into one multi tasking performer identity. The doppler effect played by three percussion players on electronic pendulums generates a harmonic microtonal background to the pianist’s and saxophonist’s performances. The singing part does not separate as a solo from the general sound mass but merges into it. This creates a perplexing effect, as the listeners cannot at first see the sound source. Because the pianist is usually playing and singing simultaneously, it takes some time before the audience realises who is singing and where the sound comes from. Instead of giving the “singer” a clear role as a soloist, the composer treats the voice as a regular instrumental line among all the others. It becomes an empowering part of the pianist’s expression that extends her energy and presence.

Because the keyboard player is in charge of three equally difficult instrumental parts at the same time, the role of the pianist transcends into a level of a “super pianist” who sings, plays the toy piano and stays in control of the complex piano part. The work significantly differs from a conventional piano piece because of its special mix of timbres, techniques, and visual characteristics. The simultaneous use of different

instruments offers the performer a vast palette of sound colours, as well as extended tuning possibilities.

4.5 Maria Kallionpää: “Toccatà” (2011)

”Toccatà” for two toy pianos and one performer was composed in order to explore the possibilities offered by an instrument with very limited sonic capabilities. I also wanted to write a virtuoso piece for a toy instrument. “Toccatà” responds to my earlier discussion of “multiple identical instruments as one super instrument”: similarly to the other composition examples of the title, the purpose of this composition project was to 1. add virtuoso potential and instrumental flexibility 2. allow textural and rhythmical overlappings within the same octave range 3. multiply the capabilities of the original instrument.

Using two identical instruments within the same octave range provides extended possibilities in terms of rhythm, space, instrumental techniques, and dynamics. This was taken into account by arranging simultaneously occurring, rhythmically shifting and similarly sounding material on the same octave range of the both instruments, which would not work out on one instrument only. The two toy pianos should work seamlessly together.

This work features two opposite aesthetic poles: on the one hand there is the essence of a “toy”, yet on the other hand “Toccatà” is an utterly dark and dramatic piece spiralling in its own never ending spheres, which gives the composition a rather disturbing and dualistic character. Rhythmical, repetitive patterns are almost constantly present on the second toy piano part but the material scored for the first toy piano is more expressive. The latter instrument is generally used to comment on the overall musical development with short melodic fragments or alternatively to contribute to the fast and repetitive rhythms of the second instrument.⁷³

⁷³ “Toccatà” shares some technical and aesthetical similarities with my wind quintet “Circular Thoughts”, which was constructed on the idea of never ending patterns derived from each other but that are almost never quite the same.

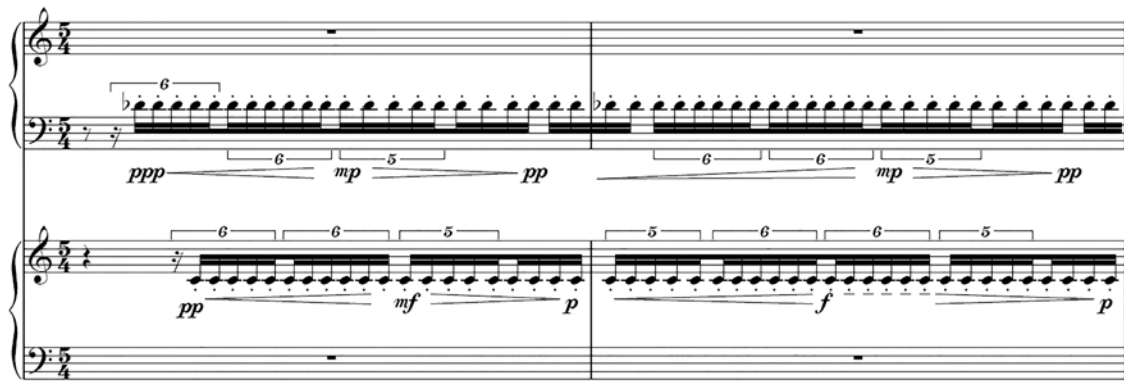


Figure 42: An excerpt from the score, bars 1-2: similar sounding rhythmically shifted material has been divided between the two toy pianos. Using two identical instruments simultaneously also allows for two different sets of dynamics.

4.5.1 Composing “Tocatta”

I started to compose “Tocatta” shortly after performing Karlheinz Essl’s “Sequitur V” for the first time. At that point I was already familiar with the basic characteristics of the instrument and I wanted to add my own contribution to the toy piano repertoire. I was also aware that composing for toy piano is different from writing for a regular piano: what works on one instrument does not necessarily work as idiomatically on the other one. I had acquired most of my knowledge about the toy pianos’ instrumental qualities by playing it, which proved to be a useful learning method. I wrote “Tocatta” out of sheer compositional curiosity.

My aim was to write a virtuoso piece for an instrument which does not have a long history as a concert instrument. The technical limitations of the toy piano had to be taken into account when composing “Tocatta”: my purpose was to enhance the instrument’s positive qualities, including its flexibility and lightness of keys, which makes the fast passages, repetitions, and scales quite idiomatic. Thick chords (except for the clusters, that seemed to work rather well as a dramatic gesture) or loud dynamics do not usually sound good on the toy piano, which has little natural reverberation and no pedals.

I based “Tocatta” on the continuum of repetitions. The beginning of this composition imitates the atmosphere of techno music, with a constant ostinato beat. It starts with

little pitch material, but the latter becomes more diverse as the work proceeds. The expressive potential culminates in bar 30 where a metrical modulation is introduced and the ostinati are replaced by scales. The shape of the dramatic culmination is partially the result of the instrumentation, as the amount of keys and octave range of a toy piano would not allow dense textures. I found out that, in order to intensify the dramatic texture, it is better to add velocity than just increase the volume.

Figure 43: Bars 29-30: the dramatic culmination point with clusters on toy piano 1. The tempo gets faster in bar 30.

4.5.2 Performing “Toccata”

The opportunity to perform the work materialised when “Toccata” was accepted for the World Toy Piano Summit 2012, at Rainy Days Festival, at the Philharmonie Luxembourg; toy pianists Isabel Ettenauer and Phyllis Cheng chose to premiere it. The work was originally composed for a single performer playing two instruments, but due to the complex nature of the music, the performers wanted to perform it together. While certain instrumental difficulties were reduced, the rhythmical details became harder to communicate and the piece possibly lost some of its super instrument characteristics. My concern was that if the musical material was divided between two instrumentalists, the work would start to resemble an ordinary chamber music piece. This would mainly apply to the listening experience of the live performance as it might be hard to distinguish from a recording for example whether the composition was played by one or two toy pianists. The two different sets of dynamics seemed to work best when the musical material was split between two performers. Both approaches have their own advantages and drawbacks, and in the end I accepted that “Toccata” can be played either

by one or two instrumentalists. Unlike most of classical works with a lengthy performance tradition, some contemporary compositions allow for more flexibility in performance set ups.

Chapter 5

TWO CASE-STUDIES FROM MY WORK

The next two case studies of my own compositions contain elements of the both previously discussed super instrument categories. Similarly to Brown's "Love and Hydrogen", my works "Celestifilia" and "Trinity Mania" have been composed in order to explore the possibilities opened by amending the essence of a solo piano work into a super instrument composition with its own identity and sonic characteristics. I emphasised this aspiration by letting one pianist play all the instruments involved, instead of composing a chamber music work for several performers. However, it is possible to perform both works together with an additional sound technician. All instrumental lines of both compositions are equally important as well as approximately equally difficult, and, computer-generated sonic material plays an essential role in terms of general sonic outcome and compositional structure. Music electronics have also been used for the tuning alterations.

The visual effect of one performer playing several instruments at the same time supports the listener's auditive experience and perception of a super instrument composition. It is perhaps easier to understand the multi-instrument identity of this kind of a work in the context of a live concert performance, rather than by listening to a recording.

5.1 Maria Kallionpää: "Trinity Mania" (2010)

I began to compose "Trinity Mania" during an artists' residency program in Benin, where I became fascinated with the rhythmic versatility and improvisatory qualities of the local music. My particular interest resided in attaining a balance between the performer's expressive freedom and the complex polyrhythmic patterns of the electronic

component. Although certain characteristics of “Trinity Mania” were inspired by West African music, the composition is not directly based on such material. The work was originally composed for a concert project taking place in Vienna in Summer 2010 and I have since performed it several times.

“Trinity Mania” was based on a combination of three different instruments (piano, toy piano and electronics) that all have their own capabilities and that together form a super instrument, in which each instrument is a complementary component of one timbral entity. There are no hierarchies between the instrumental lines: the sound sources blend and support each other, thus enhancing the virtuosity of the musical texture. I attempted to create a one-man-band of keyboard instruments in order to explore the number of timbres and technical possibilities that one pianist could control. The piano part is technically more difficult than, for example, that one of “Zusammenbinden? Winden. – Hommage a Schumann”. The aesthetic core idea is also different: in “Trinity Mania”, my purpose was to combine aspects of improvisation and pianistic brilliance. One of the main super instrument functions of the piece resides in changes to the piano's natural principles of sound production: the samples consisting of modified piano timbre contain tuning alterations and artificially made effects (such as, playing sounds backwards, as in samples 6 and 7).

Unlike many other composition examples in this dissertation, “Trinity Mania” does not apply an independent computerised system. Instead, the performer needs to “play” the electronic material by using the electronic keyboard as a MIDI controller. The role of the MIDI instrument is ambiguous: while, on the one hand, the performer soon begins to regard it as a third instrument alongside the piano and toy piano, forgetting that the device itself does not produce any sound and simply activates different musical events instead, on the other hand, it is more than a mere triggering tool because the pianist uses it to create musical situations in the same way as they normally would on any musical instrument.

5.1.1 Composing “Trinity Mania”

“Trinity Mania” was composed for a particular concert project, which also served as the final concert before obtaining my postgraduate diploma in electroacoustic composition. This work shared similar exploratory purposes as found in my previous electroacoustic pieces: its final outcome only became clear at the end of the creative process. I began by writing most of the acoustic part (piano and toy piano lines), based on a pre-structured harmonic matrix and a graphic score, which also contained an approximate temporal structure. I noticed that it was difficult to estimate the exact timing before trying out the final version with a live performer: in the end, various passages became considerably longer than originally drafted. The performer controls the approximate durations and rhythmic structures of the electronic material. A click track or other time controllers were unnecessary, because the piece does not contain any interactive external system dependent on the performer. From this perspective “Trinity Mania” resembles a traditional classical music composition more than, for example, “Zusammenbinden? Winden. –Hommage a Schumann”.⁷⁴

There are only two instrumental timbres in the piece; those of the piano and toy piano. The electronic elements fortifies and combines the capabilities of the both instruments: it is used as a booster and an extension tool, achieved by recording excerpts from the acoustic part and processing them. The pianist manages the samples, while playing the two acoustic instruments simultaneously. In order to find the best sounding instrumental combinations, I improvised with the three different elements, which helped me to define which octave ranges would fit together best in terms of sound quality.

⁷⁴ A later electroacoustic work of mine, “Sonnenschände-Sonnenwende” (2011, for guitar, electronics, and video) is based on a similar electronic system.

The image shows a musical score for two instruments: Toy Piano (t. Pno.) and Piano (Pno.). The score is written in 4/4 time and consists of two systems. The Toy Piano part is in the upper system, and the Piano part is in the lower system. Both parts are in 4/4 time and feature complex rhythmic patterns with trills and slurs. The Toy Piano part starts at measure 44 and includes a 'ff' dynamic marking. The Piano part also includes a 'ff' dynamic marking and features a '2-4X' trill pattern in the final measure.

Figure 44: Piano and toy piano are often played together in “Trinity Mania”. However, the two instruments do not sound good together in all octave ranges, which is why I searched for the most optimal sound combinations through improvisation.

Aspects of improvisation were present throughout the whole creative process, and, in the end, became one of the leading aesthetical ideas of the piece: instead of writing a fixed composition, I decided to leave a few parameters open. Moreover, the performer is invited to choose their pitch material freely in particular passages.

The image shows two systems of musical notation for piano. The first system features a treble clef staff with a key signature of one flat (B-flat) and a dynamic marking of *fff*. The bass clef staff has a key signature of two flats (B-flat and E-flat). The second system features a treble clef staff with a key signature of one flat and a dynamic marking of *fff*. The bass clef staff has a key signature of two flats. Both systems include complex rhythmic patterns and dynamic markings, with some notes marked with 's' and 'θ'.

Figure 45: The beginning of the dramatic climax of “Trinity Mania”. The rhythmical structure and dynamics have been defined by the composer but the performer can choose most of the pitch material.

5.1.2 The Electronic System of “Trinity Mania”

“Trinity Mania”, Technical Rider

- MIDI keyboard (at least 1 octave)
- grand piano
- toy piano
- audio interface (+Firewire or USB cable)
- PA system
- Macintosh computer

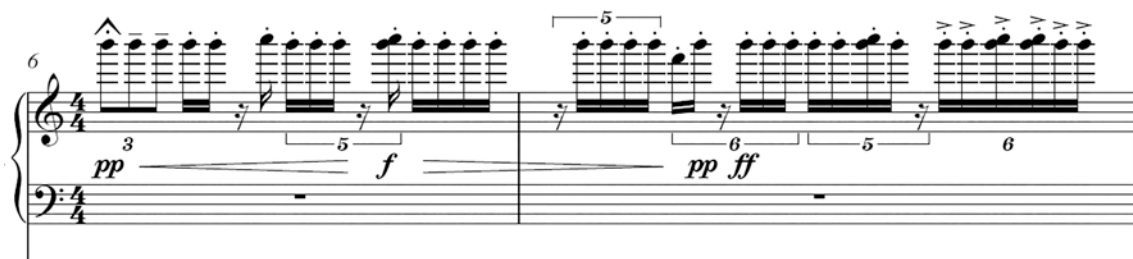
Samples List

The effect samples of “Trinity Mania” can be controlled by pressing the keys of a MIDI keyboard within the range of an octave; they have been organised consecutively from (1-8) on the keys of a C major scale.

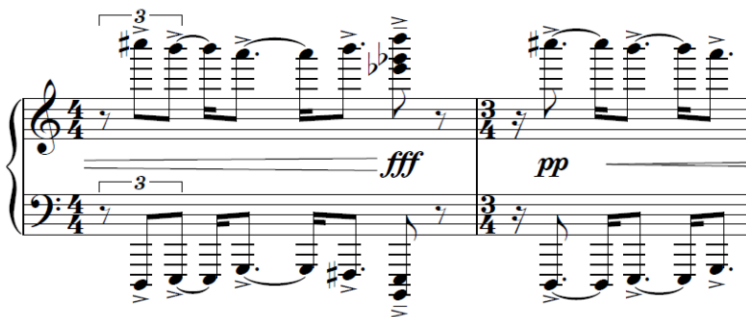
1.C: single chord in staccato (Figure 46)



2. D: high pitched repetition (Figure 47)



3. E: melodic fragment (Figure 48)



4. F: chord repetition in crescendo

5. G: chord repetition in crescendo (modulated) (Figure 49)



6. A: Low, long individual sounds (pedaled sounds of piano played backwards)

7. B: High, long, individual sounds (pedaled sounds of piano played backwards)

8. C2: Stop key

The above characterisations of the effects are generative only: in addition to their depicted pitch material, each contains microtonal shifting and other effects, such as reverberation. The samples are short processes that can be silenced by pressing the stop key (C2). Otherwise they keep running until the end of their original material. It is possible to activate several samples simultaneously or to activate the same process immediately again. The electronic system is controlled with the Max/MSP project depicted below.

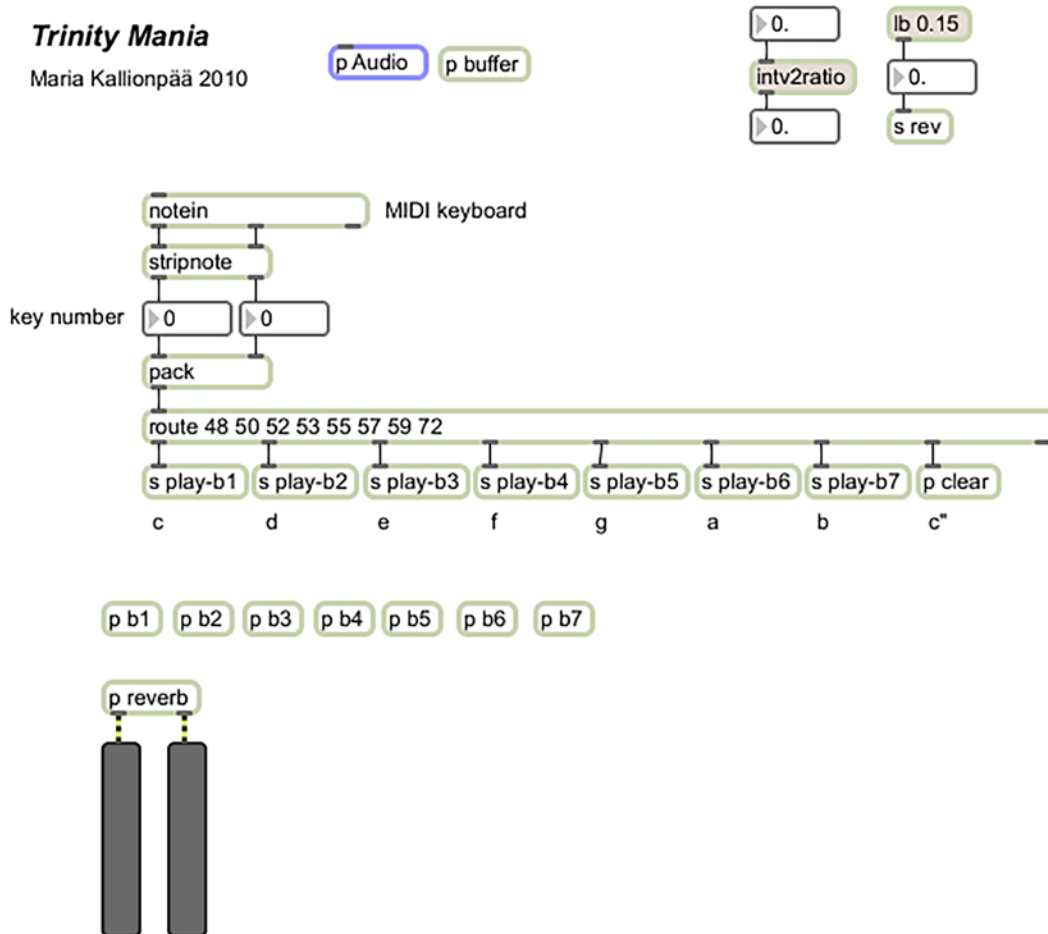


Figure 50: The Max/MSP patcher of Trinity Mania (2010); boxes above with letters “c d e f g a b c” contain the applied samples, as well as the mute-function (c”=clear).

5.1.3 Notational Aspects

As demonstrated by many of the composition examples in this thesis, notating the functions of different electronic systems can be problematic. These aspects had to be carefully considered when composing “Trinity Mania”, especially in terms of indicating the triggering points and the desired sonic results. The electronic materials are usually meant to be played freely with the notated parts of the acoustic instruments, which is why it would have not made sense to try to indicate the exact sonic outcome: each performer has their own ways of performing the piece. Different solutions for this problem exist. I chose to approximately describe some of the pitch material within the indispensable key points, but otherwise excluded some of the detailed information that would have just looked confusing. The keys of the MIDI keyboard that are used for

triggering the samples are indicated in the score. As the performer has interpretative freedom throughout, the use of spatial or relative notation (or combined aspects of the traditional and spatial notation) proving the most practical solution. I indicated the approximate textural characteristics of the music, as well as the estimated durations of the passages.

Lentissimo. Misterioso. Tempo ad lib.

The image shows a musical score for two instruments: Piano and Electronics. The score is titled "Lentissimo. Misterioso. Tempo ad lib." and consists of two systems of staves. The Piano part is written in bass clef and features a series of notes with a dynamic marking of *mp*. The Electronics part is written in treble clef and features a series of notes with dynamic markings of *mp*, *mf*, *p*, *pp*, *mp*, and *mp*. The notes in the Electronics part are positioned above the staff line, indicating they are not sounding pitches but rather triggers for samples.

Figure 51: The lower two staves show the keys that should be pressed on the electronic keyboard (MIDI controller). However, these are not sounding pitches but just indications of how to trigger the samples and what dynamics should be chosen. The pitches shown at the electronics line refer to sample 6 (A) and sample 7 (B).

The image shows a musical score for two pianos, labeled 't. Pno.' and 'Pno.'. The score is divided into two systems. The first system covers bars 40-46. The top staff (t. Pno.) has a treble clef and a 4/4 time signature. The bottom staff (Pno.) has a bass clef and a 4/4 time signature. The music features complex rhythmic patterns with many sixteenth notes. There are dynamic markings of *ff* (fortissimo) and a section labeled 'Let fade away' with a *pp* (pianissimo) marking. There are also some numerical markings (5, 6, 7) and a '9' at the end of the first system. The second system starts at bar 43 and continues to bar 46. It features a 3/4 time signature and includes a section with the instruction 'Play delays ca. every 3 seconds Sounding approximately:' followed by a musical example. The dynamic marking *mp* (mezzo-piano) is used in this section. The score is written in a complex, multi-measure style with many notes and rests.

Figure 52: A notation example from the score of Trinity Mania (bars 40-46). The excerpt combines aspects of traditional and spatial notation, as well as some verbal instructions.

5.1.4 Performing “Trinity Mania”

The performer’s perspective was taken into account at all times. Although most of the pitch material, durations, and rhythmical features were originally pre-structured, a great deal of improvisation, workshopping, and exploration also took place as a part of this particular composition project. For example, I was experimenting with different electronic solutions for live setting through improvisation with other composers, as well as through participation in Karlheinz Essl’s composition seminars during which various technological solutions and tools were showcased. I was thus able to work on my electroacoustic improvisation skills as a pianist, which gave me good training for performing with real-time solutions in a concert setting. In a way, I was both practising and writing the music at the same time, which meant that an extensive additional rehearsing period was not required. Such an approach was unusual for me: normally I

would have first composed the piece, and then learned to play it. This approach allowed me to acquire quickly the technical skills necessary for this project.

Inevitably there was still some detailed work to do from the performer's perspective: I had to learn how to shift between the three keyboards and to understand how to mix the sampled material to the acoustic part. Changing between the keyboards in the middle of the performance as well playing them simultaneously were instrumental tasks that required special attention. Additionally, the sampled material does not correspond to the actual octave ranges of the MIDI keyboard (thus, the motoric sequences and pitch selection do not correlate in a regular manner), which, of course, made it necessary to learn separately the organisation between different effects and their activation keys.



Figure 53: The author performing her work “Trinity Mania” for piano, toy piano, MIDI keyboard, and electronics. The MIDI keyboard/controller is placed on top of the toy piano. Photo by Karlheinz Essl.

“Trinity Mania” requires special qualities from its performer: not only is it challenging to divide one's concentration and instrumental techniques between several instruments, but the piano part alone is also difficult. However, once the performer overcomes these technical challenges, the performing experience is rewarding, as the computer based material forms an additional instrument that supports the image of a virtuoso performance by reflecting and multiplying the material of the original instrumental lines.

5.2 Maria Kallionpää and Hans-Peter Gasselseder: “Celestifilia” (2012)

The super instrument qualities of my work “Celestifilia” emerge both from the technical and sonic level. This work combines aspects from my electronic- and multiple instrument categorisations. The main extended functions of the piece are 1. the change of tuning through microtones 2. the added virtuoso capabilities provided by two keyboards and electronics 3. mixing electronic and acoustic timbres 4. the use of artificial sounds as a part of acoustic performance 5. the visual effects.

While the combination of the two keyboards enables the mix of two different timbres and tunings that exceeds the sonic qualities of a regular piano, the simultaneous presence of the two different keyboards also opens up various possibilities in terms of instrumental techniques. The sonic world of the so-called LogicPro version of the piece has the futuristic character of an “electronic orchestra”, as the piano timbre is not the strongest sonic element of the piece, even if the work is still intended to be a solo composition for one pianist, assisted by a sound technician. However, a crucial element regarding the essence and role of the regular piano has changed: instead of being a leading component of a solo piano piece, the usually dominating timbre is only one aspect of the sonic organisation.

As stated, “Celestifilia” is a composition with two versions: the first one is more restricted considering the tempi, whereas the second version (with micro tonal tuning only) is rhythmically more free and up to the performer’s decisions. Even if “Celestifilia” is not a work for piano and fixed media, the electronic processes require accurate and disciplined score reading from the pianist, as some of the computer-generated processes are triggered by exactly timed actions of the performer. To ensure this, the author (together with the co-author, sound technician Hans-Peter Gasselseder) has chosen to apply a constant click track. The time control is also achievable by applying a visual time displaying or other methods such as letting the sound technician scroll the score on screen during the performance: Plessas referred to the latter method as “the score following concept” (Plessas, 2013).

While the primary, electronically more complex version of “Celestifilia” includes a full and flamboyant computer generated background containing many electronic effects created with the LogicPro software, I have not applied any electronic solutions other than a specific microtonal tuning (and an additional electronic keyboard) in the secondary version of the piece. The tuning of the latter version was realized with the Ableton Live system. The microtonal tuning system should always be used in performances of both versions.

“Celestifilia” was partially composed as a tribute to Karlheinz Stockhausen and George Crumb. Just like “Zusammenbindenbinden.Winden? –Hommage a Schumann”, “Trinity Mania, and “Toccatà”, the artistic concept behind “Celestifilia” was to create music for a super instrument. The purpose of this work was to create something larger than a regular solo piano piece, yet still playable by a single performer, which is why I decided to use both piano and an additional keyboard instrument at the same time. The electronic keyboard proved to be the most practical solution for a secondary instrument thanks to the ease in changing its tuning to create the necessary microtonal harmonies.

The microtonal thinking is present from the beginning of the second part until the very end of the piece, from the moment when the electric keyboard part starts. The additional keyboard should be tuned $\frac{1}{4}$ of a tone higher than the piano. The microtonal characteristics are most audible at the end of the work, where the same lines and motifs are supposed to be played simultaneously. Haas calls this kind of microtonal writing “espressivo unisono” (Haas, 2013).

Figure 54: Bars 87-89 of *Celestifilia*. The rhythmical freedom of the performer has been indicated by spatial notation. By placing similar pitch material in both piano and keyboard parts, the microtonal tuning gets emphasised. The two instrumental lines have separate sets of dynamics.

5.2.1 The Creative Process

“*Celestifilia*” was commissioned by pianist Tuuli Lempa, with whom the author had previously collaborated: Lempa has also performed “Hommage a Schumann – Zusammenbinden?- Winden”. The special theme of Lempa’s premiere concert was space, darkness and divinity, in which “*Celestifilia*” fitted well, as it was inspired by the aesthetics of Stockhausen, including the interest in planets and stars palpable in many of his works.

References to Stockhausen can also be identified in the important role of the tuning and its electronic manipulation as well as in the performative freedom of certain passages within “*Celestifilia*”, reflecting the Stockhausenian concept of open form techniques. However, the entirety of the work was not composed by adherence to them.

“*Celestifilia*” is mostly notated throughout but a certain freedom remains for the performer in passages containing microtonal tuning, especially near the end.

As aforementioned, the two existing versions of the work drastically differ from each other. Where the LogicPro version requires the exact following of the score due to the rhythmically fixed nature of the computer generated material, the tempi of the “tuning only” version can be interpreted more freely. The author considers the co-existence of

the two versions essential because of their very different roles and functions. The primary LogicPro version is more demonstrative in terms of the use of electronics, whereas the plain keyboard version concentrates on the refined timbral colours of microtonal tuning that are not as clearly audible under the electronic sound mass of the first version. Moreover, the piano's timbre (and its alterations) is more prominent with the secondary version.

I consider "Celestifilia" to be a super instrument work because the applied combination of instruments in conjunction with electronics raises the sonic possibilities of the work above a regular solo piano work in terms of tuning, instrumental techniques, and timbre. The technical realization of the principal version⁷⁵ of "Celestifilia" has been designed in a following manner:

Signal chain:

Exciter

Ringshifter

Granulizer (with multimode filter, bitcrusher and LFO active)

PitchShift

Morphing (based on neuronal synthesis courtesy of DSPdimension/Stephan M.

Bernsee)

On-/Off Switcher with dynamic modulations

EQ (for sweeps)

Envelope (for changing sound progression/dynamics)

SpectralLimiter (spectral re-calibration of the audio source)

Granular-ReSynthesis (delay, pitch shifting and filtering according to waveshape)

Granular-ReSynthesis (Logarithmic re-alignment of granular contents)

Overdrive

Sample-Buffer (for DJ-effects: scratching, reverse, chunking)

Reverb

Limiter

⁷⁵ The author herself prefers the version applying the Logic Pro software, which is why it is here referred as the principal version.

Basic sound:

Spectral Piano triggered by MIDI-Keyboard; sound morphed according to recorded real-life piano (microphone attached). Intention: Spectral sonics of multi-sampled instrument should resemble the spectral sonics of the real piano. Morphed sounds in Spectral Piano are to be understood as an interaction of differences in lines composed / music content of both instruments. Modulation runs in accordance to parameters automatized in Host.

Examples of modulations / Parameter Automatization:

Bar 25: Residual stress implicated by LFO modulations of overdriven filters (by design - no input required). PtichShifter on/off (ms range) when second half of ending notes start. Modulating bit-chunk ranges of Granulizer.

Bar 33, Beat 2: High dynamic MIDI-input triggers higher rate of bits; modulate and sample delayed; pitch shifting slope - mixes pitch shift gradually into audio signal.

Bar 38: Morphing including ringshifting

6 Conclusions

This dissertation has offered examples of different super instrument compositions, as well as having presented some composition techniques, aesthetic approaches, and technological/instrumental solutions that have been used for such performances or composition projects. Super instrument composers combine and play with composer, performer, and instrumental identities similarly to the historical virtuoso composers, and seek ways of renewing composition- and instrumental techniques in order to extend the functions and identities of their instruments. This is supported by certain composers' own statements (for example Essl, 2013, about his works "Stern" and "Sequitur XIII"), as well as direct musical references to the historical virtuoso tradition, such as, for example, Tod Machover's project on Paganini's Caprice No. 24 or Olga Neuwirth's "Kloing!". By composing super instrument works, the composers participate in

changing how the instruments are perceived by the public, as well as developing new instruments and performance techniques.

On the basis of the results achieved through the practical artistic work executed in the composition examples of this dissertation, a “super instrument” can be defined as a concept, or a phenomenon, rather than an instrument with a fixed pre-destined identity. The idea of a super-instrument is piece-specific: each super instrument has its own special essence in the context of different compositions. A super instrument, or a super instrument composition, should be defined as an entity in which all the instrumental lines or computer-generated features complete each other in a manner which does not allow them to form separate identities, but merely to form an organic unity with its own congruent identity.

The conclusion of this research project is that the super instrument as a concept (or phenomenon) involves three parallel types of identities: the compositional identity, instrumental identity, and performer identity. The performer identities are often challenged in this repertoire because of the variety of instrumental combinations. A performer should form a new coherent identity that adapts itself to a plethora of various instruments and technological tools in terms of their sonic, technical, and technological effects and functions. The essence of a super instrument composition is not dependent on the identity of the applied concert instrument or vice versa, but these separate identities instead co-exist and support each other. The identity of a composition is gradually formed within the composition process as a consequence of the choices made by the composer, while the selection of techniques and technologies depends on the composer’s aims regarding the aesthetical or structural outcome of the piece. There are as many ways to approach the idea of a super instrument as there are composers and each composition creates its own set of rules and selection of composition techniques. The same also applies to the performers: a new technical and performative language has to be developed according to each performance.

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Appendix: Contents of CD and DVD

CD

Track 1: Maria Kallionpää: Zusammenbindenbinden.Winden? –Hommage a Schumann. Tuuli Lempa, piano; Marko Myöhänen, electronics. Helsinki 2012.

Track 2: Maria Kallionpää: Trinity Mania. Maria Kallionpää, piano; Florian Hartlieb, electronics. Vienna 2010.

DVD

Track 1: Karlheinz Essl: Sequitur V. Maria Kallionpää, toy piano; Karlheinz Essl, electronics