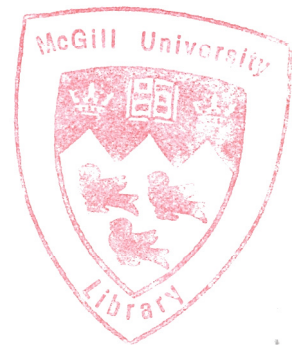# Live and Interactive Electronic Vocal Compositions:
Trends and Techniques for the Art of Performance

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Abstract

This thesis deals with technological, compositional and performance-practice aspects of computer-based live and interactive electronic vocal music. Live performance-based electronic music indicates a composition by which the vocal, instrumental and/or electronic sounds are processed in real time. By surveying historical developments, technological advances, aesthetics, and important figures, this document intends to assist singers in gaining a global perspective of the field in hopes of facilitating interest in the performing and commissioning of live electronic vocal compositions. An important element of this thesis is an annotated appendix of computer-based live and interactive electronic vocal music detailing instrumentation, technical requirements, texts, performance notes and publisher contact information. In order to assist in the study and performance of these works, relevant performance issues are explored, and a methodology and step-by-step checklist for learning contemporary and electronic vocal music is included. An analysis of three vocal works in this genre is presented: *En Écho* by Philippe Manoury, *Erba nera che cresci segno nero tu vivi* by Mauro Lanza, and a new work commissioned especially for this study, *Avant la larme* by David Adamcyk.

Cette thèse traite des aspects technologiques et compositionnels ainsi que de l'interprétation d'oeuvres pour voix et traitement électronique interactif en temps réel. Le traitement en temps réel fait référence à une oeuvre impliquant une transformation de la voix, des instruments et/ou du matériel électronique en direct. En s'appuyant sur les développements historiques, l'avancement technologique, l'esthétique, l'apport de différents protagonistes d'importance, ce document cherche à aider les chanteurs à acquérir une vision globale de ce champ d'intérêt dans le but d'encourager un intérêt pour la commande et l'interprétation d'oeuvres pour voix et traitement électronique en temps réel. Une partie importante de cette thèse a été consacrée à l'appendice recueillant les détails d'instrumentation, les prérequis techniques, les textes, les notes de programme et les coordonnés des éditeurs pour nombre d'oeuvres ayant été écrites pour voix et traitement électronique interactif. Afin de contribuer à la recherche et l'interprétation de ces oeuvres, ci-joint se trouve un document traitant des problématiques d'interprétation ainsi qu'un guide étape par étape aidant à l'apprentissage du répertoire contemporain en général et spécifique avec traitement électronique. Une analyse de trois oeuvres appartenant à ce genre est aussi présentée: « En Écho » de Philippe Manoury, « Erba nera che cresci segno nero tu vivi » de Mauro Lanza, ainsi qu'une oeuvre commandée spécialement pour cette étude, « Avant la larme » de David Adamcyk.

Acknowledgements

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Chapter 1: Introduction

The genre of computer-based live and interactive electronic vocal music is unfamiliar or intimidating to many classical singers, as the expertise required for preparing this music is generally not taught in the voice studio or the university classroom. The objective of this thesis is thus to create a detailed reference manual in order to render the study and performance of this music more accessible to singers. An annotated appendix of 62 important vocal pieces is included, noting instrumentation, technical requirements, text authorship, performance notes and publisher contact information. A growing concern in the field of contemporary music is the often *lack* of performances beyond the premiere. By providing the requisite tools necessary for the successful presentation of these works, I hope to inspire singers to embrace this exciting genre, thereby facilitating repeat performances of these important compositions.

A comprehensive review of the existing literature reveals no specific article or book devoted to this topic. The document that most approaches it is L. Montanaro's DMA Treatise, *A singer's guide to performing works for voice and electronics* (2004), though Montanaro primarily discusses works for voice and tape, and only briefly explores live vocal electronics. The format for the annotated appendix was based upon Montanero's research, as well as the publication *Literature for voices in combination with electronic and tape music: An annotated bibliography* (Edwards 1977).

An overview of performance practices and techniques in this field can be found in the publications of B. Belet, S. Emmerson, G. Garnett, M. Kimura, E. McNutt, V. Rizzardi and W. Schloss, though these do not specifically refer to vocal electronic music. A historical and technological perspective of live electronic music can be obtained from the writings of J. Chadabe, P. Manning, R. Rowe, M. Subotnick and T. Winkler. In developing a methodology for the vocal preparation of these works, I consulted the writings of J. La Barbara, L. Brown, J. Manning, S. Mabry, J. Potter and T. Wishart. References to these sources can be found in the bibliography of this thesis.

One of the primary objectives of this research has been the creation of an annotated appendix (Appendix B). As previously stated, no centralized reference document exists on this subject, which greatly limits singers interested in performing live electronic vocal compositions. With this thesis, singers may easily overview available repertoire and, upon

locating appropriate works, further research selected pieces, thereby deciding upon the viability of a performance.

In preparing the annotated appendix of computer-based live electronic vocal works, the majority of my research was based upon first-person contact with composers in the form of email and personal interviews. In order to determine what works existed in this genre, I first compiled a list of important composers of electronic music, totaling approximately 125 persons.[1] I then surveyed their compositional output through extensive internet and periodical research. After accumulating a list of relevant composers of vocal electronic music, I contacted each composer individually (when possible) to ascertain and/or verify specific details regarding their appropriate works.

The body of this thesis is devoted to a historical and technological overview of the development of computer-based live and interactive electronic vocal music, presented in chronological order. Chapter 2, *Brief history of voice and electronics*, traces the development of electronic music and its relation to the voice, and includes a discussion of the Italian Futurist movement, early electronic instruments, post-war technological advancements, and pioneers of live electronic vocal music. In Chapter 3, *Development of computer-based live electronics (1967-1990)*, I present important historical advancements in this field, including developments in computer technology, MIDI, score following techniques, and interactive composition and performance environments. Chapter 4, *Current trends in computer-based live electronics (1990-present)* defines live computer-based electronic music and interactive electronic music, and explores the aesthetics of live electronics (including works for fixed medium, or tape music). I then discuss important figures in the field of live and interactive electronic music performance, listing notable composers, performers and research institutions.

The next part of the thesis specifically discusses performance techniques relevant to this genre. Chapter 5, *Performance*, describes practical issues related to the performance of computer-based electronic music, including selecting an appropriate work, obtaining the score and other materials, learning the piece, ensuring the technical setup, and rehearsing with the electronics. In this chapter I also present a methodology for learning contemporary and electronic vocal music, gleaned from the pedagogical principles of the Italian *bel canto* school, interviews with professional contemporary singers, and my personal experience in

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[1] I would like to note that the online database of the French research institute IRCAM was particularly helpful in this regard.

this field. Included is an examination of difficulties unique to singers of live electronic music, as well as common pitfalls encountered when performing these works. In Chapter 6, *Vocal analyses*, I demonstrate a strategic system for the analysis of vocal works in this genre, and include a discussion of three representative compositions: *En Écho* by Philippe Manoury, *Erba nera che cresci segno nero tu vivi* by Mauro Lanza, and *Avant la larme* by David Adamcyk.

There are three appendixes in this thesis. Appendix A briefly explores the historical development of extended vocal techniques. The aforementioned Appendix B presents my annotated list of computer-based live and interactive electronic vocal music, while Appendix C contains a referential checklist for performers detailing specific methods for learning contemporary and electronic music.

Chapter 2: History of voice and electronics

2.1 Early electronics

From Benjamin Franklin's experimentation with electricity in the 1700's, to Thomas Edison's invention of the phonograph in 1877 and Alexander Graham Bell's research and development of the telephone in the late 19th century, mankind has been on a continuous trajectory towards our present-day state, in which electronic technology is integrated into every facet of our lives. The Industrial Revolution brought not only new technologies to western society, it also triggered monumental socioeconomic and cultural change. At the same time, it irrevocably altered the sonic environment, as the once-prevailing sounds of nature became gradually replaced by the sounds of machines and automobiles.

2.1.1 Influence of Futurism

In the early 20th century, the rise of Futurism in Italy and Russia was marked by the manifestos of poet Filippo Tommaso Marinetti, painter and sculptor Umberto Boccioni, and composer and painter Luigi Russolo. These authors rejected the political and artistic traditions of the past, and embraced what they felt should be ideals of the new century– technology, speed, and man's triumph over nature. In 1913, Russolo published *L'Arte di Rumori* (The Art of Noises), calling for the exploration of noise as a musical element,[2] and stated:

> Musical sound is too limited in qualitative variety of timbre. The most complicated of orchestras reduce themselves to four or five classes of instruments differing in timbre: instruments played with the bow, plucked instruments, brass-winds, wood-winds and percussion instruments… We must break out of this narrow circle of *pure musical sounds* and conquer the infinite variety of *noise sounds*. (Russolo 1996, 37)

This early exploration of noise and 'non-instrumental sounds' as music helped form the foundation from which electronic music would evolve.

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[2] It should be noted that the Futurists defined 'noise' as sounds found in our sonic environment (ex. from machines). The term did not solely refer to random electronic sounds (ex. 'white noise', or 'pink noise').

2.2 Early electronic instruments coupled with voice

The 1920's saw the invention of several electronic instruments including the theremin, the ondes martenot and the Hammond Organ. Lev Termen (1896-1993) developed the theremin[3] in 1920 in Moscow, and it immediately sparked great popularity and interest. The theremin is a lyrical instrument that closely resembles a viola, or the human voice. Still used today, it consists of two proximity sensors comprising a thin vertical rod that controls pitch, and a horizontal loop that controls volume. Works for voice and theremin include *Ecuatorial* (1934) by Edgar Varèse, *Petite Pièce Aléatoire* (1966) by Jorge Antunes, *Romance* (1985) and *In Whims of the Wind* (1994) by professional thereminist Lydia Kavina, *Traum Kanone (Dream Gun),* from the opera *The Birth of George* (1996) by David Simons and Lisa Karrer, and *Virtual Percussion Trio* (1999) by David Simons.

The ondes martenot was developed by cellist and music pedagogue Maurice Martenot, and received its premiere at the Paris Opera in 1928. The original instrument consisted of a vertically placed ring on a ribbon track. The ring, pulled by the right hand, allowed the performer to control pitches, while the player's left hand controlled loudness and timbre. Martenot later added a keyboard that could be used separately or in conjunction with the ribbon (Chadabe 1997, 12). Vocal works with ondes martenot include *Le visage nuptial* (1946) by Pierre Boulez (b. 1925), *Uaxuctum* (1966) by Giacinto Scelsi (1905-1988), *Saint François d'Assisi* (1975-1983) by Olivier Messiaen (1908-1992), *Nightmare* (1994) by Lindsay Cooper (b.1951) and Abdulah Sidran (b. 1944), and *Mare Teno* (2000) by Michel Redolfi (b. 1951). Tom Yorke and Johnny Greenwood of the English band Radiohead composed *Arpeggi* for voice, ondes martenot and orchestra. This was performed with the London Sinfonietta and the Arab Orchestra of Nazareth at the Ether Festival in March 2005.

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[3] Originally called the aetherphone, the instrument was later renamed the theremin.

2.3 Post-war technological advances

In 1937, composer John Cage (1912-1992) stated in his credo on the future of music: "I believe that the use of noise to make music will continue and increase until we reach a music produced through the aid of electrical instruments which will make available for musical purposes any and all sounds that can be heard" (Cage 1966, 3). Beginning in the late 1940's, Cage's prediction would come true. Following the Second World War, a great revival of western art took place. Rapid advances in technology had occurred during the late 1930's and 40's, and the post-war cultural climate was primed for exploration of new sound techniques using these technologies. Two important electronic studios were established in Europe around 1950, the *Groupe de Recherche de Musique Concrète* (later renamed the *Groupe de Recherches Musicales*) in Paris, France, and the Electronic Music Studio of the Northwest German broadcaster, the *Nordwestdeutscher Rundfunk* in Cologne. The Parisian group was founded by Pierre Schaeffer, inventor of *musique concrète,* a form of electronic music in which composers cut and splice recordings of *concrète,* natural sounds in order to create a composition. On the other side of the spectrum, the Cologne-based *Nordwestdeutscher Rundfunk* studio developed *elektronische musik,* a form of music that used purely electronic means such as sine wave oscillators and white noise generators to create sound. Early members of the Cologne studio included Herbert Eimert, Robert Beyer, Gottfried Michael Koening and Karlheinz Stockhausen. Though the two studios remained sharply (and at times bitterly) divided in their philosophies and methods, elements of both schools of thought were eventually brought together in Stockhausen's landmark work *Gesang der Jüngling.* Completed in 1956, *Gesang der Jüngling* became one of the first pieces to combine the compositional aesthetics of *musique concrète* and *elektronische musik* by using vocal recordings coupled with synthesized sounds. Shortly thereafter, the *Studio di Fonologia Musicale della rai* in Milan, founded in the 1960s by Luciano Berio and Bruno Maderna, began experimenting extensively with the process of manipulating recorded speech, often by deconstructing text into a series of phonemes. Berio's *Thema: Omaggio a Joyce* (1958) became the first well-known tape piece to utilize the female voice as a source of compositional material (Bosma 2003).[4] Using these text-sound compositional techniques, Berio also composed *Visage* in 1961.

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[4] In this piece, Berio altered the recorded vocal sounds of Cathy Berberian with fragmentation, overlaying, and filtering of the vocal timbre (Manning 2004).

Early electronic compositions consisted of an artifact recorded onto tape. Concerts of these works essentially entailed the audience sitting in a hall watching a set of speakers while listening to the music. Towards the end of the 1950s, however, composers came to appreciate the appeal of a human presence onstage, and began combining a live performer with tape music. Some of the first pieces for voice and tape include Milton Babbitt's *Vision and Prayer* (1961) and *Philomel* (1964), and Luigi Nono's *La Fabbrica Illuminata* (1964). Other notable compositions for this medium include Jean-Claude Risset's *Inharmonique* (1977), *L'Autre Face* (1983), and *Invisible* (1996), Charles Dodge's *The Waves* (1984), Simon Emmerson's *Time Past IV* (1984) and *Recollections* (1985), Joel Chadabe's *Several Views of an Elusive Lady* (1985), Trever Wishart's *Vox Cycle* (1982-1989), and Jonathan Harvey's *Nachtlied* (1984).

2.4 Early live electronics and voice

2.4.1 Overview

During these early years, composers also experimented with the manipulation of electronic sounds within a live performance. French sound engineer Jacques Poullin, working with the French composer and inventor of *musique concrète* Pierre Schaeffer (1910-1995), explored real time spatialization with his *potentiometre d'espace*, a four-channel sound diffusion system for recorded music developed in 1951. Poullin's *potentiometre d'espace* utilized a multi-track tape machine, and routed each of four tracks directly to a separate speaker. A performer manipulated a coil of wire between four large circular elements to control the spatial trajectory of the audio of a fifth channel in real time.

Early techniques involving electronic processing of instrumental sound during a live performance evolved with the commercialization of the electric guitar in the early 50s; these included bass and treble control, reverb and echo, delay, looping, tremolo, the wah-wah pedal, phasing and flanging (Manning 2004). Two of the earliest examples of live vocal processing are Karlheinz Stockhausen's *Mikrophonie II* (1965)[5] composed for choir, Hammond organ, and four ring modulators, and Luigi Nono's *A floresta é jovem e cheja de vida* (1965–66) for soprano, voices, clarinet and copper plate.

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[5] In this piece, the acoustic sound of the choir is altered in real time with ring modulation, a process by which two audio signals are multiplied together, and the sum and difference of the two waveforms are output.

2.4.2 Luigi Nono

Italian composer Luigi Nono (1924-1990) was highly regarded as one of the eminent artists of the post-war European avant-garde, along with Stockhausen (b. 1928), Iannis Xenakis (1922-2001) and Pierre Boulez (b. 1925). One of the first composers to embrace live electronics as a tool for enhancing dramatic context, Nono created a substantial repertoire of vocal works in this genre. Though he maintained an early association with the Milan *Studio di Fonologia Musicale della rai* (founded by Luciano Berio and Bruno Maderna), Nono's most important vocal pieces with live electronics generated from his work in the 1980s at the *Experimentalstudio der Heinrich-Strobel-Stiftung* in Freiburg, Germany.

Nono utilized live electronics as a means to explore 'mobile sound'.[6] As his compositions strongly reflected his desire to assimilate space and technology with music in live performance, his works generally involve intricate architectural setups. Nono's belief was that a composition should be a living object, embodied in the moment of performance. In order to implement this ideology, he often sat at the mixing board during performances of his works, controlling dynamics and spatialization in real time.[7] Roberto Fabbriciani, flautist and famed interpreter of new music, discusses Nono's use of live electronics:

> Nono was cautious in his use of live electronics, not to produce effects which were all end in themselves (sic), since these could create a superficial listening. His aim was in fact to produce a more conscious listening, a readiness to savour every little change loaded with significance and to generate strong emotions against any established, traditional form... Live electronics became a structural component of his music, totally interdependent with the interpreter since the machine acted on the resulting sound in relation to opportune and specific actions of the executant. Technically, the live electronics consisted of only a few sound treatments, however they were used with such a variety of applications and in such varied contexts, that often the original score was unrecognizable. Such treatments would include: amplification, spatial projection, delay, pitch shift (harmonizer), filtering and mixing. The novelty of being able to take advantage of these techniques in real time generated new ideas and opened the way to numerous innovations. (Fabbriciani 1999, 9)

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[6] Gerard Pape provides a more detailed description of Nono's usage of live electronic elements. "Nono used various real-time transformation devices to obtain *mobile sounds* by technological means. For example, he used harmonizers for obtaining micro-intervallic transpositions and retrogradations; the Halophon for programming various kinds of spatial movements over time; the digital delay for creating canon-like effects; band pass filters for selecting only certain portions of sound spectra. In addition, he used vocoders to modulate one sound by another and gates to control the onset of a sound. Nono used all these live electronic effects in various works in the 1980s in combination with a tremendous variety of new instrumental and vocal techniques to attain his goal of the *mobile sound*" (Pape 1999, 62).

[7] Unfortunately, the only technical record of this remains in the memory of the technicians who assisted Nono in performance. This has led to a very real issue of authenticity in Nono's works – the amount of indeterminate and/or improvisatory elements in Nono's live performances reduces the authenticity of the notated score. Undoubtedly this was not of terrible concern to Nono, who continuously sought in his compositions to separate the *idea* of the composition from the objectification of its score (Rizzardi 1999).

Nono's compositions reached a profound artistic maturity towards the end of his life. Though 1966's *A floresta é jovem e cheja de vida* is noted as one of the first pieces to utilize live electronics (Rizzardi 1999), Nono generated most of his live electronic vocal compositions in the 1980s, including *Io, frammento dal Prometeo* (1980/81), *Quando stanno morendo. Diario polacco nr.2, Guai ai gelidi mostri* (1983), the opera *Prometeo, tragedia dell'ascolto* (1984), and *Risonanze erranti* (1986).

2.4.3 Morton Subotnick

Composer Morton Subotnick (b. 1933) pioneered developments in early electronic music and interactive performance systems (Whipple 1983).[8] In 1975, Subotnick invented the *ghost box*, an interactive analog system consisting of pitch and envelope followers,[9] a voltage controlled amplifier, frequency shifter and ring modulator. Subotnick would compose a 'ghost score' by creating a series of control voltages and recording them to tape or EPROM. A miked performer played 'through' the ghost box, and the sonic output was processed according to these pre-recorded control voltages in real time. Harold Whipple explains the process in further detail:

> ...the recorded control voltages are patched to synthesizer components – envelope and frequency followers then ring modulators, frequency shifters, voltage controlled amplifiers (VCA's) – which use the information to process signals from oscillators, noise generators, and so forth. At this point the sound is recorded or the composition is "performed" in concert. Ghost-score works replace the synthesizer's audio signal sources with live sound picked up by microphones; the modified sound is amplified and played back into the performing area over loudspeakers. At no time are the taped signals heard: hence, the name "ghost score." (Whipple 1983, 432-433)

The ghost box is an example of early, analog-based live electronics. As the sound of the recorded control voltages were silent or 'transparent', Subotnick coined the term "ghost score" to refer to the electronic score.[10] The first vocal piece composed in this medium was

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[8] Subotnick was highly influential in the establishment of the San Francisco Tape Music Center in 1962 (later moving to the Mills Center for Contemporary Music) along with composers Ramon Sender, Terry Reily and Pauline Oliveros. In the late 1960s Subotnick worked with Donald Buchla and Ramon Sender to develop the Buchla synthesizer, realizing several important compositions with this instrument, including *Silver Apples of the Moon* and *The Wild Bull*.

[9] Pitch tracking and envelope following refer to the process by which the computer follows the live performer by tracking either *frequency changes* or *amplitude variations*.

[10] Subotnick reflects on the importance of this element. "I think that technology has to be transparent. You cannot be aware of the technology, but [it should be] a world that you move into seamlessly" (Machover 1999, 20).

The Last Dream of the Beast (1979), written for Joan La Barbara.[11] Subotnick went on to become an important developer of interactive digital performance, and will be discussed further in chapter 3.[12]

2.4.4 Joan La Barbara

One of first female composers to enhance vocal performance art with electronics was Joan La Barbara (b. 1947) (Weber-Lucks 2003). A pioneer in the field of extended vocal techniques and vocal sound exploration,[13] La Barbara does a great deal of improvisatory and reactionary performancing. She first became involved in the medium of electronics in 1967 as a student at Syracuse University. There, she experimented with composition using a MOOG synthesizer, and became intrigued with the process of sonic exploration on an electronic level. La Barbara later learned to process her voice electronically using electric guitar effects (La Barbara, 2002). She went on to create numerous pieces for voice and live electronics, including *Vocal Extensions* (1975) for voice and electronics, *Thunder* (1975) for six timpani, voice and electronics, *Autumn Signal* (1978) for voice and Buchla synthesizer, and *73 Poems* (1993), a collaborative work with text artist Kenneth Goldsmith written for electrically modified voices. *Vocal Extensions* used a phase shifter, pitch modulator, and delay unit, while *Autumn Signal* used the Buchla synthesizer to process the voice. In a personal interview with La Barbara, she discussed her early experiments with electronics:

> I sometimes used electronics that were commercially available… to electric guitar players, and I used the microphone to feed [my voice] through these devices. I used a phase shifter, and an object called a frequency analyzer, which was like a ring modulator… and also something called the Roland Space Echo, which was a marvelous device, a little tape loop in a box [by which] you could alter the speed of the tape loop by turning dials… This little device would allow me to loop and adjust the speed infinitely… In *Vocal Extensions* I was working with [the electronics] the way I would work with musicians improvising, so that I would often times just turn the dials, and then react to that as I would react to a person who was making a new sound [in performance]. (La Barbara 2005)

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[11] La Barbara notes that *The Last Dream of the Beast* combined an electronic score with traditional singing and extended vocal techniques, modified by a ghost score in real time. This work was expanded into an instrumental version and utilized in Subotnick's stage tone poem *The Double Life of Amphibians* (1984) (La Barbara, 2002).

[12] In order to ensure the longevity of these works, the electronics in Subtonick's early ghost pieces are currently being transferred to Max/MSP format, available upon rental of the score.

[13] La Barbara's development of her signature extended vocal techniques, including multiphonics, circular singing, ululation and glottal clicks, are further discussed in Appendix A.

When asked to elaborate upon the concept of electronics as an extension of acoustic performance practice as opposed to being an entirely new medium, La Barbara responded:

> [They are] both – it's a new medium, but it certainly is an extension of our existing harmonic vocabulary because we're human, and we've used machines to make machine noises. Many times composers use the machines to make very musical sounds [though] sometimes they use them to make very *un*musical sounds. I would think that some of the work of David Tudor is a great example of just trying to get to the *machineness* of the machine sounds. But a lot of times you'll find that the electronics are very fluid. They're used as kind of an enhancement of instrumental or vocal sound, or some way of giving an atmosphere to the voice or instrument… I've always used electronics as a further extension of what I can do with the voice. (La Barbara 2005)

La Barbara continued to explore the alteration of her voice with electronics strictly as a performer, working with such noted composers as Alvin Lucier, David Behrman,[14] Morton Feldman, Charles Dodge, Roger Reynolds and Morton Subotnick.

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[14] In 1975, David Behrman created an early interactive composition for Joan La Barbara entitled *Voice with Melody-Driven Electronics*. This was a simple interactive network consisting of pitch sensors that tracked La Barbara; as she sang pre-determined pitches, those pitches triggered chord changes.

Chapter 3: Development of computer-based live electronics (1967-1990)

3.1 Early technological developments

The dawn of the digital age of computers, marked by an exponential growth of processing power, heralded rapid advancements towards real-time computer-based electronic music.[15] The integration of microprocessors into computer circuits can be regarded as one of the great technological innovations of computers, paralleling the development of magnetic core memory and transistors. Beginning with the invention of the silicon-based microprocessor chip in 1971,[16] improvements in miniaturization allowed computer hardware to greatly decrease in size.

> The design revolution signaled by the fabrication of circuits in silicon was to affect the development of computer music systems in [a]…fundamental way, as it facilitated the construction of custom-built [complex] devices devoted exclusively to audio applications. The efficiency gains achieved by using optimized hardware were of sufficient magnitude for the execution of a number of real-time synthesis and signal processing functions in real time. (Manning 2004, 222)

Within several years of the initial development of microprocessor chips, microcomputers became commercially available. Originally only accessible in a university environment, composers and researchers could now access affordable technology outside the confines of a research laboratory.

The first interactive performance system for live electronics was developed in 1967 by computer music researcher Max Mathews. Working at Bell Laboratories, Mathews, along with his programming assistant F. Richard Moore, developed GROOVE (Generated Real-time Output Operations on Voltage-controlled Equipment), a pioneering hybrid system for real-time digital control of analog synthesis. The GROOVE system allowed a 'performer' to control a preprogrammed score in real time. A performance essentially consisted of pressing keys and turning knobs to control dynamics, tempo and balance of the synthesized

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[15] Real-time refers to the computational speed by which computers receive and process data. A real-time operating system responds to input immediately, with minimal latency.
[16] Developed by Intel.

'ensemble'.[17] GROOVE was further developed in 1973, when Laurie Spiegal and Max Matthews conceived the term *intelligent musical instrument* "to describe an instrument that first sensed its performer's intent by the type and context of the performer's actions and then extended the performer's controls [in order] to execute the music automatically" (Chadabe 1997, 334).

Two years later, Mathews implemented more sophisticated software into the GROOVE system, which lead to the creation of the Conductor program.[18] The Conductor program was an interactive system by which a performer utilized a controller to interpret a musical score programmed into the computer. Mathews designed a handheld sensor rod to effectively mimic the gesture of a conductor's baton; this rod allowed the user to interpret control data, thereby adding musical nuances to the score (Manning 2004). In the early 1980s, Mathew's research progressed significantly. He developed the Sequential Drum and the Radio Baton, interactive control devices based on custom-designed sensors. Later additions to Mathew's GROOVE system foreshadowed future technological developments, as the newer system incorporated a graphical interface, several years ahead of the implementation of the WIMPS design.[19]

3.2 Technological advancements of the 1980s

3.2.1 Overview

The 1980s witnessed rapid advances in the development of computer technologies. The 1981 launching of the first Personal Computer (PC) by IBM heralded not only a technological step forward, but also the commercialization of computers within a mass market. Developments in software paralleled the popularization of the PC, and composers discovered a new world of music editors, sequencers and notation programs. Composer Robert Rowe notes: "Digital computers afford[ed] the composer or sound designer

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[17] Though the initial development of GROOVE was primarily intended for research applications, several composers worked with the system, notably Joseph Olive, Emmanuel Ghent and Laurie Spiegal.

[18] This was done with the support and encouragement of Pierre Boulez, then director of the newly established IRCAM.

[19] Windows, Icons, Mouse, Pointers, Systems. The WIMPS design was popularized with the 1984 release of the Apple Macintosh. The release of the Macintosh computer was highly significant in the development of musical computation, editing processes and artistic applications, as the new graphical interface made the processing and editing of digital media highly attractive to users.

unprecedented levels of control over the evolution and combination of sonic events" (1993, 2). Coupled with significant progress in digital signal processing (DSP) implementations,[20] composers and engineers now had the tools to dramatically transform the nature of electronic composition.

3.2.2 IRCAM 4X Synthesizer

In 1981, The French research institute IRCAM (Institut de Recherche et Coordination Acoustique Musique/Institute for Research and Coordination of Acoustics and Music) launched the powerful 4X synthesizer. Developed by Giuseppi di Giugno, the 4X was a formidable machine capable of advanced digital signal processing and direct sound synthesis. The first large-scale work premiered with the 4X was Pierre Boulez's *Répons*.

> *Répons* is a significant milestone in terms of the pioneering frontiers of digital audio technology and the exploration of its creative potential at the time of composition… In particular it highlights the complex nature of the relationships that may be established between performers and their sound-producing agents in situations in which the acoustic results of their physical actions interact directly with external processes, preprogrammed to make context-dependent decisions of their own. (Manning 2004, 234)

Composed for orchestra, six soloists (piano, synthesizer, vibraphone, xylophone, cimbalom, harp), computer and six loudspeakers,[21] *Répons* featured sophisticated signal processing techniques for real-time spatialization not available to most composers during these early years.[22]

3.2.3 MIDI

Rapid expansions in music technology led to the development of commercialized products from various manufacturers. However, the varying hardware devices did not have a common 'language' with which to communicate, and users were often frustrated by the lack of compatibility of modules from different manufacturers. With the goal of establishing a universal standard for musical interaction between devices, the MIDI (Musical Instrument

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[20] DSP involves the alteration of a digital signal through real-time control of signal processing parameters, and/or changes in signal routing. Instrumental or vocal sounds can be processed using a variety of techniques such as filtering, pitch shifting, ring modulation, frequency modulation, amplitude modulation, chorusing, looping, nonlinear wave shaping, distortion, reverb, delay or spatialization.

[21] The soloists' music was processed and spatialized throughout the six speakers in the hall.

[22] The importance of *Répons* was recognized in 2000, when it was awarded a Grammy for best contemporary composition.

Digital Interface) protocol was established in 1983. Initially the brainchild of Dave Smith of Sequential Circuits, Ikutaro Kakehashi of Roland, and Tom Oberheim, MIDI was an impressive accomplishment in the commercial sector, as internationally competitive companies cooperatively joined together to create a global format for their products. Though limited in several aspects,[23] MIDI became an important platform for developments in interactive performance systems. The ability of computers to send and receive musical data in the form of MIDI messages formed an important bridge between computers and musical instruments. Proprietary hardware devices could now be interconnected to create custom-made portable interactive environments, and the usability and robustness of these systems in concert situations rapidly increased. Finally, though the low data transfer rate limited the representation of complex musical structures, it nevertheless allowed for real-time processing of musical information.

3.2.4 Score following

Vast improvements in processing speed in the early 1980s allowed technology to evolve towards a more sophisticated level of interactive composition, one in which the computer has the ability to *listen* and *respond* to ongoing musical events. In 1983, two separate researchers independently succeeded in improving human-computer interaction by developing score following techniques, effectively solving one of the principle barriers to effective interactive systems. Roger Dannenberg, working at Carnegie Mellon University, explored elements of score following based on trumpet performance. "For this purpose, he used a small transducer inserted in the mouthpiece of the trumpet to convert the acoustic signal into a digital function, passed to a real-time pitch analysis program" (Manning 384, 2004). Essentially a pitch tracker, Dannenberg's computer system was able to follow and synchronize the score with a soloist; his work was successfully demonstrated at the 1984 International Computer Music Conference in Paris, France. Separately, Barry Vercoe, affiliated with MIT[24] and IRCAM, was actively researching the same issue, and resultantly developed the Synthetic Performer with flutist Larry Beauregard. The Synthetic Performer

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[23] MIDI limitations include a low data transfer rate (bandwidth protocol), unidirectional communication between devices, and lack of control over subtle nuances of sound. Additionally, the development of MIDI for the keyboard interface has prevented (or made extremely difficult) non-keyboard gestures (e.g. MIDI divides the octave into 12 discrete half-step intervals, each assigned an integral number, making alternative divisions of the scale difficult to achieve).

[24] Massachusetts Institute of Technology

utilized optical tracking of Beauregard's flute fingerings supplemented with pitch tracking of the sounds generated, and demonstrated the ability to make musical decisions based on performer input (Chadabe 1997). The first major piece to implement Barry Vercoe's research by successfully synchronizing a pre-composed electronic score with a live performer was Philippe Manoury's *Jupiter* (1987), for solo flute and live electronics.[25] Attesting to its significance, Vercoe's Synthetic Performer went on to win the Computer World/ Smithsonian Award for Media Arts in 1992.[26]

3.3 Developments in interactive environments

The middle of the 1980s signified an exponential influx of developments related to interactive systems, as the pioneering efforts of Barry Vercoe and Roger Dannenberg were followed by the development of interactive compositional and performance software such as HMSL, M, Jam Factory, Interactor, Cypher, Kyma and Max.

3.3.1 HMSL

In the early 1980s, David Rosenboom, Larry Polansky and Phil Burk worked on the development of HMSL (Hierarchical Music Specification Language), an object-oriented programming language whose creation originated in discussions between Rosenboom, Polansky and James Tenney in the 1970s. "The development of HMSL had been… an immense effort… yet the three developers remained consistently noncommercial in their orientation. Their goal was more to encourage a community for experimentation than to develop a commercial package" (Chadabe 1997, 304). HMSL had considerable applications for interactive composition and improvisation, and was used extensively by Larry Polansky, notably to compose *B'rey'sheet* (1984) for voice and interactive computer system. Other composers who utilized HMSL to create electronic works include David Rosenboom, John Bischoff, Phil Burk, Nick Didkovsky, David Mahler and Jeane Parson.

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[25] Manoury's *Jupiter* also became the first piece to be composed using Miller Puckette's Max software, designed in 1986.

[26] As noted on the CSound website: http://www.csounds.com/vercoe/

3.3.2 David Zicarelli

Software designer David Zicarelli created numerous interactive algorithmic composition applications in the 1980s, including Jam Factory, M, and OvalTune. Jam Factory, conceived in 1986, was an attempt to construct an intelligent program skilled at improvising in a duet with MIDI input. Zicarelli's efforts continued during this period with the creation of M. Conceptualized and developed by Joel Chadabe and Zicarelli with the assistance of Antony Widoff and John Offenhartz, M was released by the research and development company Intelligent Music.[27] "A collection of algorithms, portrayed graphically on the computer screen and manipulated with particular graphic controls…" (Chadabe 1997, 317), M became the first commercially available real-time interactive compositional software, allowing the user to transform MIDI patterns on the computer screen and hear the results in real time. Zicarelli continued his exploration of interactive processes with the 1989 development of OvalTune, a MIDI program that enabled the composer to create graphics and music simultaneously by painting with a computer mouse.

3.3.3 Interactor

In 1986, Morton Subotnick and Mark Coniglio developed Interactor, interactive software capable of being utilized in numerous multimedia contexts. A preliminary version was used in the composition *Hungers* (1986), an electronic opera featuring video artist Ed Emshwiller and soprano Joan La Barbara. *Hungers* was performed by a singer, dancer, and three musicians, and allowed the singer to control video images through musical gesture.[28] Though La Barbara's voice was not electronically processed, the amplitude and timbre of her voice was controlled in real time by the computer as she alternated between multiphonics[29] and traditional singing.

Later compositions to utilize the Interactor software include Joan La Barbara's opera *Events in the Elsewhere* (1990), Subotnick's *The Misfortune of the Immortals* (1994-95), and *Intimate Immensity* (1997), also composed by Morton Subotnick. *The Misfortune of the Immortals*, a multimedia collaboration between La Barbara, Subotnick and Coniglio, is an

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[27] Owned by Joel Chadabe, Intelligent Music also released Jam Factory and a commercialized version of Miller Puckette's Max.

[28] La Barbara used sensors attached to her wrists, called air-drums, which transferred physical location data to the computer in the form of MIDI messages.

[29] Inherently softer in dynamics.

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"interdisciplinary interactive media opera for voices, dancers, actors, video projections (by Steina and Woody Vasulka), MIDI instruments and interactive computer systems allowing onstage performers to interactively control the theatrical environment."[30] *Intimate Immensity* is an interactive media poem written for Joan La Barbara and Thomas Buckner, utilizing a Balinese dancer, infrared light, and two video artists, whose images were choreographed and manipulated in real time.

3.3.4 Kyma

In 1984, Kurt Hebel and Lippold Haken, students at the University of Illinois at Urbana-Champaign, custom-designed and built Platypus, a digital signal processor for real-time audio. One year later, Carla Scaletti, also a student at the University of Illinois, wrote the first programming environment for the Platypus workstation, Kyma. Apple gave Scaletti a grant to design a graphical interface for Kyma in 1987, which eventually became known as the Kyma System, a visual programming language for sound design. In 1989, Scaletti and Hebel founded the Symbolic Sound Corporation as a vehicle for the production and distribution of Kyma, as well as other inventive software and hardware tools for sound.[31] Still in existence today, Kyma X is regarded as an industry standard for music production and cinematic post-production.[32] Vocal compositions using Kyma's interactive software include Steve Everett's *k A M* (1999), a two-hour interactive shadow play for actor, dancer, Javanese dalang (shadow puppeteer), psindhen (female vocalist), gamelan ensemble, western musicians, and video projection system, and Everett's *The Maiden Returns* (1994-95), a musical-poetry performance for soprano, two percussion, harmonica, readers, dancers, tape, Kyma, HMSL, and Max interactive computer systems.

3.3.5 Cypher

Pioneering interactive computer music developer Robert Rowe worked to increase musical intelligence within interactive systems (Dodge 1997). In 1987, he began the development of Cypher with the intent of creating an interactive instrument capable of

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[30] As noted on Joan La Barbara's website: http://www.joanlabarbara.com/comp.html

[31] That same year Hebel designed the Capybara to replace the Platypus.

[32] Kyma X is described on the company website as "an incredibly flexible and powerful sound design environment being used in music and post-production studios, research labs, art installations, game developers' studios, educational institutions, home studios, and live performances." As noted on the Symbolic Sound website: http://www.symbolicsound.com/cgi-bin/bin/view/Company/WebHome

analyzing what it heard, and producing an appropriate and interesting musical response. He assigned basic functions to the system, personified as 'Listener' and 'Player'. A live performer generated MIDI data, whereby the computer 'Listener' analyzed the data in various ways, qualifying the incoming data based on loudness, speed, and/or register, and then sending a message to the 'Player' based on this information, which accordingly generated a response. Rowe notes the following aesthetic benefits of a truly interactive system:

> Using processes for the generation of music moves the compositional act to a meta-level where the evolution of the music's character is controlled over time through the manipulation of a limited number of parameters… By delegating some of the creative responsibility to the performers and a computer program, the composer pushes composition up (to a meta-level captured in the processes executed by the computer) and out (to the human performers improvising within the logic of the work. (Rowe 1999, 84–85)

Compositions for Cypher include Rowe's *Maritime* (1992) for solo violin and interactive music system (performer Mari Kimura plays an electric Zeta violin, which outputs MIDI data into Cypher*)*, and *A Flock of Words* (1995) an intricate interactive piece involving instruments, animation, video, holography, and interactive computer system.[33]

3.3.6 Max

Though the aforementioned software products were an important step in the evolution of interactive systems, arguably the most significant contribution to a global development of interactive music was the creation of Max by Miller Puckette in 1986. A graphical, object-oriented programming language designed for interactive composition (Winkler 1998),[34] Max was initially created for the purpose of obtaining greater control of real-time signal processing applications for IRCAM's 4X synthesizer. Because of the inherent difficulties in programming the massive 4X hardware, Puckette designed Max as

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[33] Rowe has written numerous compositions for performer and interactive system dating back to 1986, when he composed *Hall of Mirrors* for bass clarinet and the 4X real-time system. Rowe's large-scale vocal work, *The Technophobe and the Madman* (2001), was composed for two singers, two pianos, bass, percussion and interactive music systems as a collaborative project between New York University and Rensselaer Polytechnic Institute. Additional contributors to *The Technophobe and the Madman* included Nik Didkovsky, Tyrone Henderson and Neil Rolnick.

[34] Object-oriented programs are built using modules of code, called class libraries. The tremendous advantage of building code with modules lies in the ability for the modules to be reused in other applications written in the programming language, as well as shared with other users. Over time, a very rich set of class libraries will become developed for a popular programming language.

control software for the 4X, to be utilized with the Macintosh platform.[35] Max was later developed by David Zicarelli for commercial applications, and released by Opcode Systems, Inc. Additional contributors included Corte Lippe, Lee Boynton and Zack Settel. The first piece to be composed using IRCAM's Max/4X system was Philippe Manoury's *Pluton* (1988), for solo piano and interactive electronics.

Max was eventually adapted for the IRCAM Signal Processing Music Work Station (ISPW), and greatly improved the processing power available to composers.[36] In addition to including a library of signal processing objects, Max, using a specially designed operating system entitled FTS (Faster Than Sound), was now equipped to influence significant processing and production of audio signals, controlling sampling, oscillators, delay lines, filtering, harmonizers, and pitch tracking. "The ISPW represented a flexible and powerful hardware environment, replacing the need for MIDI devices, with Max as a single unified 'front end' to control every aspect of music production" (Winkler 1998, 18). However, use of the incredibly powerful software was limited to the ISPW environment. Consequently, the aforementioned programmer David Zicarelli designed a commercial version of Max, which was released in 1991.

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[35] In essence, Puckette established the 4X as a massive MIDI control device. Puckette had previously worked with Barry Vercoe at MIT on the issue of score following, and was well versed in the challenges inherent to implementing a successful interactive music system.

[36] The ISPW was a hardware platform for digital signal processing developed at IRCAM in the late 1980s.

Chapter 4: Current trends in computer-based live electronics (1990-present)

4.1 Live versus interactive: defining terms

This chapter presents an overview of developments in live and interactive computer-based electronics over the past fifteen years. The terms *live* and *interactive* are often erroneously used interchangeably, with no clear differentiation made between the two.

> The terminology used in computer music is fluid and therefore often confusing… The terms 'real-time music', 'interactive performance', and even 'artificial intelligence' have been used and misused so often they have been rendered virtually meaningless as they have morphed into academic jargon. (Belet 2003, 306)

While the musical result of these genres often appears to be similar, the compositional process for each is distinct, and their performance preparation reflects these differences. The poetics of live electronics reflect a desire to *extend* human musical capability by transforming the performer's sound with technology, while the poetics of interactive music involve a collaborative, give-and-take relationship between performer and machine. The computer's ability to respond to performer input in an interactive system implies a level of "intelligence" on the part of the computer not present in live electronics or music for fixed medium.[37]

4.1.1 Live electronics

Live electronics with live performer – the subject of this thesis – designates a composition in which the instrumental sound and/or electronics are processed in real time. Real time refers to the computational speed by which computers receive and process data; a real-time operating system responds to input immediately, with minimal latency.[38] Live electronics normally involve real-time control of signal processing parameters, and/or changes in signal routing. Composers may utilize these elements to affect the sound of the voice using a variety of techniques such as filtering, pitch shifting (including harmonization, FFT

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[37] The expression *fixed medium* is used in lieu of "tape" to include playback from CD or computer hard drive, as well as tape.

[38] Delay in processing.

analysis/resynthesis, and granulation), ring modulation, frequency modulation, amplitude modulation, chorusing, looping, nonlinear wave shaping, distortion, reverb, delay, spatialization, or a myriad other possible digital effects.

4.1.2 Interactive electronics

Within the genre of live electronics, there exists a sub-genre called *interactive computer music*, defined by Winkler as:

> "…a music composition or improvisation where software interprets a live performance to affect music generated or modified by computers. Usually this involves a performer playing an instrument while a computer creates music that is in some way shaped by the performance. This is a broad definition that encompasses a wide range of techniques, from simple triggers of predetermined musical material, to highly interactive improvisational systems that change their behavior from one performance to the next. (Winkler 1998, 4)

The fundamental defining characteristic of interactive electronic music is the active–reactive reciprocal relationship between performer and computer; essentially, the performer and the computer engage in a musical dialogue. Using the voice as an example, this *dialogue* is initiated by the singer, who generates an acoustic signal that is picked up by a microphone and converted into a digital format. The computer interprets acoustic parameters of the signal (such as frequency or amplitude) using specialized software. A response is generated by the computer based on algorithmic parameters created by the composer, and the result is then played back through speakers. Metaphorically, the computer is listening and responding to the actions of the singer.

4.2 Levels of interaction

Three possible levels of interaction can be identified (Winkler 1998), and compositions can operate at one or several levels in the same piece. At the simplest level, the performer controls only one element, such as the triggering of sound files or establishing tempi. In Mauro Lanza's *Erba nera che cressi segno nero tu vivi* (1999-2001), for example, the soprano has control over certain temporal elements of the piece. She manages the duration and intensity of the numerous fermatas written in the score by triggering sound files using a hand-held device or foot-pedal to begin a new phrase following a fermata. However, other

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elements such as tempo and rubato are fixed. The structure of the electronics in *Erba nera* is similar to that of a composition for fixed medium, since all of the sound files are pre-composed, and the voice is not processed in real time. The temporal control afforded the performer, however, allows for interpretive variation between performances. At this first level of interaction, the system might also change its signal processing based on triggers from the performer. Subotnick's ghost box, discussed in Chapter 2, is an example of this kind of interaction

At the second level of interaction, the computer listens and *responds* in real time to the performer in a quasi-intelligent interpretation of the performer's input. In this instance, the sound and even structure of the composition can change dramatically from performance to performance, as the work is subjected to a vast array of interpretive decisions made by the performer. Philippe Manoury's *En Écho* (1993) was one of the first pieces composed for voice utilizing this level of interaction. In this composition, Manoury synchronizes the computer accompaniment and the vocal line with pitch tracking; the computer listens and analyzes the frequencies output by the singer, and matches them to a pre-programmed score using score following techniques. As the performer advances through the piece, the computer matches its output to the timing and interpretation of the singer's performance, just as a piano accompanist would. *En Écho* is fully interactive, following a chamber music model. As there is no conductor leading the piece, each 'performer' (which includes the singer, two sound technicians *and* the computer) must continuously listen and react to each other in order for the composition to be musically effective.

The final level of interaction is based on the properties of improvisation. The performer does not play from a pre-determined score, but instead melodically and rhythmically improvises while the computer responds "intelligently" in accordance. Jazz trombonist, composer and software developer George Lewis began exploring this degree of interaction in the late 1970s. Lewis is considered one of the early pioneers of the field, and is widely renowned for his interactive computer music software *Voyager* (1985-1987). In performance, *Voyager* 'listens' to Lewis's trombone improvisation and generates a musical response based on elements such as melody, harmony, rhythm, and ornamentation.

4.3 Aesthetics of live electronics

4.3.1 Introduction

There are a number of aesthetic considerations regarding the performance of works for computer-based live electronics, interactive systems, or fixed media.[39] Works for fixed media imply a certain degree of *inflexibility*; the electronic part is pre-recorded, and remains unchanged once completed. This presents several practical performance concerns. Once playback has begun, there is little room for rubato, dramatic pauses, or alterations in tempo. "The tape or other fixed electronic sound media is relentless and unforgiving as it simply plays on" (Belet 2003, 306). The rigidity of this genre does not allow for great variety of interpretation – over time the work may become static and dated. Conversely, within the spectrum of interactive composition, the music evolves and matures as the communicative relationship between human and computer grows (Rowe 1999). The remainder of this section provides an overview of the aesthetic approaches of a number of important figures in the field of computer music.

4.3.2 Guy Garnett

Composer Guy Garnett, currently a professor of composition and theory at the University of Illinois at Urbana-Champaign, argues for the importance and aesthetic relevance of live performers to computer music composition in his article 'The aesthetics of interactive computer music', published in the *Computer Music Journal*.[40]

> The inclusion of an active performer in one way or another re-introduces into computer music elements that had been almost entirely removed from computer and electronic music of the recent past. The first group of these aesthetic elements is brought about by the re-emphasis on human performance and human cognition that comes from working with a live performer. It is a re-emphasis in the context of music as a whole, where the performance element has played a large role since the beginning of musical time. However, it is a new emphasis for computer music, which has tended toward abstraction and objectivity, often with disappointing results. (Garnett 2001, 25)

Garnett explores intrinsic musical and humanistic qualities live performers bring to computer music, including gestural nuance, physical and cognitive restraints, and inherent

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[39] The term *fixed media* is used in lieu of tape music.

[40] In this article, Garnett does not differentiate between *live* and *interactive*, instead defining interactive computer music as a sub-genre of what he calls "performance-oriented computer music", ostensibly in contrast to purely algorithmic composition, acousmatic music, and music for fixed medium.

variability.[41]   Unlike acousmatic or fixed medium works that remain temporally and interpretively fixed, live electronic music is subject to variation with each performance, and the interpretation of the work can evolve through time.

> Since the work is not fixed, it is open to new interpretations, and therefore the possibility at least exists for the growth of the work over time or across cultural boundaries. The work can thus maintain a longer life and have a broader impact culturally, because it is able to change to meet changing aesthetic values. (Garnett 2001, 27)

Garnett is currently composing a cyber opera entitled *The Death of Virgil*, based on the novel by Hermann Broch, which incorporates singers, instrumentalists and technology in a meditation on life, love and art.[42]

4.3.3 Todd Winkler

Composer and multimedia artist Todd Winkler, currently on the faculty of Brown University, further explores the symbiotic nature of interactive music in his book *Composing interactive music: techniques and ideas using Max.*

> Using the techniques of interactive composition, elements of a live performance can be used to impart a human musical sense to a machine, forming a bridge to the musical traditions of the past through the interpretation of expressive information. At the same time, the computer opens up new possibilities for musicians to expand their abilities beyond the physical limitations of their instrument. (Winkler 1998, 8)

Winkler also comments upon the relevance of the audience's perception and understanding of the interactive process.

> Live interactive music contains an element of magic, since the computer music responds "invisibly" to a performer. The drama is heightened when the roles of the computer and performer are clearly defined, and when the actions of one has an observable impact on the actions of another, although an overly simplistic approach will quickly wear thin. On the other hand, complex responses that are more indirectly influenced by a performer may produce highly successful musical results, but without some observable connection the dramatic relationship will be lost to the audience. (Winkler 1998, 9)

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[41] Gestural nuances refer to interpretive subtleties such as rubato, phrasing, dynamic contrast, and articulation, while physical and cognitive restraints delineate the "performability" of the music, suggesting that what is cognizable to the performer is also more capable of being grasped by the listener. "Constraining music to what is cognitively graspable, without confining it to what is already cognitively grasped, brings about a more realistic compositional attitude which in turn leads to more successful works" (Garnett 2001, 26). Finally, inherent variability characterizes the work's changeability over time.

[42] As noted on Garnett's website: http://cultural.cs.uiuc.edu/~garnett/

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Winkler's work explores various ways human actions can affect sound and images. He composes for interactive video instillations, dance productions, and live computer-based electronic performance.[43]

4.3.4 Robert Rowe

Robert Rowe, composer and inventor of the interactive software Cypher, and currently a professor at New York University, further outlines difficulties inherent to the presentation of fixed media (tape) with live performer.

> Works for performers and tape have been an expression of the desire to include human musicianship in computer music compositions. Coordination between the fixed realization of the tape and the variable, expressive performance of the human players, however, can become problematic. Such difficulties are more pronounced when improvisation becomes part of the discourse. And, as taped and performed realizations are juxtaposed, the disparity between levels of musicality evinced by the two often become untenable. (Rowe 1993, 5)

In support of interactive systems, Rowe states that this level of composition inspires the exploration of new technologies and opens up new compositional domains while simultaneously encouraging collaboration between humans and computers (Rowe 1999).

4.3.5 Jean-Claude Risset

At the other end of the aesthetic spectrum, Jean-Claude Risset, French composer and early pioneer of digital synthesis, spiritedly defends music for fixed medium. He describes the importance of the compositional process as one requiring time and space as requisite elements, and cautions against the prevailing modern day enthusiasm and commitment towards real-time systems:

> Composition is not – or should not be – a real-time process. Musical notation applies time over space. It refers the reality of the music to a representation – the score – which is out of time. This representation suggested transformations that could not be conceived or performed in real-time – such as symmetries with respect to the pitch or the time axis used in counterpoint. Non real-time operation is necessary to free oneself of the arrow of time and its tyranny, of the dictates of haste, instancy, habits, [and] reflexes. (Risset 1999, 37)

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[43] As noted on Winkler's website:
http://www.brown.edu/Departments/Music/sites/winkler//bio/index.html

Citing limitations in compositional complexity and a less flexible control of sonic parameters, Risset additionally underscores the problem of portability in real time composition. He notes that the continuous progression of technology resulting in new operating systems, upgraded software, and new modes of composition can contribute to an ephemeral quality of many real-time works. The effort involved in porting a piece onto a new operating system is considerable, and Risset notes a troubling tendency of composers to spend their energy producing a new piece rather than adapt an older piece to a new system. "This situation leaves no chance to develop traditions for performance or to let musical works become classics. It brings the risk of a perishable, memoriless electronic art" (Risset 1999, 35). Regardless of the compositional benefits Risset affords to music created for fixed media, current trends remain focused on the production of works with live electronics. Ironically, fixed media pieces generally have greater longevity, as they are relatively easy to reproduce, while live electronics often require continuous adaptation to new and updated software. Interactive pieces have proven to be the most difficult works to sustain throughout time and technological developments; it is common for an interactive work to experience only a limited number of performances.

4.4 An important tool: Max/MSP

Interactive performance systems are defined as a composition/performance environment consisting of a combination of hardware devices and software that enable the computer to listen and respond to the performer in real time. Such performance systems can be used to present music, video, and lighting controlled by sonic elements (musical performance) or physical elements (dance).[44] When performing a live or interactive work, a basic functional understanding of the interactive system is highly recommended, though detailed knowledge of the software is not necessary. While numerous compositional software environments exist, including Logic, SuperCollider, CSOUND, Ableton Live,

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[44] John Cage and Merce Cunningham are credited with creating the first interactive dance work, *Variations V* (1965).

Cypher and Kyma X,[45] I will limit this discussion to arguably the most relevant performance system, Max/MSP, and its open source relative, Pure Data.

MSP is an additional component of the original Max protocol discussed earlier in this thesis.[46] The combination of Max and MSP forms an object-oriented graphical programming environment used for interactive music and multimedia applications (Winkler 1998). An additional video processing subsystem, Jitter, was added to Max/MSP in 2003. "Jitter extends the Max/MSP programming environment to support real-time manipulation of video, 3D graphics and other data sets within a unified processing architecture."[47] Both Max/MSP and Jitter are currently distributed by the San Francisco based company Cycling'74, and remain the standard software for interactive performance and instrument design, utilized in universities and compositional studios throughout the world.
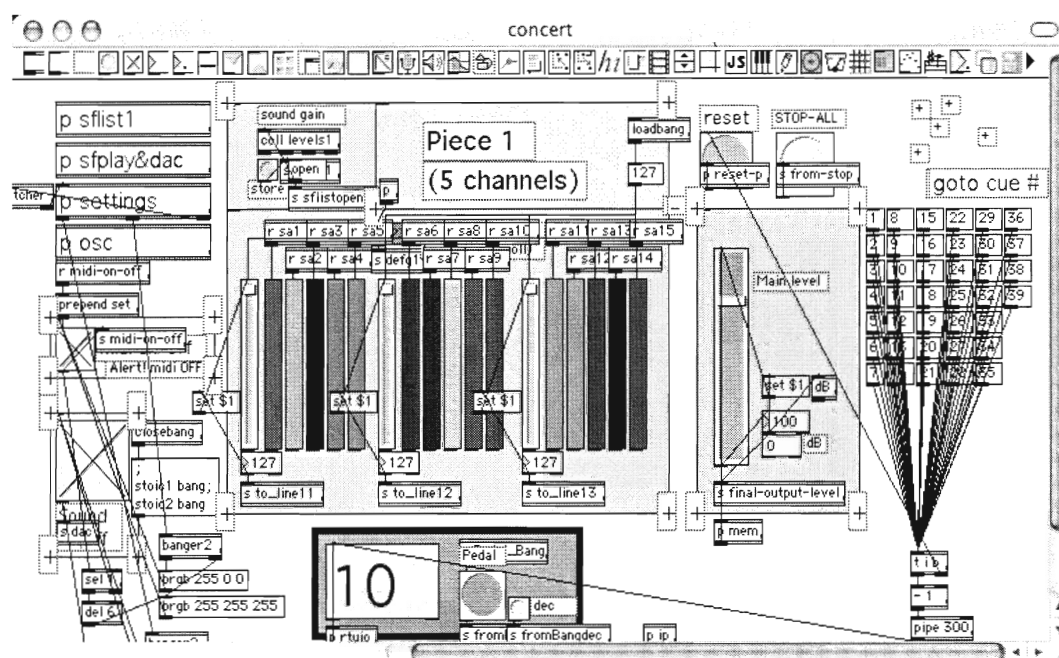
Example 4.1 Max patch for Mauro Lanza's *Erba nera che cresci segno nero tu vivi*

Pre-dating the release of Max/MSP, Puckette created Pure Data (Pd), an open source programming language used for multimedia works and interactive computer music. The Pd software was designed to provide the indispensable features of the earlier developed

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[45] Chapter 3 outlines the historical background of Cypher and Kyma.

[46] The original Max protocol was designed by Miller Puckette in the 1980s at IRCAM, with a commercial version developed by David Zicarelli, and released by Opcode in 1990.

[47] As noted on the Cycling'74 website: http://www.cycling74.com/products/jitter

Max and FTS while addressing various shortcomings of the original Max blueprint. Additionally, Pd contains several potent capabilities, particularly the ability to integrate video processing and 3-D graphics into the established audio synthesis and signal processing design, creating a unified multidisciplinary work environment.

4.5 Important contributors to the field of live and interactive electronic music performance

4.5.1 Overview

From the early days of cutting and splicing tape, technological advances have continued to influence compositional techniques. Many composers who experimented with tape and electronic sounds naturally evolved their composition style towards works for live electronics. This section will present an overview of important contributors to the field of live and interactive electronics over the past fifteen years, including composers, performers, and research centers. The discussion of composers is limited to important figures not previously mentioned in this thesis.[48]

4.5.2 Luciano Berio

Luciano Berio, regarded as one of the giants of the 20th century, was a founding member of the post-war European avant-garde as well a pioneer in the evolution of electronic music. In 1987, Berio founded the Italian Centro Tempo Reale in Florence.[49] His objective was to create "a structure in which to investigate the possibilities of real-time interaction between live performance and programmed digital systems" (Giomi 2003, 30). Heavily influenced by his relationship with famed contemporary music soprano Cathy Berberian, Berio created a large catalogue of vocal compositions throughout his life. Perhaps in reaction to the purely electronic experimentation of the Cologne school and its subsequent followers, Berio strongly advocated the use of technology as a means to extend and augment human expression. His primary concern was "the creation of a homogenous path between acoustic sources on the one hand (voices and instruments) and electroacoustic

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[48] For an in-depth look at composers of live electronic vocal music, see Appendix B.
[49] Prior to the creation of Tempo Reale, Berio was director of IRCAM's electroacoustic program from its inception until 1980.

sources on the other (live electronics)" (Giomi 2003, 32). To this end, Berio was not interested in the creation of new sounds, and generally neglected the trends of complex algorithmic composition,[50] instead preferring relatively straight forward techniques such as harmonization, delay, sampling, and spatialization to achieve his compositional goals.

Among the numerous works realized by Berio at Tempo Reale are several important vocal compositions, including *Ofanìm* (1988), *Outis* (1996), *Altra voce* (1999), and *Cronaca del luogo* (1999). *Ofanìm,* composed for two children's choirs, two instrumental groups, female voice, and live electronics, utilizes sound spatialization and electronic amplification to achieve an amalgamated acoustic result (Giomi 2003). *Outis* is a large-scale opera composed for 19 soloists (instrumentalists and vocalists), a separate vocal group of 8 singers, chorus, orchestra, and live electronics. Composed for the architectural structure of the famed *Teatro alla Scala* (La Scala), Berio sought to create, in his words, "an acoustical dimension... which no longer corresponds to that of the orchestra pit."[51] In order to accommodate his amplification and diffusion systems to the hall, Berio placed loudspeakers strategically throughout the theater, including inside the main chandelier situated in the center of the ceiling.[52] *Altra voce,* for mezzo-soprano, contralto flute and live electronics, sought to liberate the voice and flute and develop "their respective autonomies and harmonic premises" through the use of live electronics.[53] Finally, Berio's opera *Cronaca del luogo* utilizes multimedia interactive systems for on stage real-time movement analysis, and control of sound synthesis and live electronics.[54]

4.5.3 Jonathan Harvey and Simon Emmerson

There are several important British composers of live and interactive electronic compositions, including Jonathan Harvey (b.1939) and Simon Emmerson (b. 1950). Harvey began working at IRCAM in the 1980s at the request of Pierre Boulez. Amongst his vocal compositions are *Inquest of Love* (1992), a full opera with live electronics, and *One Evening*

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[50] Interestingly, though not uncommon to electronic composers, Berio did not maintain the facility to program his own electronics, instead relying upon technicians to interpret and engineer his instructions. One can conjecture whether or not he would have shown a greater interest towards interactive compositions were the technology more readily accessible during this time period (Max/MSP was released in 1997, just six years prior to his death in 2003).

[51] As noted by Giomi (2003, 41).

[52] Berio later adapted the setup of *Outis* for the Théâtre du Châtelet in Paris in 1999.

[53] Ibid.

[54] As noted on the InfoMus Lab Website. http://www.infomus.dist.unige.it/Events/CronacaDelLuogo.html

(1994) for soprano, mezzo soprano, chamber ensemble, real-time devices, and signal processing. In his article 'The metaphysics of live electronics' published in *Contemporary Music Review*, Harvey states:

> With live electronics… two worlds are brought together in a theatre of transformations. No-one listening knows exactly what is instrumental and what is electronic anymore. Legerdemain deceives the audience as in a magic show… When they lack their connection to the familiar instrumental world electronics can be inadmissibly alien, other, inhuman, dismissable (like the notion of flying in a rational world). When electronics are seamlessly connected to the physical, solid instrumental world an expansion of the admissible takes place, and the 'mad' world is made to belong. (Harvey 1999, 80)

Simon Emmerson is a noted British composer and author of numerous books and articles concerning live electronic music, including *Music, Electronic Media, and Culture* (2000), and *The Language of Electroacoustic Music* (1986). Emmerson's electronic vocal works include *Ophelia's Dream II* (1979) for six singers and electronics, *Songs from Time Regained* (1988) for soprano, ensemble and electronics, and *Sentences* (1991) for soprano and live electronics.

4.5.4 Kaija Saariaho, Philippe Leroux, Philippe Manoury

Several continental European composers have contributed importantly to the maturing repertory of live electronic music. Finnish composer Kaija Saariaho (b. 1952) has lived and worked in Paris since 1982, the year she attended computer music courses at IRCAM.[55] Known for her elegant vocal writing, Saariaho's exquisite *Lohn* (1996), for soprano and live electronics, premiered at the 1996 Wien Modern Festival and was subsequently recorded by soprano Dawn Upshaw. In this work, Saariaho intricately intersperses pre-recorded vocal material and concrète sounds (birds, wind, rain) synthesized and processed with AudioSculpt and CHANT (both IRCAM software).[56] Saariaho went on to compose the electronic opera *L'Amour de loin*, which premiered in 2000 at the Salzberg Festival, directed by Peter Sellers and conducted by Kent Nagano.[57]

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[55] Since this time, Saariaho has interwoven electronics into many of her most successful compositions.

[56] AudioSculpt (based on the phase vocoder analysis/resynthesis engine), allows composers to easily modify spectral information with an easy-to-use graphical interface. Composers may utilize techniques of cross synthesis, filtering, and expansion/compression of time using only the mouse (i.e. no complicated programming techniques are required). CHANT has become a highly utilized real time synthesis vehicle, and is one of the main products of the Max/MSP library.

[57] Many of Saariaho's works have been performed as visual concerts, designed and realized by her husband, Jean-Baptiste Barrière. More information can be found online: http://www.petals.org/Petals.html

French composer Philippe Leroux (b. 1959), a student of Pierre Schaeffer, Olivier Messiaen and Iannis Xenakis, can be considered one of the most significant French composers of electronic music. *Voi(REX)*, composed in 2002 and premiered by French soprano Donatienne Michel-Dansac, is quickly becoming a classic in the repertoire, and has been performed in Paris, Montreal, San Francisco and New York. In 2006 Leroux completed *Apocolypsis* for four voices, fifteen instruments and electronics, one of the largest works in his oeuvre to date.

> Apparently indifferent to the concept of silence as the expression of vacuity, Leroux's music makes sound itself its very essence - not in a contemplative or dramatic manner, but always in movement. This perpetual flux (give Heraclitus his due) speaks of the appearing and disappearing of sound, but mostly of the necessary nurturing process that allows it to evolve. This music may go for velocity over virtuosity - yet it is not without risk. More interested in intervals than in pitches or particular notes, it surrenders to the playful, almost mischievous, interplay of [combinations] - music morphing ad infinitum - but never at the expense of its performers, whom it intend to glorify.[58]

Philippe Manoury is widely regarded as one of the most important contributors to the oeuvre of interactive electronics, and is historically significant in having composed both the first piece for Puckett's Max software, *Jupiter* (1987), and one of the first interactive vocal compositions, *En Écho*.[59] "Both of these works are some of the most sophisticated and compelling electronic compositions realized in the late 1980s and early 1990s, a period during which IRCAM was actively developing innovative software and hardware for electronic music."[60] In addition to *En Écho*, Manoury has composed several important large-scale electronic vocal works, including three operas. *60e Parallèle*, composed from 1995-1997, was originally titled *La Nuit du Sortilège*. Written for voices, large orchestra, and electronic sounds, it premiered at the Théâtre du Châlet in 1997. *K...* was commissioned and premiered by the Paris Opera in 2001, and is a work in twelve scenes for voices, orchestra, and real-time electronics. The text was written by Bernard Pautrat and André Engel, and is derived from Franz Kafka's *Der Prozess*. Manoury's most recent opera, *La Frontière,* a chamber work for six singers, nine musicians and real-time electronics, was composed in 2003. That same year he composed *Noon* as the composer-in-residence for the

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[58] As noted on the Gérard Billaudot Éditeur website: http://www.billaudot.com/ english/compo_lero.html
[59] A detailed discussion of Manoury's *En Écho* occurs in Chapter 6.
[60] As noted on the Electronic Music Foundation website:
http://www.emfproductions.org/year0506/manoury.html

Orchestre de Paris. *Noon* is a large work for soprano, choir, orchestra, and real-time electronics based on a text of Emily Dickenson.

4.5.5 Luca Francesconi, Fausto Romitelli and Mauro Lanza

Italy has recently born several electronic composers of historical importance in addition to twentieth-century giants Luigi Nono, Luciano Berio and Bruno Maderna. Luca Francesconi (b. 1956) studied composition with Berio and Stockhausen, and founded the musical research center *Agon Acustica Informatica Musica* in 1990.[61] Among his vocal electronic compositions are *Etymo* (1994) for soprano, chamber orchestra and electronics on a text of Charles Beaudelaire, *Lips, Eyes, Bang* (1998) for actress/singer, twelve instruments, and audio-video tape in real time, *Ballata* (2002), a two-act opera based Samuel Taylor Coleridge's *Rime of the Ancient Mariner'* and *Atopia* (2005), an interactive opera project utilizing the temporal and spatial elements inherent to Spanish painter Diego Velázquez's *Las Meninas*.[62]

Fausto Romitelli (1963-2004) sought to integrate elements of techno, rock, European traditionalism and the French spectral school into his compositions.

> At the centre of my composing lies the idea of considering sound as a material into which one plunges in order to forge its physical and perceptive characteristics: grain, thickness, porosity, luminosity, density and elasticity. Hence it is sculpture of sound, instrumental synthesis, anamorphosis, transformation of the spectral morphology, and a constant drift towards unsustainable densities, distortions and interferences, thanks also to the assistance of electro-acoustic technologies. And increasing importance is given to the sonorities of non-academic derivation and to the sullied, violent sound of a prevalently metallic origin of certain rock and techno music.[63]

One of Romitelli's most know works, *In EnTrance* (1995-96) was written for soprano, ensemble and electronics, utilizing a mantra from the Tibetan Book of the Dead.[64] *An Index of Metals* (2003), the last work completed before his tragic death from illness, is a video opera composed for soprano soloist, ensemble, multimedia projection and electronics.

Finally, one of the youngest yet most prolific Italian contemporary composers is Mauro Lanza. Employed at IRCAM as a research composer and teacher since 1999, Lanza's most profound vocal work is a cycle of pieces titled *Nessun suono d'acqua*, a large-scale

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[61] As noted on the Ricordi website: http://www.ricordi.com/Compositori/Dettaglio.asp?IdCompositore=169
[62] *Las Meninas*, painted in 1656, is currently on display at the Prado Museum in Madrid, Spain.
[63] As noted on the Ricordi website: http://www.ricordi.com/Compositori/Dettaglio.asp?IdCompositore=298
[64] Ibid.

multimedia work for voice, ensemble, electronics, new instruments and multiple video projections. *Nessun suono d'acqua* (which translates as "No water sound") is comprised of four vocal pieces, based on Amelia Rosselli's *Prime Prose Italiene*. The cycle includes *Barocco* (1998-2003) for soprano and toy instruments (6 players), *Erba nera che cresci segno nero tu vivi* (1999-2000) for soprano and live electronics, *Mare* (2004) for soprano, small ensemble, toy instruments and live electronics, and *Cane* for soprano, ensemble, toy instruments and electronics. *Cane* is a commission of the McGill Digital Composition Studios with the assistance of the Daniel Langlois Foundation, and is scheduled to be premiered in March 2007 during the Montreal *New Music International Festival.*[65]

4.5.6 North American composers

Important North American composers of live and interactive vocal electronic music not yet mentioned include Zack Settel (b. 1957, New York), Bruce Pennycook (b. 1949, Toronto), Laurie Radford (b. 1958, Manitoba), and alcides lanza (b. 1929, Argentina). Settel studied with Morton Subotnick at the California Institute of the Arts, and was employed by IRCAM as a musical assistant until 1995, where he assisted Puckette in the development of MAX.[66] He composed *Hok Pwah* (1993) for soprano, percussion and live electronics, as well as *L'enfent des glaces* (2000), an electroacoustic opera with real-time vocal processing conceived by soprano Pauline Vaillancourt.[67]

Bruce Pennycook received his DMA in Musicology from Stanford University, California, where he studied under John Chowning and Leland Smith. Following his return to Canada, Pennycook founded a research center for music and technology at Queens University, Ontario. One of his most important works is *Praescio I-VIII,* a series of interactive compositions in which each piece focuses on a different instrument. *Prascio II* (1989) for soprano, chamber ensemble and interactive system, utilizes the poetry of Canadian author Tessa McWatt.

Laurie Radford, noted for his significant output of electronic, electroacoustic and instrumental works, has composed interactive works with live computer-controlled signal processing of both audio and video. Radford's works for voice and electronics include *in the*

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[65] A detailed discussion of Lanza's *Erba nera che cresci segno nero tu vivi* occurs in Chapter 6.

[66] Cort Lippe also assisted in the development of Max.

[67] A DVD performance of *L'enfent des glaces* was released in 2006 by the Montreal contemporary opera company *Chants Libres* on Atma Classique.

angle (1998) for soprano, Bb clarinet, violin, piano, and digital signal processing, *of circles and seconds* (1999) for soprano, soprano saxophone or Bb clarinet, violincello, percussion, and digital signal processing, and *I was struggled...!* (2002) for voice/actor, piano, electroacoustic music, and digital signal processing.

alcides lanza became a naturalized Canadian citizen in 1976. Prior to this he worked with Vladimir Ussachevsky at the famed Columbia-Princeton Electronic Music Center under a Guggenheim fellowship. lanza went on to become director of the McGill University Electronic Music Studio, and in 1983 founded *The Group of the Electronic Music Studio* (g.e.m.s.) at McGill with Claude Schryer and John Oliver.[68] He has composed several works for voice and live electronics, including the song cycle *Trilogy: Ekphonesis V* (1979), *Penetrations VII* (1972), and *Ekphonesis VI* (1988), written for actress-singer, lights, electronic sounds (tape), and electronic extensions. lanza also composed *vôo* (1992), for acting voice, electroacoustic music and digital signal processors. Both compositions were written for his wife, singer-actress Meg Sheppard.

4.6 Performers of vocal electronic music

Few vocal performers devote their entire lives to electronic music. Those that do are endowed with extraordinary musical and vocal abilities. As discussed in Chapter 2, Joan La Barbara is one of the most important contemporary vocalists of the twentieth century, renowned for her unique vocal styles and the development of what have become her signature vocal techniques. Her collaborations with husband Morton Subotnick, as well as her own compositional output has resulted in the creation of a wide diversity of works for live and interactive electronics and extended vocal techniques. La Barbara continues to perform extensively with electronics, and is a featured composer at 2007 Santa Fe Electronic Music Festival. She is also involved in *The Human Voice in a New World*, a series of

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[68] "The ensemble has presented numerous concerts of all genres of contemporary music, acoustic, electroacoustic, interactive live-performance, music theatre and multi-media. Many of the works premiered by g.e.m.s. during its fifteen consecutive seasons have been major international prize-winners and have been performed at Contemporary Music concerts and festivals in Canada, the USA, Europe, South America and Japan." As noted on the McGill University website. http://www.mcgill.ca/music/organizations/#GEMS

performances for voice and interactive electronics sponsored by the Electronic Music Foundation.[69]

Though not a traditional singer, Laurie Anderson is a renowned performer of spoken word. She first experimented with stereo spatialization of her voice in *Stereo Song for Steven Weed* (1977). This piece utilized two microphones and two speakers placed on opposing sides of a small performance space – Anderson then explored conversational gestures in a public self-personified dialogue. She subsequently began to incorporate more sophisticated electronic effects into her performances, using a vocoder in her 1981 piece *O Superman*. Anderson's spoken prose is often more politically oriented, although her vocal processing and affectations explore roles of gender ambiguity and duality (she often uses two microphones, one to represent the 'female voice' and one to represent the 'male voice'). In the 1990s she toured *Stories From the Nerve Bible*,[70] a multimedia work discussing the Gulf War 'syndrome'.[71] Anderson is currently performing *The End of the Moon*, the second piece in an epic trilogy exploring American society and culture. In 2003 Laurie Anderson became the first artist-in-residence at NASA (an interesting post due to her politically outspoken performances speaking against the Gulf War). "The End of the Moon", which coupled as her final report for her research at NASA, is comprised of music for spoken voice, violin and electronics. In Anderson's words, this piece "looks at the relationships between war, aesthetics, the space race, spirituality and consumerism" (Anderson 2006).

French soprano Donatienne Michel-Dansac has collaborated with composers from IRCAM since 1993, premiering numerous works by Philippe Manoury, Luca Francesconi, Fausto Romitelli, Mauro Lanza, Georges Aperghis, and Philippe Leroux. Michel-Dansac regularly sings with ensembles throughout Europe, including the Tapiola Orchestra of Helsinki, the London Sinfonietta, the Orchestre National de France, and the Orchestre Philharmonique de Radio-France. Other notable vocalists who promote electronic music

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[69] Other vocalists involved in this festival include Golan Levin, Thomas Buckner, Earl Howard, David Wessel, Zachary Lieberman, Jaap Blonk, Paul Botelho and David Moss.

[70] In the video *The Sensual Nature of Sound,* Anderson states that the concept of the 'Nerve Bible' represents the essence of the physical body.

[71] In this piece, Anderson conversed about the American public's overt patriotism for the Gulf War, citing the glorification of guns and other weapons of mass destruction.

include Dutch composer/vocal performer/sound poet Jaap Blonk, Canadian soprano Barbara Hannigan, and American sopranos Tony Arnold and Juliana Snapper.[72]

Extending the realm of vocal sonic experimentation, Pamela Z and Franziska Baumann are among a special class of performers who utilize electronic body instruments to accentuate and extend their vocal capabilities. San Francisco based composer/performer/audio artist Pamela Z uses The BodySynth™, a specially designed MIDI controller created by Chris Van Raalte and Ed Severinghaus. The BodySynth™ senses muscular energy generated by the body's muscles, and then translates the information into MIDI data.[73] Pamela Z combines elements of the *bel canto* style, extended vocal techniques, and spoken word, and processes her voice in real time with MAX/MSP software.

Swiss composer/vocalist/flutist Franziska Baumann specializes in live vocal electronics in addition to sound installations and theater music. As an artist-in-residence at STEIM (Studio for Electronics and Interactive Musicians), she developed an interactive SensorLab-based cyberglove that she wears on her right arm, enabling her to sculpt her voice in real time.[74]

4.7 Important research and production centers

In creating and mounting technologically complex computer-based electronic works, an affiliation with a major research institution in this field is of great benefit (even necessity) for performers and composers, as these institutions maintain the infrastructure, expertise, and financial backing to produce major projects. One of the most important institutions for scientific research of music and sound is IRCAM, located in Paris, France, founded in the 1970s by Pierre Boulez (at the request of the French President Georges Pompidou). Though Boulez was in charge of the Center from its opening in 1977, numerous important figures in the electronic music scene were involved at the administrative level, including Luciano Berio, Jean-Claude Risset and Max Matthews. The establishment of IRCAM paved

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[72] Juliana Snapper performed the American premiere of Manoury's *En Écho* at the Sounds French Festival (New York), and continues to perform the work throughout the United States. She has sung at Stanford University, the San Diego Museum of Art, and the Electronic Music Foundation series (presented in cooperation with New York University).

[73] As noted on Pamala Z's website: http://www.pamelaz.com/bodysynth.html

[74] As noted on Franziska Baumann's website: http://www.franziskabaumann.ch

the road for the creation of numerous other private and public research facilities throughout the world.

The aforementioned STEIM, established in 1984, is located in Amsterdam, Netherlands, and focuses on the research and development of instruments and tools for performers in the electronic arts.[75] Other European institutions include: NOTAM – Norwegian network for Technology, Acoustics and Music (Oslo, Norway); DIEM – Danish Institute for Electroacoustic Music (Denmark); CRM – Centro Ricerche Musicali (Rome, Italy); IEM – Institut für Elektronische Musik und Akustik (Graz, Austria); and La Kitchen – Center for Research and Development of Interactive Tools (Paris, France). Several European universities of note include University of York (U.K.), Birmingham University (U.K.), De Montfort Univerity[76] (Leicester, U.K.), Pompeu Fabra University (Barcelona, Spain), Queen's University (Belfast, Ireland), and the University of Helsinki (Finland).

North American research centers are primarily situated in academic settings, and include: CCRMA – Center for Computer Research in Music and Acoustics (Stanford University, California); McGill University's Digital Composition Studio and CIRMMT – The Centre for Interdisciplinary Research in Music, Media and Technology (Montreal, Canada); MIT Media Lab (Cambridge, Massachusetts); CNMAT – Center for New Music and Audio Technologies (University of California, Berkeley); CREATE – Center for Research in Electronic Art Technology (University of California, Santa Barbara); and CRCA– Center for Research in Computing and the Arts (University of California, San Diego).

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[75] As noted on STEIM's website. http://www.steim.org/steim
[76] As of 2004, Simon Emmerson has been on faculty as Professor of Music, Technology and Innovation.

Chapter 5: Performance

5.1 Overview

There are several practical issues related to the performance of computer-based electronic music, including selecting an appropriate work, obtaining the score and other materials, learning the piece, ensuring the technical setup, and rehearsing with the electronics. Contemporary vocal music often contains virtuosic writing and extended techniques. As modern compositional aesthetics seem to celebrate an exploration of *extremes*, that of dynamics, range, color and extended techniques[77] (the vocal works of Anton Webern, Luciano Berio and George Crumb serve as excellent examples of this). While these aesthetics generate exciting contrasts in the music, proper execution requires tremendous technical skill. Singers approaching this repertoire should be experienced performers with a robust and healthy voice, and maintain a strong fundamental understanding of breath, support, resonance and phonation. Such a singer must also possess excellent musicianship skills, and a natural curiosity that seeks to explore new and exciting artistic directions.[78]

5.1.1 Vocal readiness

In this chapter I will present a step-by-step methodology for learning contemporary vocal music, based upon my personal experience as a performer of this repertoire, as well as conversations with contemporary vocalists Joan La Barbara, Lucy Shelton, Rosemary Hardy and Ingrid Schmithüsen.[79] An understandable hesitation exists among some vocal pedagogues regarding the possibility that contemporary vocal performance may inflict harm upon the voice (Miller 1986). The technical challenges of contemporary vocal repertoire are similar to the difficulties present in the operas of Richard Wagner. Just as one should not venture to sing the *Liebestod* from *Tristan und Isolde* without adequate training and vocal maturity, one should not approach virtuosic contemporary repertoire without a similar level

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[77] Appendix A contains a brief history and description of extended vocal techniques.

[78] Inappropriate repertoire selection and indiscriminate practicing can endanger the voice, possibly causing long-term vocal harm. I strongly recommend that initial exploration of contemporary music be done under the supervision of a contemporary vocal specialist.

[79] The reader is encouraged to explore the many wonderful CD's these vocalists have produced.

of preparation and training. It is also important to note that only certain voices are suited for this type of repertoire. Singers *must* be discriminatory in the repertoire they perform – one must know one's capabilities and limits, and only commit to singing music well suited to the individual voice. That being said, it is also important to distinguish difficult, virtuosic repertoire that is *well written* for the voice, from that which is *poorly* written for the voice.[80] A tremendous advantage of singing new music, however, is the potential for collaboration with the composer, which can result in alterations of the vocal writing if necessary. In this relationship, singers must learn to express their vocal concerns in a positive and productive way, while composers should be receptive to any constructive criticism offered.[81]

5.1.2 Principles of the Italian *bel canto*

In tying together my personal observations with the opinions of seasoned professionals, a clear consensus has emerged: excellent singing based on the teachings of the Italian *bel canto* school[82] coupled with diligent care of the instrument, will serve to ensure vocal longevity. The fundamental principles of the Italian *bel canto* school, including *appoggio*, the 'noble stance', and *chiaroscuro*, lay an important foundation towards vocal health, and are applicable towards both traditional classical singing and contemporary singing. *Appoggio*, from the word *appogiare* (to lean against), describes the Italianate concept of 'support', and is a pedagogical philosophy that embraces a total equilibrium of the vocal mechanism, spanning from the initial intake of breath to the subsequent production of sound. "[The] breath is purposely retained longer by not inducing emission through the use of inward abdominal force" (Miller 1997, xxiii). Discussion of this technique first appeared in pedagogical writings of the late nineteenth-century.[83] Physiologically, *appoggio* can be related to elevated subglottal pressure, and is inherently related to the concept of the 'noble stance', a posture which entails a moderately raised sternum and elongated back, and is important for

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[80] Works that are vocally well written tend not to exhaust a singer's tessitura, demand excessively fatiguing extended sounds, or lay predominantly at the extremes of the vocal range.

[81] It is worthwhile to note that Mozart and Händel often composed music based upon a specific singer's capabilities. Modern collaboration with composers continues this tradition.

[82] *Bel canto*, a highly nuanced term, broadly refers to the development of virtuosic singing techniques in the Italianate operatic style.

[83] Discussions of *appogio* followed the early writings of Manuel Garcia II with the publications of Dr. Louis Mandl (1886) and Francesco Lamperti (1884). It is important to note that the pedagogical teachings of Garcia II were based upon the music Mozart and Rossini, while Lamperti taught to the operas of Meyerbeer, Verdi and Wagner, music which required stronger breath support in order to create a larger vocal sound.

the production of steady breath pressure.   Pedagogue Francesco Lamperti (1813-1892) stated:

> By singing *appoggiata,* is meant that all notes, from the lowest to the highest, are produced by a column of air over which the singer has perfect command, by holding back the breath, and not permitting more air than is absolutely necessary for the formation of the note to escape from the lungs… In this, in my idea, lies the great   secret of the art of singing. (F. Lamperti as quoted in Stark 1999, 101)

The word *chiaroscuro* (essentially the balance of light and dark timbral qualities of the voice) is first noted in Giambattista Mancini's *Pensieri e Riflessioni Pratiche Sopra il Canto Figurato* (1774),[84] though references to dull *(obtuse, mute)* and biting *(mordente)* vocal timbre can be traced back to Lodovico Zacconi's *Prattica di musica* (1592).   Manuel Garcia's *Hints on Singing* (1894) gives an excellent physiological overview of *chiaroscuro,* though he does not use this terminology.

> The *timbres* may be divided into two classes, the clear (bright), or open, and the dark or closed.   These two opposite qualities are obtained principally through the agency of the larynx and the soft palate.   The movements of these two organs are always in a contrary direction.   The larynx rises when the soft palate falls, and when the larynx falls, the soft palate rises.   The high vault produces the dark *timbres,* the lower arch the clear ones. (1982, 11)

Garcia further advises the rounding of closed vowels on the high notes.

> "The Italian I and the French U in the head and high chest notes must be rounded rather more than in speaking, or their tint would be unpleasant.   Carried to excess, these *timbres* would render the voice respectively hoarse and hollow, or harsh and trivial, like the quack of a duck." (1982, 12)

Chiaroscuro, the balance of the light and dark qualities of vocal timbre, sonically seeks to attain a desirable balance of the fundamental pitch and its upper partials, which can be associated with the speed of vibrato.   Scientific study of the voice suggests that a bright vocal quality is achieved with firm glottal closure, which produces a tone rich in high frequency components.   This is balanced by a dark quality created by resonances of an open vocal tract, and a relatively lower than normal laryngeal position (Stark 1999).[85]   The aesthetic ideals of

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[84] Noted in the English translation in the bibliography, *Practical Reflections on Figured Singing.*

[85] The darker quality, associated with a lowered larynx and raised palate, slows the rate of vibrato, while the emphasis of the brighter partials speeds the vibrato, creating an ideal balance (Miller 1997).

chiaroscuro originated in sixteenth-century art, as painters sought to depict stark contrasts of light and dark within their works, and exist today as an ideal timbral balance in western classical vocalism.

5.2 Getting started

In selecting a suitable piece, it is important to view the score and listen to a recording (when possible) before committing to a performance of the work. Scores can usually be obtained through publishers or national music centers such as the Canadian Music Center, the American Music Center, or the British Music Information Center. Composers may also be contacted directly. When corresponding with a composer, take care to establish and develop a professional working relationship. The preliminary contact should be concise but informative, and can include a brief biography, an explanation of your interest in the composer's music, and intentions for their works (performances, scholarly research, etc.). Most composers are happy to have performer interest in their compositions, and will do what they can to assist in the acquisition of necessary materials. Evaluate the overall difficulty of the work and determine the viability of mounting a performance based upon the following factors: vocal range and tessitura, any highly demanding vocal passages, complex rhythms, extended vocal techniques, and electronic requirements.

The performance of a composition with live electronics involves a great deal of technical support and logistical preparation. Of primary importance is the assistance of an excellent computer technician well experienced in Max/MSP, and a live sound specialist. These collaborators are responsible for obtaining and setting up equipment, running sound-checks, and ensuring that rehearsals and performances run smoothly. Musically, the technicians are often part of the 'ensemble' as well.[86] Working with technical assistants is analogous to working with chamber music partners. A mutual respect between parties is essential so that a strong, collaborative musical relationship is enjoyed.

A common logistical concern involves securing rehearsal space. Since set-ups often require six to eight channels of audio (necessitating a large room), adequate rehearsal locations can be difficult to secure. A full dress rehearsal in the actual performance hall is

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[86] Manoury's *En Écho* requires the computer technician to trigger sound files in the performance, while the sound technician is responsible for controlling the dynamics of the electronic accompaniment in real time.

crucial, since elements such as balance, amplitude, envelope and reverb can vary greatly in different acoustic spaces (Kimura 1995). For these reasons, performer affiliation with a university or similar institution is beneficial, since institutions with computer music departments generally have the equipment, technical staff, and adequate rehearsal and performance spaces to successful mount concerts with live electronics.

5.3 Methodology for learning contemporary music

The following suggested methodology for learning contemporary music is based upon my experience as a pianist, assistant choir director, and professional contemporary music vocalist. Appendix C details a step-by step checklist for the preparation of contemporary vocal music and electronic music. This preparatory checklist is primarily based upon personal observations of my own practice sessions, supplemented with choral rehearsal techniques I have developed over the years.

5.3.1 Background research
Once a work is selected and programmed, conduct detailed background research on the composer, the poet, and the history of the piece. This information serves as an invaluable preparatory tool, affording the singer an in-depth understanding of the circumstances surrounding the creation of the work.[87] The research should include biographical backgrounds of the composer and poet, analysis of the compositional style, historical and philosophical context of the poetry (including translation), and information about the premiere. Once these background studies have been completed, one may begin initial preparation of the music. Carefully study any composer notes placed in the beginning of the score – these often refer to contemporary notation, pronunciation, extended vocal techniques, or other compositional elements specific to the work.

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[87] Sharon Mabry's excellent manual of contemporary singing, *Exploring Twentieth-Century Vocal Music* (2002), presents a detailed method for preparing new works, while Jane Manning's *New Vocal Repertory* (1986) and *New Vocal Repertory 2* (1998) examine important compositions of the late 20th century.

5.3.2 Score preparation

Before the first note is sung, visually organize the score so important elements are easily visible to the eye. The complexity of contemporary music is often daunting, and a score filled with meter changes and numerous dynamic markings can be difficult to decipher. First, mark the score with colored highlighters or pencils, clearly outlining meter changes, tempi changes, dynamics, and extended vocal techniques, and write in any necessary translations. Next, divide the piece into sections based on change of tempo or new material, and identify demanding or potentially problematic passages for detailed practice. Joan La Barbara states: "Your brain can only process so much information in real time. When trying to progress through a score, you want the brain to be able to see something and react to it as quickly as possible" (La Barbara 2005). Each contemporary piece has its own inherent difficulties; it is important for a singer to recognize and evaluate them in order to organize practice sessions accordingly. When the initial score preparation is complete, preliminarily read through the work in order to attain a global perspective of the piece.

5.3.3 Practice methods

Once the background research and preliminary score preparation is complete, begin learning the piece in small segments. I have divided the learning process into four separate elements: pitch, rhythm, text and dynamics.

Pitch

Pitch is often the best element to begin with, to allow the voice maximum time to attain intervallic muscle memory (though in a piece with a high level of rhythmic complexity such as Lanza's *Erba nera che cresci segno nero tu vivi*, rhythmic practice may be commenced first).[88] While learning pitches, first play the notes on the piano. Working at a slow tempo, identify intervallic relationships, and when possible, relate pitches to a tonal or chordal progression. Begin singing the pitches without exact rhythmic values on a neutral syllable or hum, adhering to a general sense of rhythmic proportion (i.e. sixteenth note gestures sung faster than eighth notes or quarter notes). Work through difficult passages slowly, gradually increasing speed until the piece is close to performance tempo. When singing new music,

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[88] The performer should first evaluate a piece for its inherent difficulties, and then devise a practice plan, allotting extra time to the more difficult aspects of the work.

always transpose higher pitches down an octave until the ear can reproduce the intervallic progressions perfectly. This will save the voice unnecessary vocal fatigue.

Rhythm

Next, practice the rhythm separately, proceeding diligently and methodically. In passages with complex rhythms, it is helpful to clearly divide the measure into individual beats. Tap or *ta* difficult rhythms until they become organically ingrained in the body. Next, play the pitches in rhythm on the piano if keyboard skills allow. When rhythms are solid, begin to sing pitches in precise rhythm slowly and lightly on a neutral syllable. Always work with a metronome to ensure maximum accuracy and attention to detail. Begin slowly, gradually working the piece up to tempo. When utilizing a metronome, it is beneficial to gradually increase the speed until the piece can be sung a few clicks *above* the indicated tempo – this will ensure that the actual performance tempo is technically comfortable, and is not at the maximum threshold of the singer's vocal capabilities.

Text

The next element to add is text. If unfamiliar with the language, work with a vocal coach or language specialist to ensure proper pronunciation. IPA (International Phonetic Alphabet) is a helpful tool to notate accurately the phonetic sounds of the words. Practice the pronunciation by first speaking the text out of rhythm. Drone the text in a monotone using proper breath support. It is important to focus the pitch of the monotone in the middle of the voice – practicing this technique at the bottom of one's range can cause laryngeal tension or fatigue. Next, speak and then drone the text in rhythm, working slowly and methodically with a supported breath. Finally, add the text to the sung vocal line under tempo, and gradually work up to performance tempo. Always be attentive to good vocal technique, ensuring at all times that the voice is fully supported, and the jaw, shoulders and neck are free from tension that can arise when one is concentrated on learning new music.

Dynamics

The final element to add to the vocal preparation is dynamics. Dynamics in contemporary music can be quite difficult to execute; composers often write several types of accents in one measure, or include sudden, dramatic shifts in color and volume. A singer who lacks full technical command of the vocal line before adding dynamics runs the risk of jaw tension, support problems and vocal fatigue. The breath should be solidly phrased at a *mezzo forte* before attempting to incorporate louder and softer vocal elements. The dynamics must have a strong, emotional connection to the interpretation of the work, and must not be performed mechanically or appear arbitrary to the listener. It is essential to possess a clear understanding of the poetic meaning of the piece and the composer's dramatic intent when working at this stage.

5.3.4 Incorporating the electronics

Once the vocal part is comfortable and secure, begin to incorporate the electronics. Contact the composer or publisher to secure any available rehearsal tools such as click tracks or rehearsal patches for Max/MSP.[89] Once these tools are obtained, it is helpful to consult with the sound technician to fully understand the role the electronics play in the piece: Does the performer trigger sound files? Does the technical assistant trigger sound files? Is the piece based on live electronics, which primarily entail vocal processing, or is the piece interactive? If interactive, how to the vocalisms affect the electronics? What degree of interaction is present in the composition? Mark any relevant information in the score.

When preparing an electronic work, it is essential that one fully understand how the electronics and the voice (and other instruments if present) co-exist. Live and interactive electronics often simulate chamber music, yet instead of a string quartet or piano trio, the ensemble consists of the live performer, the live sound technician, the computer operator, and/or the computer. Like chamber music, all members of the ensemble must actively listen and respond to each other in order to create a connected, cohesive musical performance.

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[89] It is not necessary for a singer to own the Max/MSP software. Rehearsal patches commonly work with Max/MSP Runtime, a free download that allows performers to rehearse with the electronics without a full technical set up.

5.4 Difficulties unique to singers

It is necessary to consider several physical elements when incorporating live or interactive electronics into the vocal part, including the use of triggers and microphones. Performers commonly use triggers to initiate sound files or begin a click track. Though many electronic devices can serve as a trigger (e.g. the space bar of a laptop), singers commonly use either a hand-held device or a foot-pedal. Take care to not allow the physical motion of using the trigger to interfere with the breath support or tone. When selecting the type of trigger to use in performance, choose a device that is the most comfortable and least intrusive to the sound.

In order to process the voice, the acoustic vocal signal must be converted into a digital signal.[90] Singers are generally asked to wear a headset microphone, which is either attached to a power source, or a wireless battery pack that can be worn around the waist. With a headset microphone, "…vocalists may sing as though they [are] performing acoustically… The position of the microphone around the hairline emphasizes forehead and head resonance, facilitating vocal projection" (Lebon 1999, 37).

The use of amplification is often foreign to the classically trained singer, and can be an intimidating factor in the performance of live electronic music, as "…the player's physical and sonic identity is significantly altered by the prosthesis of amplification" (McNutt 203, 2003). Though a singer's technique need not dramatically change with the use of amplification, there are several issues to watch for, such as peaking and balance. Peaking occurs when the amplitude of the voice exceeds the system's capability to reproduce. Balance reflects the proper volume adjustment for all elements of the composition (voice, electronics, other instruments), and is essential to a successful performance. Be aware that issues of balance are often not attended to in rehearsals. Since the acoustics of the rehearsal space are normally quite different from the concert hall, fine-tuning of levels for performance can only take place in the actual acoustic space. For the purpose of rehearsing, the sound technician will create a general balance between the voice and electronics, and will perfect the levels during the sound-check.

The task of balancing levels in the hall is incredibly important, as improper sound adjustment can be a great detriment to the performance. A sound specialist with a keen

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[90] Digitization requires a microphone to convert the sound into an electrical signal.

aural understanding of the composition is vital to the success of the concert. In the performance hall, singers are often equipped with monitors, speakers that face the performer to allow for sonic feedback with minimal delay. In the sound-check, it is the singer's responsibility to ensure that the volume of the monitors is satisfactory; if the speakers are too loud, one runs the risk of vocal over-compensation, and may try to compete or sing *above* the electronics rather than sing at a comfortable volume. As a vocal safety rule, singers must take great care to *never* over-sing! It is the sound technician's job to modify the sound to optimally complement the voice, but it is the singer's responsibility to ensure that she is always singing with good technique.

5.5 Common pitfalls

When performing a piece for live electronics, there are several common pitfalls singers must be aware of. Due to the extensive technical set-up, numerous rehearsals are often grouped very close to the concert, and the sound-check/dress rehearsal is often on the same day of the performance. Continuous practicing of strenuous, virtuosic music can run the risk of vocal fatigue or exhaustion, and singers should try to incorporate plenty of vocal rest between rehearsals. Additionally, I recommend that one avoid scheduling rehearsals the day prior to the concert, so the voice can be fresh for the performance.

A pertinent concern in the presentation of older live electronic pieces is the issue of outdated software or old patches. Technology is continuously evolving, and electronic components created as little as a year ago can require revision in order to accommodate a new operating system or software update. When planning the performance of a live electronic work, it is important to contact the composer as soon as possible to acquire the electronics. In preparation for the lecture-recital component of this thesis, I contacted Mauro Lanza and Philippe Manoury directly in order to acquire the necessary Max/MSP patches. Since Lanza's *Erba nera che cresci segno nero tu vivi* was composed in 1999, the piece was composed in Mac OS9, and extensive revisions were necessary in order to make the piece function in Mac OSX. Manoury's *En Écho*, more frequently performed then *Erba nera*, currently maintains versions in Pd and Max/MSP, but was originally composed in 1993

using the older Max software, and has undergone several major modifications over the years to accommodate the advancing technology.[91]

Performers working with electronics will naturally become attuned to possible complications inherent whenever technology is involved. Long periods of waiting are often experienced while technicians ensure that the technical set-up is working properly, and painful and potentially damaging feedback can occasionally occur during sound-checks. Problems with running the software are common, and bugs in the patch often must be worked out during the initial rehearsal sessions. Systems crash, laptops freeze, speakers don't emit sound, any one of a myriad of technical problems can occur in rehearsals and in concert. The performance of live electronic computer-based music is not an absolute science. Diligence, great patience, dedication and an unfailing cooperative spirit are required from all involved in this endeavor.

Because of the complexities in both learning and mounting these works, it is common to encounter performer hesitation or intimidation. McNutt (2003) describes the large schism between composer/performer and performer/machine, and cites several deterring factors that prevent performers from exploring this genre. As mentioned above, inevitable software and hardware difficulties can contribute to unproductive practice sessions. Scores are often difficult to read and poorly notated, and the composer's intention for the electronic sounds may be difficult to understand on paper. Useful cues may be omitted, incorrectly written or unrecognizable, and crucial trigger events may not be notated clearly. Additionally, vocal (or instrumental) writing may not be well suited for the instrument, and performers may understandably feel apprehension towards singing the piece. Ultimately, composers that neglect attention to the overall performer experience contribute to the fear and hesitation that many singers understandably have towards embracing new works. However, in a collaborative relationship between the two, singers have a wonderful opportunity to communicate their vocal and musical needs, and composers should be receptive to this first-hand information.

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[91] A large-scale project for the near future will entail porting pieces originally composed in Max/MSP for the Mac Powerbook to the MacBook Pro with Intel processor, as significant changes have been made to the internal hardware. Porting Max/MSP to run natively on the Intel Mac should greatly improve performance, and hence the complexity that will be possible in future compositions.

Chapter 6: Vocal analyses

The following section contains analyses of three live electronic vocal works performed in my doctoral lecture-recital, November 2, 2006 at Tanna Schulich Hall, McGill University, Montreal.

6.1 *En Écho* by Philippe Manoury

6.1.1 Background

Philippe Manoury (b. 1952, Tulle, France), considered one of the pre-eminent composers and computer music researchers in the world today, has been an important contributor to the development of interactive electronics.[92] He studied composition with Gerard Condé, Max Deutsch (one of Schoenberg's first students in Vienna), Michel Philippot, Ivo Malec and Pierre Barbaud. In 1987, Manoury composed the first large-scale interactive work, *Jupiter*, for flute and electronics, based upon Barry Vercoe's previously developed score-following techniques. This became the first piece in Manoury's *Sonus ex Machina*,[93] a series of compositions for solo instruments, ensemble and real-time computer processing.[94] In 1993 Manoury composed *En Écho*, the first major vocal work to utilize interactive electronics. Realized at IRCAM with the assistance of Miller Puckette, Corte Lippe and Leslie Struck, it remains one of the most often performed works in the repertoire of voice and live electronics. *En Écho* premiered June 28, 1993 with soprano Donatienne Michel-Dansac as part of IRCAM's *Espace de projection de l'Ircam.*

The text is a series of erotic poems written at Manoury's request by French poet and novelist Emmanuel Hocquard (b.1940).[95] Manoury reworked a larger body of material provided by Hocquard into the seven poems that make up *En Écho*. Recalling the erotic

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[92] Manoury has been affiliated with the French research institution IRCAM since 1981.

[93] *Sonus ex Machina* includes *Plutons* (1987) for piano and live electronics, *La partition du Ciel et de l'Enfer* (1989) for large ensemble and live electronics, and Neptune (1991) for percussion and live electronics.

[94] As noted on the University of California San Diego website:
http://music.ucsd.edu/public/fm_music_directory.php?cmd=fm_music_directory_detail&query_Full_Name=+Philippe+Manoury.

[95] Hocquard grew up in Tangiers, Morocco.

longing of Nabokov's *Lolita*,[96] these poems evoke sensual images centered on specific places or objects.

> *En Écho* is a cycle made up of seven melodies. Various inter-relationships exist between them, concerning both the music and the text. Each of the melodies is focused on the place, object or idea in the title. Each of them is also associated with a sound component (generally a natural sound) which acts as a poetic and musical reference.[97]

Manoury repeats fragments of these melodies throughout the work. *En Écho* is divided into seven movements, totaling just over thirty minutes.[98] Though the piece contains pre-composed synthesized sounds and vocal samples, several elements of the electronic accompaniment are created during the performance of the work through live processing of the soprano's voice. Manoury uses the techniques of score following, primarily pitch tracking, to synchronize the vocal part of *En Écho* with the computer.

6.1.2 Pitch tracking

In order for the computer to participate interactively with the performer, the computer must listen to ongoing musical events and extract pertinent information from the performance through the process of score following,[99] which uses various techniques to synchronize the computer with the performer, including pitch tracking and envelope following. Score following generally affords the performer temporal freedom, since the software is primarily tracking pitches and the attack of the note (envelope).

Pitch tracking is a process by which the computer listens and analyzes the frequencies output by the performer, and matches them to a pre-programmed score. Several problems are associated with pitch tracking, as discussed by Elizabeth McNutt (2003). Pitch tracking can lock performers into a 'prison of perfection', as pitch trackers can be negatively affected by variations in acoustics, microphones, and specific performances. Pitch tracking sometimes does not respond well to rubato, or other musical elements of musicality. When

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[96] As noted on the Electronic Music Foundation website:
http://www.emfproductions.org/year0506/manoury.html.
[97] Manoury, P. *En Écho/Jupiter.* (Accord: ACRD465526-2 – CD)
[98] The original version was comprised of the first movement, *La Rivière*, and the last movement, *La Table*. The remaining five movements were composed afterward.
[99] Current MSP versions of *En Écho* uses Miller Puckette's *fiddle~* object, an external object written for Max/MSP, to track the location of the vocalist by analyzing the sung pitches. The software also notes fricatives, such as the sound of an *f* or *s*, and envelope following, a process by which the computer tracks the vocal attacks.

working with pitch tracking, the performer must often adjust to the computer. For example, excessive vibrato or slight issues of tuning can become problematic, as the computer may not accurately read the pitch information. As noted by Puckette, vibrato can cause fluctuations in pitch by two semitones, and occasionally more (1995). Singers must 'learn' the amount of vibrato the system will respond to, and adjust the singing accordingly. In order to ensure an accurate and successful performance, the presence of a human operator at the computer to oversee the score following is recommended. If a cue fails to trigger, or triggers early, the computer technician may make any necessary corrections manually.

6.1.3 Vocal and rehearsal techniques

The vocal writing of *En Écho* is extremely lyrical, with recitative-like elements interspersed throughout the piece. It requires a traditional, beautiful *bel canto* sound, and does not contain extended vocal techniques. The most challenging vocal aspect of the piece is the inclusion of large intervallic leaps, at times nearing or exceeding two octaves. Manoury creates the rhythmic structure of the vocal line around the inflection of the language, and uses accents, tenuti, staccatti and sudden dynamic shifts to further embellish the meaning of the text. Though the harmonic structure contains elements of polyphony, the piece is primarily monophonic, with the electronic accompaniment supporting the vocal line.[100] There is a prevalent sense of tonality in the piece, and the electronics are often chordally-based, doubling the voicing of the solo vocal line. This allows the singer to easily tune her voice to the accompaniment.

The difficulty of *En Écho* rests not in the notes or rhythms, but the synchronization of the ensemble. Since the electronic accompaniment is completely dependent upon interactive elements, there is no way to rehearse the ensemble without the full electronic set-up. The piece requires two technicians, one to operate the computer, and one to supervise the live sound. The computer operator is responsible for triggering sound files and overseeing the score following,[101] while the sound technician controls the dynamics of the live electronics during the performance (as notated in the score). The compositional nature

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[100] The exception to this is the third movement, *Broadway*, which consists of an *a cappella* solo line processed in real-time with harmonization, spatializaton and reverb.

[101] The accompaniment is divided into two elements: events triggered by the sound technician, and events triggered by the computer as it tracks the singer's performance in real time with score following.

of the piece affords the singer temporal control, though she should take care to adhere to the metronome markings indicated in the music. *En Écho* follows a chamber music model. As there is no conductor, each 'performer' (the singer, the live sound technician, the computer operator *and* the computer) must continuously listen and react to each other in order for the performance to be musically effective.

6.2 *Erba nera che cresci segno nero tu vivi* by Mauro Lanza

6.2.1 Background,

Mauro Lanza (b. 1975, Venice) has worked at IRCAM as a researcher, composer and instructor since 1999. His compositional studies include workshops with Brian Ferneyhough, Gérard Grisey and Salvatore Sciarrino. *Erba nera che cresci segno nero tu vivi* is part of a larger cycle of four works, entitled *Nessun suono d'Acqua* ("No water sound").[102] Lanza cites the vocal music of the Italian composer Salvatore Sciarrino (b.1947),[103] as well as his own ethnomusicological studies as major compositional influences in writing the cycle *Nessun suono d'Acqua*. *Erba nera che cresci segno nero tu vivi* was premiered on September 29, 1999 by soprano Donatienne Michel-Dansac at the *Concert of the Curses de composition de l'IRCAM* in the Auditorium Saing-Germain-des-Prés.

The text of *Erba nera* is derived from *Prime Prose Italiane,* written in 1954 by Italian poet Amelia Rosselli (1930-1999). Rosselli was the granddaughter of Amelia Pincherle Rosselli (1870-1954), a famed Jewish writer and supporter of the Italian liberal monarchy, and daughter of Carlo Rosselli (1899-1937), an Italian anti-fascist revolutionary. Carlo and his brother Nello, both leaders in the anti-fascist resistance, were assassinated by Mussolini's men in 1937. Following the assassination, the Rosselli family spent the remainder of the war in exile in England, France and the United States. Amelia did not return to Italy until 1950, when she settled in Rome.

Amelia Rosselli, also known as a critic, musicologist, and composer, is considered one of the major poets of the Italian avant-garde. *Prime Prose Italiane* is a short collection of

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[102] Other works in the cycle include *Barocco* (1998), *Mare* (2003-04), and *Cane* (to be premiered in 2007).

[103] Sciarrino is known for his fast ornamentation and extensive use of glissandi.

Italian prose, inspired in part by the Tiber River[104] along which Amelia lived. *Erba nera che cresci segno nero tu vivi*, which translates as 'Black grass that you grow black sign you live', is a prosodic fragment; there is no contextual meaning with which to draw from. Tragically, Amelia led the troubled life of a paranoid schizophrenic. Following the death of her mother Marion, Amelia suffered a nervous breakdown, and eventually committed suicide in Rome by leaping from a window.[105]

Lanza cites as inspiration for *Erba nera* T.S. Eliot's *The Wasteland* and Noam Chomsky's theory of generative linguistics. Lanza specifically chose Rosselli texts that encompassed the same thematic analogy as the large leitmotifs from *The Wasteland:* The ritual death of the god-king, transfiguration,[106] and fertility and resurrection. Speaking of his attraction to Chomsky, Lanza states:

> I've been studying Chomsky's generative linguistics, and I think there is a relationship between his idea of language and the idea of polyphony I developed in *Erba Nera* (the "original pattern" of my model of heterophony is similar to the "deep structure" of language). But he has strictly nothing to do with (the) poetry.[107]

Erba nera does not emulate the traditional lyric writing usually found in vocal music, but is instead built from rhythmic components. The entire piece is made up of fragments of the text, which in completion totals the eight words of the title. The piece uses the idea of heterophony, a form of polyphony by which the same melodic line is performed simultaneously (with slight variations) by two or more performers. Sections of the vocal line can be heard in the synthesized accompaniment, which was built to emulate a "sort of virtual Gamelan in the electronic part."[108]

Erba nera also makes extensive use of microtones.

> Harmonies in *Erba Nera (*and melodies too) are mainly subsets of pitches from the harmonic spectra, and that explains the use of microtones... The only thing that I am using consciously in the voice part to mimic eastern music (but these are also features of Sciarrino's vocal style) are fast ornamentations (which are not to be interpreted as '*bel canto*'), glissandi, and strong dynamic contrasts.[109]

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[104] The Tiber is the main Roman waterway, and is the third largest river in Italy.
[105] Amelia's death was eerily foreshadowed by her grandmother in the play, *Li'dea fissa* (1906), in which the protagonist suffered from multiple personalities and eventually commits suicide by jumping from a window.
[106] Death by drowning, as depicted in Wagner's opera *Tristan und Isolde.*
[107] Email conversation with Mauro Lanza: November 3, 2006.
[108] Ibid.
[109] Ibid.

6.2.2 Vocal techniques

One of the challenges in learning *Erba nera* is incorporating the highly complex rhythms into the voice, which are demonstrated in the example below.

Example 6.1 *Erba nera che cresci segno nero tu vivi* (mm. 141-143)

In order to understand the rhythmic structure of the work, divide each measure into individual beats. Reinforce the bar lines and meter changes so that pertinent information in the score is easily viewed. When commencing work on the piece, conduct and *ta* the rhythms with a metronome until they become ingrained. Always work at a slow tempo, increasing the speed gradually until the rhythms are performable at the indicated performance tempo. Once the rhythms are organically ingrained into the body, begin incorporating the pitches.

Another challenge of the piece lies in tuning the quartertones. Microtones are common to music of eastern cultures, and have been used by western composers such as Harry Partch, Giacinto Scelsi, LaMonte Young and James Tenney. When preparing the work, pay close attention to tuning, and do not allow the pitches to migrate to the nearest semitone. One method for accurately learning microtones is to locate the surrounding semitones on the piano, sing both pitches, and then bend the tuning of either pitch towards

the microtone. One should work closely with a piano, continuously checking that the microtones have not reverted to pitches on the diatonic scale. Additionally, understand and mark where the important *non*-microtonal pitches lie, and ensure that these notes are always perfectly in tune.

Extended vocal techniques in *Erba nera* are generally limited to glissandi, which are prevalent throughout the piece. The glissandi should be sung with a straight tone, with careful adherence to the dynamic markings. A bit of breathiness may be used on the first page to achieve a greater timbral contrast from the rest of the piece. When incorporating the dynamics, take care not to over-sing the piece. Excess weight in the voice will not permit the voice to float freely through the fast rhythms, pitch changes and dynamic contrasts, and may contribute to vocal fatigue. As the voice is closely miked, an *operatically* projected sound is not required; this affords the singer greater opportunity to portray subtle vocal nuances. Limited use of vibrato is advised so the pitches and dynamics may be clearly perceived. Despite the extreme rhythmic complexity and musical sophistication of the work, the vocal line must never feel stiff or metronomic. Lanza has beautifully composed the rhythms. When sung correctly, they should appear improvised and natural.

6.2.3 Rehearsal techniques

Erba nera utilizes the first level of interaction, described in Chapter 4. The soprano is responsible for triggering pre-recorded sound files in real time,[110] but the voice is not processed (beyond reverberation), and the composition does not use score following techniques. By triggering sound files, the performer controls certain temporal elements of the piece by determining the duration and intensity of the numerous fermatas written in the score.

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[110] A trigger is an electronic device that the performer uses on stage to initiate electronic commands, either triggering sound files or initiating click tracks. Common devices include hand-triggers and foot-pedals.

Example 6.2 *Erba nera che cresci segno nero tu vivi* by Mauro Lanza

Example 6.2 demonstrates the first page of Lanza's score. The numbers enclosed in squares represent the various sound files – there are a total of thirty-nine in the piece. Each time a number appears in the score, the performer is responsible for triggering the corresponding sound file. Within the synthesized electronic accompaniment of *Erba nera*, a beat or sense of rhythm cannot easily be discerned. In order for the performer to perfectly synchronize with the electronics, the composer provides a visual metronome to be used in rehearsals and performance, as shown below.
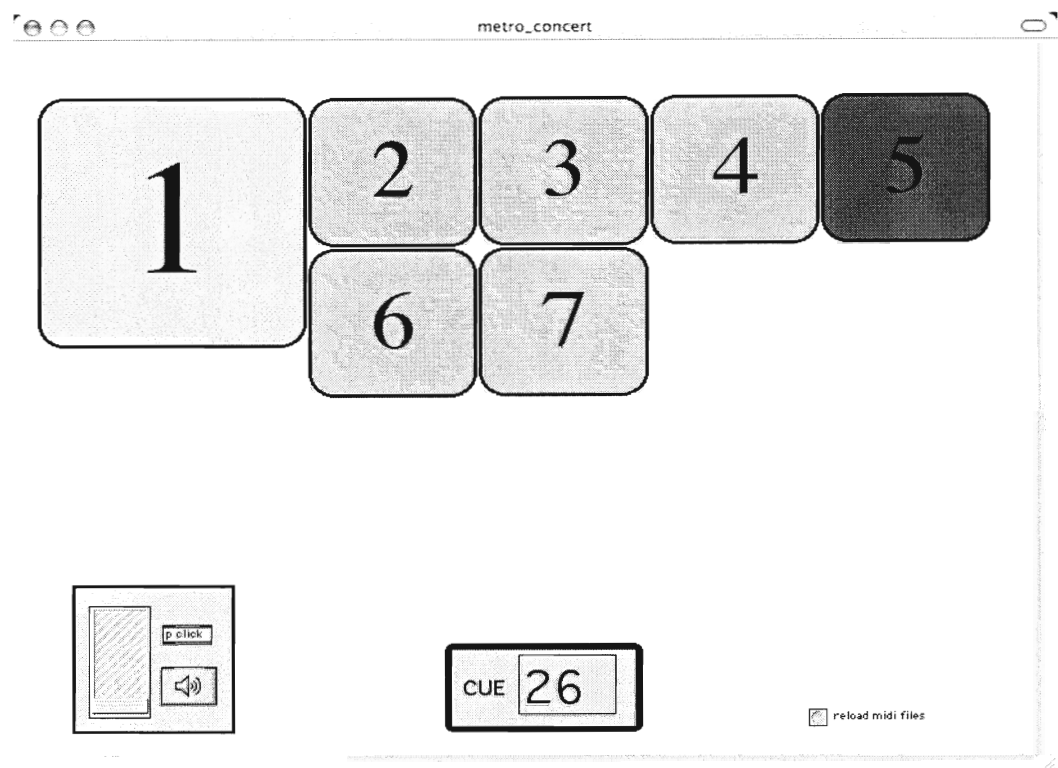
Example 6.3 Metronome patch for *Erba nera che cresci segno nero tu vivi*

The numbers flash according to the corresponding beat of the music. In the middle, faster section of the piece, the singer must trigger sound files at precise moments. The metronome patch flashes the word *'attacca'* in red to indicate exactly when the next sound file should be triggered. One of the physical challenges of performing *Erba nera* is to watch the score and the visual metronome patch at the same time, while simultaneously coordinating the numerous meter and tempi changes and dynamic indications.

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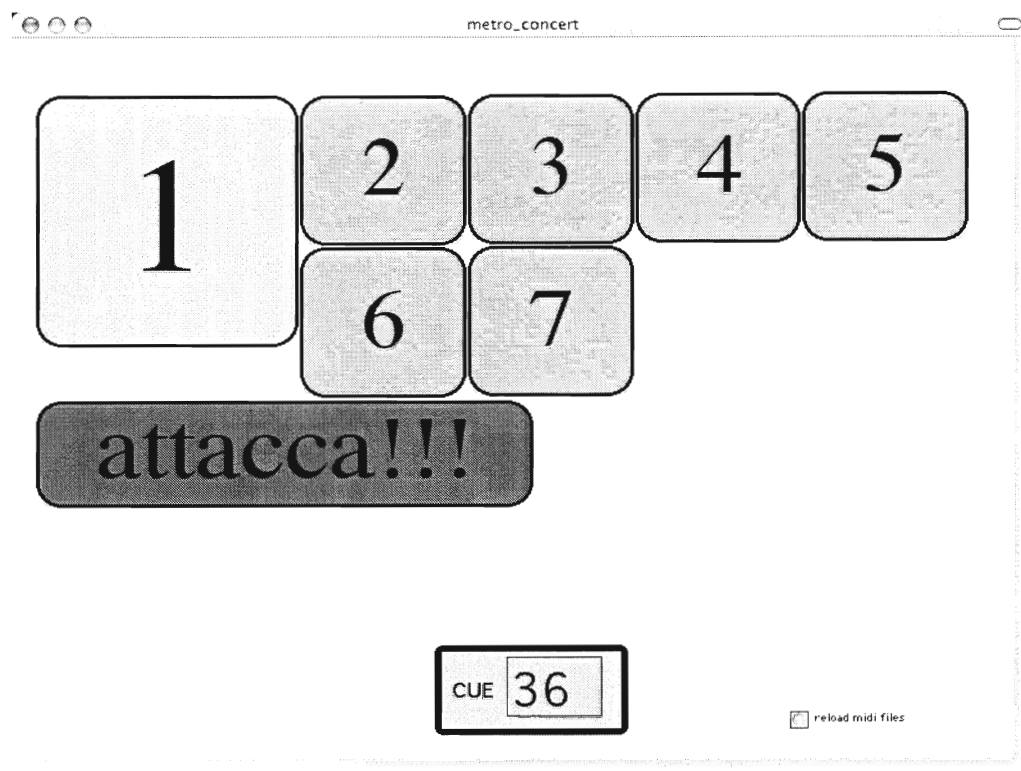
Example 6.4 Metronome patch with *attacca!* for *Erba nera che cresci segno nero tu vivi*

The composer provides a Max/MSP rehearsal patch to facilitate rehearsals without a technician. In order to use this patch, it is not necessary to own the Max/MSP software. Singers may rehearse the electronics with Max/MSP Runtime, a free download available on the Cycling'74 website.[111] Since the success of *Erba nera* lies in the performer's ability to coordinate her vocal line with the metronome patch, extensive practice with the rehearsal patch is extremely valuable to the preparation of the piece. In order to minimize the possibility of falling out of step with the music, the performer should possess an intimate familiarity with the accompaniment. Once the piece is well learned, I recommend the singer rehearse by singing softly with the electronics, so she may learn the sounds of the accompaniment, and observe how the voice fits in. This will allow the singer to note instances where the vocal line is present in the accompaniment. An inherent understanding of the electronics will afford the singer the opportunity to easily re-synchronize with the accompaniment if necessary.

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[111] The singer can use the space bar of a computer to trigger sound files.

6.3 *Avant la larme* by David Adamcyk

6.3.1 Background

For the purposes of this research project I wished to commission a new work for voice and live electronics from a young composer. I approached David Adamcyk in 2005, and *Avant la larme* is the musical result. David Adamcyk (b. 1977) is a Canadian composer who has been affiliated with McGill University since 1999. His compositional training includes studies with Philippe Leroux, John Rea and Brian Cherney. Seeking to expand the boundaries of traditional aesthetics, I hoped to inspire a composition that was unlike standard electroacoustic works. The composer and I embarked upon a series of invigorating discussions on the nature of art and music in contemporary society and in doing so discovered a mutual desire to create music that did not attempt to conform to an idealized aesthetic. The end result is wonderfully successful. *Avant la larme*, composed for soprano, saxophone, electric guitar and live electronics, is an exploration of extremes, in dynamics, mood, and aural sensations. It was premiered on October 28, 2006 in Pollack Hall, Montreal, with a revised version presented on November 2, 2006 in Tanna Schulich Hall, Montreal.

The text of *Avant la larme* was inspired by the sound poem *Gadji Beri Bimba*, created in 1916 by the Dadaist poet Hugo Ball (1886-1927).[112] Using the medium of experimental art, including spoken word, dance and music, the founders of Dadaism[113] collectively expressed their disdain for the political and artistic ideals of what they considered the 'old world'. With the famed Cabaret Voltaire as his platform, sound poet Hugo Ball dissolved the written word into a sonorous object, thereby eradicating contextual meaning; the aural sounds of the performed poetry were more important than the written poem itself.[114]

The text of *Avant la larme* was chosen strictly for its sonic qualities, and bears no linguistic meaning. Adamcyk states of the piece:

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[112] Dadism is an artistic movement that evolved in Zürich, Switzerland in 1916.

[113] The founding members included the German poet Hugo Ball, his companion Emmy Hennings, and poets Tristan Tzara and Richard Huelsenbeck.

[114] The process of de-contextualizing the written word would eventually help inspire Luciano Berio's first vocal tape piece, *Thema (Omaggio a Joyce)* (1958), where the pre-recorded vocal sounds of Cathy Berberian are cut and spliced, and re-assimilated in dramatic alteration.

Avant la larme literally translates as 'before the tear', but can also be understood phonetically as 'before the alarme'. It was composed in reaction to the paradox found in the nonchalance with which we, as a 'developed' society, deal with the challenges that lie before us. The piece is divided into three uninterrupted movements of distinctive texture and atmosphere entitled *Angoisses passagères* (momentary anguish), *Précipitations et dégonflements* (rush and deflate), and *Vers le vide* (towards the void). Contrarily to most vocal repertoire, the soprano in *Avant la larme* does not play a dominant role, but is rather treated like an instrument on par with the guitar and the saxophone. Hence, the text – inspired by *Gadji Beri Bimba* (1916), a sound poem by Dadaist poet Hugo Ball (1886-1927) – was chosen purely for its sonic qualities and its lack of semantic content. (Adamcyk 2006)

By treating the voice as an equal instrument in the ensemble, Adamcyk deconstructs the traditional role of the singer as the principal focal point of the performance. In stripping that context away, the role of 'communicator' is altered. The drama is not conveyed in the poetic meaning of the text (as is traditionally the case), but is instead portrayed through strict attention to dynamics and articulation. The vocalist must resist the tendency to perform in the traditional 'theatrical' mode; to do so will lesson the dramatic intention of the composer. In this way, the piece embraces a different kind of aesthetic rarely found in vocal music.

The musical structure of *Avant la larme* necessitates extreme rhythmic clarity from the performers. In order to ensure exact rhythmic precision between the three players, the ensemble is held together with a click track. Though this may initially seem confining and unmusical, adherence to a click track is similar to following a conductor. The music is aligned within strict rhythmic parameters, yet performers must still find an organic sense of ebb and flow to the beat so that the music does not become metronomic.

Stylistically, the piece dramaticizes stark contrasts in rhythm, timbre and color, and explores extremes in dynamics and register. *Avant la larme* contains numerous accents and sudden, dramatic shifts in color and volume, as demonstrated in the example below.

Example 6.5 *Avant la larme* by David Adamcyk (mm. 29-37)

Note within the three parts the rapid dynamic shifts from *piano* to *forte*. Adamcyk also composes light extended vocal techniques throughout the piece, including speaking, whispering, straight tone (senza vibrato) and glissandi. The electronics consist of pre-processed audio samples and real-time processing of the instruments with Max/MSP. The effect modules Adamcyk utilizes for the real-time processing include harmonization, delay, band-pass filtering, FFT filtering,[115] resonators,[116] guitar distortion, amplitude modulation, and spatialization over six loudspeakers.

Since *Avant la larme* is the only work discussed in this thesis to make extensive use of vocal and instrumental processing,[117] the remainder of the analysis will focus upon Adamcyk's compositional integration of electronics with the instruments.[118] As mentioned above, the three sections of *Avant la larme* each have a distinct texture and atmosphere, and to some extent, a different set of electronic effects. In the first section, *Angoisses paasagères* ("Momentary anguish" mm. 1-68), Adamcyk conveys the idea of tension building and suddenly dissipating. The entire section is compsed as one large gesture, beginning with simple quarter notes (mm. 7), and ending with a steady stream of sixteenth notes distributed among the three performers (mm. 45-50). This large gesture is further divided into three sub-sections, each consisting of a small build-up or crescendo. The electronics greatly support the music, as they provide additional material that articulates the three build-ups. In the first of these (mm. 7 to second beat of mm. 17), a sound file instigates the increase in tension. This sound file was created by running multiple passes of the saxophone's recorded multiphonic (mm. 9) through a delay, and transposing the result. Adding to the effect, the soprano's crescendo (beginning in mm. 14) is passed though an FFT filter. This creates a slight distortion to the voice, which further enhances the intensity of the crescendo.

The second build up (mm. 18-37) is also primarily articulated with a pre-composed sound file, though this file is characteristically smoother in sound quality, and increases in

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[115] FFT filtering involves taking a 'snapshot' of the sound and altering it using spectral analysis.

[116] A resonator is similar to a band-pass filter, yet it can contain up to one hundred bands. The effect is that of shadowing the sound, similar to that of a piano sustain.

[117] One of the novel approaches Adamcyk took vis-à-vis the electric guitar was to have all the distortions effects produced via a plug-in included in the Max/MSP patch, and not through effect pedals, as is traditionally the case. In this sense, the guitar can be considered as continuously processed, as its sound is always run through a distortion plug-in. This procedure enabled Adamcyk to control the various distortion, clean, and wah-wah effects with more precision, and most importantly, to alter certain parameters dynamically in real time.

[118] The analysis references specific measures in the score, which can be viewed online: http://www.music.mcgill.ca/~adamcyk/Avant%20la%20larme-11X17.pdf

density with the addition of richer frequencies. Following this, mm. 38-52 combines a long sound file with a series of live effects. The sound file provides a sustaining 'filler' sound, which essentially increases in tension though a broadening of the harmonic spectrum. The various effects, including harmonizers, delays, and buffers, are used to create a percussive texture, while simultaneously confusing and complicating the overall rhythm.

Within the second section, *Précipitations et dégonflements* ("Rush and deflate" mm. 69-165), Adamcyk states the music should be "fast and energetic at first, but with interspersed losses of energy, reflective of our busy life style."[119] A steady stream of eighth notes characterizes the music, coupled with melodic material derived from curve-like graphical contours. Within this section, sound files created from processing pre-recorded instrumental sounds with various granular synthesis effect units are heard,[120] though Adamcyk states his compositional focus is primarily upon the instrumentalists and not the electronics.

The final section of *Avant la larme*, entitled *Vers le vide* ("Towards the void" mm. 166-end), contrasts starkly with the rest of the piece. Meant to convey a gradual ascent towards a 'void', Adamcyk intended the music to be perceived in one of two ways, either as a feeling of serenity, or zen-like state, or a feeling of complete loss and desperation.[121] The section begins with a series of loud chords separated by sound files, again derived from the real-time instrumental performance. The processes used to create these sound files utilize infinite reverb, to which granular synthesis is then applied in addition to a number of other sounds (primarily more piano impact sounds). In mm. 186 to the final played note, live processing is the only remaining electronic element. The processing is applied to all three instruments equally as they perform material B in the score, with the resultant effect depicting the performed music shadowed electronically. To accomplish this in performance, Adamcyk first processed the instruments through resonators.[122] The output was then passed through a granular synthesis object, and finally spatialized into the four speakers located around the audience, resulting in a reverb effect with added color and highlighting of particular notes.

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[119] Ibid.

[120] An example of this is demonstrated in mm. 119-158, where the processing results in a kazoo-like percussive layer which highlights the attacks of the performers. Adamcyk also utilizes unprocessed samples throughout the section. Mm. 68-69 depicts the recording of a stick striking the lower strings of a piano. A cymbal is presented in mm. 80 and 157, and in mm. 100-108, a low Brazilian flute-type instrument can be heard

[121] The composer leaves the interpretation up to the listener.

[122] Objects programmed to respond only to frequencies of the chromatic scale. The sonic result is a kind of "tuned" reverberation.

Conclusion

This thesis has been devoted to the creation of a detailed reference manual for the study and performance of music for voice with computer-based live electronics. In comparison to studies of traditional classical western music, scholarship dedicated to the performance of live electronic music is in its infancy, and publications dealing with the performance of live electronic vocal music are almost nonexistent. My intention in writing this thesis has therefore been to help singers learn about electronic music. By creating this centralized reference document, I hope to inspire singers to embrace this exciting genre, and to facilitate repeat performances of pieces from this repertoire. The annotated list of vocal works (Appendix B) is the beginning of my efforts to document this music. I intend to continuously expand this list into an online database, allowing singers, composers, musicologists and others interested in the field to easily reference this material.

I am often asked why I have chosen to devote myself to such a specialized area of vocal music. The answer is easy. I have a deep, ideological belief that we as a society must continuously move forward. Though we must understandably study and appreciate traditional classical western music, we cannot live solely in the past. Technology is a pervasive element in our daily existence, and it is only natural for us to incorporate it into our music and art. Guy Garnett states:

> One cannot turn one's back on the most significant technological breakthrough in history without risking irrelevance to that history. One cannot avoid taking advantage of the ubiquity of this technological marvel because that very ubiquity renders all other technologies in some sense less significant. One *must* take computers into account, and take them to task, because it is a response to the technology of our time, to the situation of our time. To make music with the technology of our time, and specifically the computer, poses a tremendous challenge for the artist. To address this challenge, in itself, will help keep music alive and significant. (Garnett 2001, 32)

As people and cultures continuously evolve, art must also evolve. Art is a living, breathing organism that must be cultivated and kept alive through a strong commitment from performers, composers, writers and audience members. We must work together to help produce new works, perform them, understand them and appreciate them. It is my hope that this thesis will help do just that.

Appendix A: Extended vocal techniques

Extended vocal techniques encompass a wide range of expressive vocalisms. Traditionally, vocal sounds produced outside the spectrum of *bel canto* are termed extended techniques. However, a number of techniques considered 'extended' are not extended at all, and exist in the basic repertory of human utterance. Sharon Mabry's excellent manual of contemporary singing, *Exploring Twentieth-Century Vocal Music* (2002), notes eleven common vocal effects, including laughter, whispered tones, shouts, heavy breathing, falsetto, tremolo muting (waving the hand in front of mouth to change timbre), glissando, tongue click/cluck, tongue trills (flutter tongue, essentially a rapidly rolled Italian 'r'), whistling, and vocal muting (a gradual opening and closing of the mouth). These utterances are inherent to man's communicative language, and their production generally does not require specialized training.

Distinct from these extended vocalisms, extended *techniques* of singing involve a sophisticated use of the vocal apparatus, and specific training in these techniques is necessary for safe reproduction. Established in the 1970s separately by Joan La Barbara (closely affiliated with the New York avant-garde scene) and the Extended Vocal Techniques Ensemble of San Diego, California,[123] extended techniques include vocal fry, reinforced harmonics, overtone singing, ululation, chant/multiphonic singing, and circular singing.[124]

Vocal fry, also known as 'creaky voice', is perceived as dry, clicking pulses. Technically, vocal fry is generally induced by a segregation of a portion of the vocal folds from the main oscillating parts – this area co-oscillates at subharmonic modes (Edgarton 2004). The pulse rate is controllable (e.g. can range from slow separate clicks to a fast stream of clicks), and the pitch generally resides lower than a singer's natural register. Joan La Barbara's *Cathing* (1977), *Autumn Signal* (1978), and *Twelve for Five in Eight* (1979) all incorporate vocal fry techniques.

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[123] The Extended Vocal Techniques Ensemble was established in 1972 at the University of California San Diego (UCSD). In 1975 they produced the *Lexicon of Extended Vocal Techniques*, a reference manual describing seventy-four different extended techniques, classifying them into three main categories: monophonic extensions (noted as a single clearly pitched sound); multiphonic extensions (two or more clearly pitched sounds); and miscellaneous extensions (indefinitely pitched sounds) (Brown 2002).

[124] One of the first compositions to utilize extended vocal techniques is Stockhausen's *Stimmung* (1968). Six vocalists realize the overtones of a low B-flat drone, and expand the sound spectrum by utilizing the harmonics of the low B-flat as fundamental frequencies.

Reinforced harmonics can also be identified as spectral accentuation. The harmonics of a sung fundamental are manipulated by adjustment of the resonance track (i.e. movement of the lips, tongue and/or jaw), which affects harmonic-to-formant tuning, creating bandwidth reduction or expansion within the resonating cavity. The range of possible fundamentals and harmonics vary. Reinforced harmonics can produce an awareness of two voices in the listener, most often perceived as a drone with a melody (similar to the sound of a bag pipe). The technique derives primarily from the spiritual chanting of Mongolian and Tuvan cultures, and is also used in sacred chanting of Tibetan monks, and Xhosa and Bulgarian women. Compositional examples of reinforced harmonics include Stockhausen's *Stimmung* (1968), and Joan La Barbara's *Voice Piece: One-Note Internal Resonance Investigation* (1974).

Ululation is a rapid and/or periodic interruption of a phonated tone. This technique can easily be produced through articulation of the tone either with aspiration (puffs of air or "h") or glottal stops. Ululation often sounds like the firing of machine gun or the bleating of sheep, and can be traced back to Renaissance vocal music, seen in the *trillo,* or *notae vinnulae* (neighing notes) (Leonard 1990, 50). Ululations are common in world music, though Joan La Barbara states her unawareness of their use in other cultures prior to her experimentation. La Barbara discovered this technique through her attempts to imitate birds. La Barbara pieces utilizing ululations include *quatre petites betes* (1978-79), *Twelve for Five in Eight* (1979), and *Klee Alee* (1979). Multiphonics are the most difficult, and inherently the most vocally dangerous extended technique. Common in the chanting of Tibetan monks, the production of this effect entails the creation of two pitches simultaneously by producing a multiphonic fundamental. This often involves vibration of the vocal folds *and* the ventricular folds (false vocal folds), but Tibetan chanters can produce chant with just vibration of vocal folds (Edgarton 2004). Tibetan and Tuvian singers build multiphonics from root up, through throat constriction, while La Barbara creates this effect by first singing the *upper* fundamental, and then relaxing her throat to create an octave below the sung pitch[125] (Brown 2002). La Barbara was inspired to experiment with chant tones while listening to a reading by Armand Schwerner of "Mila Repa" from the *Tibetan Book of the Dead* during an

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[125] La Barbara notes that she sometimes has the ability to create an additional sub-tone of a fifth below the lower octave multiphonic. Conversely, Tuvan throat singers do not create sub-tones.

improvisation rehearsal. Compositions with multiphonics include La Barbara's *Chandra* (1978) for solo voice, five male singers, and chamber orchestra; Morton Subotnick's *The Last Dream of the Beast* (1979) which was the first piece to compose multiphonics on specific pitches; and Charles Dodge's *The Waves* (1984) which uses various extended vocal techniques as well electronic processing of the voice. Both Subotnick's and Dodge's pieces were written for La Barbara.

For further research of extended vocal techniques, I encourage the reader to consult two books which present invaluable research on this subject, T. Wishart's *On sonic art* and M. Edgerton's *The 21st century voice: contemporary and traditional extra-normal voice*. Several PhD. Dissertations are devoted to extended techniques including: *Some compositional aspects and performance problems of selected extended vocal techniques* by D. Kavasch, *Proposal to expand solo vocal pedagogy to include selected extended vocal techniques* by G. Leonard, and *The Beautiful in Strangeness: The Extended Vocal Techniques of Joan La Barbara* by L. Brown. Specific references to these sources can be found in the bibliography of this thesis.

Appendix B: Works for voice and live electronics

The following information is based upon first-person contact with composers in the form of email and personal interviews, internet research, and a review of published documents, including CD liner notes and program notes. In many instances, the material is derived from email contact with the composer. When information is noted from the Internet, the website is noted in the footnotes. In cases where work is not published, the composer's contact information is given instead. Regarding the discussion of score notation, this has been included only in cases where the style deviates from standard/traditional notation practices.

Composer	David Adamcyk (b. 1975)
Title	Avant la larme (2006)
Instrumentation	Soprano, saxophone, electric guitar, live electronics
Tech. requirements	The following is a short list of equipment particular to this piece. Items may be substituted for others of equivalent quality and performance: 1 DPA head mic for singer 1 AKG clip on mic for sax, 1 AKG C-414 mic for guitar 6 EAW JFX100 speakers 1 mixer with at least 9 ins (3 XLR and 6 balanced 1/4") and 6 outs MacBook Pro laptop with 2x2.16 GHz processor speed (including1MB Ram, and running OS 10.4.8 and Max/MSP v.4.6.2) Motu Traveler soundcard 1 t.c. electronics M3000 reverb unit 3 HearBack units and small earphones (for click track)
Text	Inspired by Hugo Ball's sound poem *Gadji Beri Bimba*
Duration	11'
Composer contact	david.adamcyk@videotron.ca
Recording	Non-commercial recording available from composer
Notes	(See Chapter 6)

Composer	Aperghis, Georges (b. 1945, Athens)
Title	Machinations (2000)
Instrumentation	Four female voices, electronics and video projection
Tech. requirements	(unknown)
Text	François Regnault and Georges Aperghis
Duration	60′
Publisher contact	Éditions Durand-Salabert-Eschig / Ricordi Paris / Amphion (D. & F. 15403) 5, rue du Helder F-75009 Paris Téléphone : +33 (0)1 53 24 80 01 Télécopie : +33 (0)1 53 24 80 69 Web: www.durand-salabert-eschig.com
Recording	Una Corda, Accord 472916
Notes	Premiered at IRCAM (2000)

Composer	Aperghis, Georges
Title	Avis de Tempête (2004)
Instrumentation	Soprano, two baritones, dancer/actress, electronics, video and ensemble
Tech. requirements	Detailed information available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	Original text of Georges Aperghis and Peter Szendy with fragments of: Herman Melville, Charles Baudelaire, Victor Hugo, William Shakespeare and Franz Kafka
Duration	70′
Composer contact	georges.aperghis@wanadoo.fr Score can be downloaded on composer's website: http://www.aperghis.com
Recording	Cyprès, CYP 5621
Notes	Commissioned by Opera De Lille.

Composer	Berio, Luciano (1925-2003, Oneglia, Italy)
Title	Outis (1996)
Instrumentation	Opera/musical theater work for nineteen soloists, vocal group of eight singers, chorus, orchestra, live electronics
Tech. requirements	(unknown)
Text	By Berio and the Italian Hellenist Dario Del Corno; based on Homer's *The Odyssey*
Duration	Almost 2 hours
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Notes	Composed for Teatro alla Scala (La Scala), Milan, Italy.

Composer	Berio, Luciano
Title	Cronaca del luogo (1999)
Instrumentation	Musical theater /opera
Tech. requirements	Utilizes multimedia interactive systems for on-stage real-time movement analysis and control of sound synthesis and live electronics
Text	Talia Pecker Berio
Duration	(unknown)
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Recording	N/A
Notes	Composed for dramatic soprano Hildegard Behrens. Opera consists of a prologue and five scenes set within a biblical landscape.

Composer	Berio, Luciano
Title	Altra voce (1999-2001)
Instrumentation	Mezzo soprano, flute, live electronics
Tech. requirements	(unknown)
Text	Talia Pecker Berio
Duration	15′
Publisher contact	Universal Edition (not published yet) Universal Edition Aktiengesellschaft Karlsplatz 6 A-1010 Vienna Tel: 43/1/337 23 - 0 Fax: 43/1/337 23 – 400 Web: http://www.universaledition.com/ Email: office@universaledition.com

Notes

Berio notes: "As we all know, in true polyphony each voice contributes to the whole, yet retains its own identity, if not complete autonomy. In *Altra voce*, I have liberated one voice (mezzo-soprano) and one instrument (alto flute) from the whole and developed their respective autonomies and harmonic premises by, among other means, using live electronics.[126]

Composer	Burtner, Matthew (b. 1971, Alaska)
Title	Animus/Anima (2001)
Instrumentation	Voice and electronics
Tech. requirements	Large bass drum, sand blocks, 2-channel playback, two microphones, mixer with or without outboard devices or computer
Text	None
Score notation	Graphic
Duration	11′
Composer contact	mburtner@virginia.edu
Recording	Non-commercial recording available from composer
Notes	Extreme extended techniques.

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[126] (Giomi, et. al. 2003).

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Composer	Burtner, Matthew
Title	Imaq/Windcombs (2005)
Instrumentation	Bass voice (throat singing), female spoken voice, high blown instrument (such as flute or shakuhachi), low blown instrument (such as saxophone or horn), high chordal instrument (such as accordion or piano), low chord instrument (such as piano or organ), high string instrument (such as violin or viola), low string instrument (such as cello or bass), percussion, 4-10 moving theatrical percussionists, 4 dancers
Tech. requirements	Max/MSP, special instruments (supplied by composer), DVD projection, 2-6 channel sound projection
Text	Matthew Burtner
Score notation	Uses some aleatoric notation techniques
Duration	30′
Composer contact	mburtner@virginia.edu
Recording	Non-commercial recording available from composer
Notes	Harmonic throat singing, microtonal instrument technique, many extended instrumental techniques.

Composer	Burtner, Matthew
Title	Kuik (2006)
Instrumentation	Soprano, baritone (using harmonic throat singing), spoken voice, percussion, four dancers/aux percussionists, Windtree (special light sculpture/computer instrument created by composer), Shaman Hands (theatrical alternate controller hands instrument created by composer)
Tech. requirements	Max/MSP, special instruments (supplied by composer), DVD projection, 2-6 channel sound projection
Text	Alaskan legend by Antone Evan, libretto by Matthew Burtner
Score notation	Mixed notation score including a conductors score and separate instrumental parts – uses graphic and traditional notation
Duration	Several versions of varying lengths available. Full version 40′, Kuik aria version 17′
Composer contact	mburtner@virginia.edu
Recording	Non-commercial recording available from composer
Notes	Soprano uses a range of clicking/breath/sung styles, low voice, uses harmonic throat singing. More information available online: http://www-ccrma.stanford.edu/~mburtner/Kuik.html

Composer	Campion, Edmund (b. 1957, Dallas, Texas)
Title	Me (2001-02)
Instrumentation	Baritone and interactive computer system
Tech. requirements	Max/MSP, wireless microphone system, speakers (stereo to full surround sound)
Text	John Campion
Duration	14′
Composer contact	campion@cnmat.berkeley.edu
Recording	N/A
Notes	

Commissioned by the CIRM in Nice, France. "The second in a three-part collaboration by composer Edmund Campion and Poet John Campion, ME is a virtual, real-time exploration of the rise and development of consciousness in its egotistical, patriarchal sense. The persona 'ME' (represented by the sole baritone) grows through a series of archetypal and historic incarnations of the 'Everyman as Superman'."[127]

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Composer	Cole, Andrew (b. 1980, New York)
Title	I Sing Body Electric 7 (2006)
Instrumentation	Arranged for baritone or soprano, chamber ensemble, live electronics
Tech. requirements	Max/MSP, 10 mics, MOTU 828 (or any digital audio interface with 8 ins and outs), mixing board. The mixing board must be either a digital board that can connect to an audio interface and has at least 10 inputs, or an analog board with at least 17 inputs and 10 outputs.
Text	Walt Whitman
Score notation	Traditional
Duration	Between 7-9′
Composer contact	andrewscole@gmail.com
Recording	(see below)
Notes	

Originally composed for baritone and chamber ensemble. Winner of 2006 Prix d'ete. Soprano and baritone recordings available online:
http://pcm.peabody.jhu.edu/%7Eacole/music/ISBE7Soprano.mp3
http://pcm.peabody.jhu.edu/%7Eacole/music/I%20Sing%20Body%20Electric%207.mp3

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[127] As noted on the CNMAT website: http://cnmat.cnmat.berkeley.edu/~campion/MUSIC.ME/ME.htm

Composer	Danajloska, Evdokija (b. 1973, Tetovo, Macedoniaß)
Title	Dédoublement (2004)
Instrumentation	Female voice and electronics
Tech. requirements	Macintosh G4, Macintosh PowerBook, finger switch connected to MIDI
Text	(no text)
Duration	8′
Composer contact	evdokija_2000@yahoo.fr
Recording	Contact composer
Notes	Composed for IRCAM compositional course (2004).

Composer	Durieux, Frédéric (b. 1959, Paris)
Title	So schnell, zu früh (in memoriam Dominique Bagouet) (1993)
Instrumentation	Soprano, ensemble, real-time electronics
Tech. requirements	(unknown)
Text	Based on the text of J.S. Bach's Cantata BWV 26 *Ach wie flüchtig, ach wie nichtig*
Duration	18′
Publisher contact	Editions Henry Lemoine 41, rue Bayen 75017 PARIS Tel: 33 (0) 1 56 68 86 65 / Fax: 33 (0) 1 56 68 90 66 Web: http://www.editions-lemoine.fr
Recording	Adès/MFA/Fondation Crédit Lyonnais collection compositeurs d'aujourd'hui AD750
Notes	Commissioned by IRCAM, dedicated to the memory of Dominique Bagouet.

Composer	Emmerson, Simon (b. 1950 Wolverhampton, U.K.)
Title	Sentences (1990/91)
Instrumentation	Soprano, live electronics
Tech. requirements	Max/MSP version available from composer
Text	(see notes below)
Score notation	Extended traditional (time-space)
Duration	13′
Publisher contact	British Music Information Centre: www.bmic.co.uk or composer: s.emmerson@dmu.ac.uk
Recording	Sargasso (London): www.sargasso.com

Notes

"The original symbolism of the piece stems from a contrast of the simple elements earth, air, fire and water. This led directly to the choice of texts and the four movements of the piece: 1. Earth: Walt Whitman's *Passage to India* (from *Leaves of Grass*); 2. Air: Henry David Thoreau's *Woof of the sun, ethereal gauze*; 3. Water: Shakespeare's *Full fathom five*; 4. Fire: a combination ('alchemical transformation') of materials from the previous three texts."[128]

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[128] (Emmerson 1997, 316).

Composer	Everett, Steve (b.1953, Rome, Georgia)
Title	Endenich: Circle of Angels (1990)
Instrumentation	Soprano, flute, clarinet, piano, percussion, electronic instruments and HMSL interactive programming language
Tech. requirements:	Macintosh Computer with MIDI interface using HMSL Interactive Programming Language, 8 channels of sampled and digitally synthesized voices, MIDI foot-pedal, Pitchrider Analog-to-MIDI Converter, Digital Effects Processor, Stereo PA system, 5 microphones with stands
Text	*Tarantula* by Bob Dylan, chorale melody *"Wenn mein Stründlein vorhanden ist"*
Duration	9'
Publisher contact	Published by composer: gsevere@emory.edu

Notes

"**Concept** The last two years of Robert Schumann's life were spent in the psychiatric hospital in Endenich. Just prior to entering, Schumann was tormented by "voices" which appeared to him in dreams, first as angels singing beautiful melodies, then as demonic animals torturing him. The angels revealed a "glorious melody" which he notated, *Thema in Eb*, and later wrote a set of variations on. While at Endenich, Schumann also became increasingly obsessed with order that resulted in a renewed interest in the music of J.S.Bach. He spent numerous hours putting names and cities in alphabetical order. This is the setting for the material used in the work. The angels/demons, represented by the instruments, voice and computer-controlled electronics, are seen as surrounding the composer at times encouraging him with "beautiful melodies" (Thema in Eb) and with dense counterpoint at others.

Structures The formal design closely resembles a retrograde theme & variations form with ritornello-like episodes between the variations. Some melodic material is generated by manipulating pre-composed melodies, Thema in Eb by Schumann and the 16th century chorale melody, *Wenn mein Stründlein vorhanden ist*. Most of the melodic, harmonic, and rhythmic material is created by applying various transformations of the Magic Square of Venus. Magic squares are symmetric numerical patterns which have been used most perhaps by Renaissance alchemists for the transformation of base metals. The Magic Square of Venus is a 7x7 matrix. Text excerpts were drawn from poems in *Tarantula* by Bob Dylan.

Interaction The HMSL (*Hierarchical Music Specification Language*) programming language is a software environment, originally developed at Mills College in California, for computer-generated and computer-controlled composition. The composer, working in the FORTH-83 language on a Macintosh, develops his own interactive relationships between computer and performers. In this work, all performers except piano are able to interact with the computer."[129]

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[129] Steve Everett, personal email correspondence, 2006.

Composer	Everett, Steve
Title	Enter Dependent (1992)
Instrumentation	Soprano, alto saxophone, contrabass, keyboard and percussion/MIDI triggers, dancers & interactive electronic instruments
Tech. requirements:	Macintosh Computer with MIDI interface using HMSL Interactive Programming Language, 8 channels of sampled and digitally synthesized voices, MIDI foot-pedal, Pitchrider Analog-to-MIDI Converter, Digital Effects Processor, Stereo PA system & 5 microphones with stands
Text	*Tarantula* by Bob Dylan, chorale melody *"Wenn mein Stründlein vorhanden ist"*
Duration	25'
Publisher contact	Published by composer: gsevere@emory.edu
Recording	Available from composer
Notes	

"This work was written for the 1992 Arts Festival of Atlanta and New Music America. It was performed by Thamyris New Music Ensemble. The original version used an interactive computer program, Hierarchical Music Specification Language (HMSL), controlling instruments and four dancers. Dancers were able to input the computer through MIDI drum triggers. The concept of this work deals with the progressive stages which one encounters in letting go of dependencies. These stages often occur as one encounters various trials confronting the human condition. The electronic instruments are controlled by a Macintosh computer interpreting performer input using the composer's code written in HMSL (Hierarchical Music Specification Language)."[130]

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[130] Steven Everett, personal email correspondence, 2006.

Composer	Everett, Steven
Title	*The Maiden Returns* (1994-95)
Instrumentation	A music-poetry performance for two percussion, oboe, shakuhachi, steel drum, keyboard, harmonica, Tibetan bowl, didjeridoo, orators, dancer, tape, and interactive computer-controlled electronics using the Kyma sound synthesis system and Max programming language
Tech. requirements	Uses Kyma and Max, Macintosh computer
Text	Louise Glück, Revati Devi, Vimala, Sandra Bernhard
Duration	35′
Publisher contact	Published by composer: gsevere@emory.edu
Recording	Available from composer
Notes	

"This is a performance of interactive music-poetry in an exploration of principles associated with three Greek Goddesses: Aphrodite (sensuality, eroticism), Artemis (individuality and nature), and Hestia (security, protection). This performance provides a setting for audience members to explore diverse images of femininity in mythology and literature from around the world utilizing elements of music, theater, art, dance, computer interaction, poetry, humor, sacred texts, prayer, and ritual.

The interaction and aural framework are created using the Kyma digital sound-synthesis system and the Max programming language. This environment for sound computation is the basis for a morphogenetic model of computer music composition with real-time interactive performer input. It is used to record and transform sounds and words generated by performers."[131]

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[131] Steven Everett, personal email correspondence, 2006.

Composer	Everett, Steven
Title	*K A M* (1999)
Instrumentation	Interactive shadow play for actor, dancer, Javanese dalang (shadow puppeteer), psindhen (female vocalist), gamelan ensemble and western musicians,
Tech. requirements	Kyma Composition System, I-Cube Sensor System, Max, Videodelic interactive live video, and video projection system. Audio Equipment: Kyma computer music system (4 channel diffusion), Macintosh, MIDI mixer, 24 x 4 audio mixer, ADAT 8 channel digital recorder, Digital effects processors, 4 channel sound system (8 speaker locations) Video Equipment: 2 video projectors, 2 video players, 4 slide projectors 2 dissolve units, transparent theater projection screen app. 6 x 3m
Text	Based on an unpublished manuscript, *Ki Ageng Mangir*, by Indonesian author and political dissident, Pramoedya Ananta Toer
Duration	Two hours
Publisher contact	Published by composer: gsevere@emory.edu
Recording	Available from composer
Notes	

"Movement, shadow puppets, and music are able to interact with the use of several computer-based hardware-software programs: Kyma DSP Composition System, I-Cube Sensor System, MaxMSP Object Oriented Programming and Videodelic interactive live video."[132]

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[132] Steven Everett, personal email correspondence, 2006.

Composer	Everett, Steve
Title	Tembang Gede (2005)
Instrumentation	Soprano, contrabass, and interactive electronics
Tech. requirements:	Kyma, Macintosh computer
Text	Javanese: Tembang Macapat poetry "Pangkur"
Duration	9′
Publisher contact	Published by composer: gsevere@emory.edu
Recording	Available from composer
Notes	

"Tembang gede refers to a category of ancient Javanese poetic song (tembang macapat) of Indian origin written during the Hindu-Buddhist period of Javanese history (pre-15th century). Tembang macapat resembles western folk-song in its relatively free and performance by a solo singer. This composition uses text from the macapat form, Pangkur. The seven-line Pangkur is thought to have originally been created by Sunan Murjapada, one of the Moslem saints that brought Islam to Java in the 15th century.

This composition utilizes the Kyma sound processing system to create a "sonic bridge" between the vocalist and the instrumentalist. During the performance, each performer has the ability to control some aspect of each other's sound, creating a loop in the performer–instrument relationship. This expanded musical instrument concept merges the two instruments into one collaborative performer process."[133]

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[133] Steven Everett, personal email correspondence, 2006.

Composer	Felciano, Richard (b. 1930 Santa Rosa, California)
Title	Responsory (1991)
Instrumentation	Solo male voice and live electronics
Tech. requirements	Stereo amplification system, two signal processors, mixing board
Text	Plainsong Gradual for the Mass of Christmas Day
Score notation	Neumatic; tape cues and temporal cues in electronic part.
Duration	7′
Composer contact	felciano@cnmat.berkeley.edu
Recording	(unknown)
Notes	

"*Responsory* is set up in such a way that the singer sings only the original chant. While there are no new pitches, individual contours are isolated through pauses and sometimes repetitions, in order to form the appropriate 'contrapuntal' interaction with the processed sound, which is itself derived solely from the singer's voice. The composition of the work consisted in designing processes whose character would evolve to a conclusive end, not simply a momentary interaction with each plainsong gesture."[134]

Composer	Francesconi, Luca (b. 1956, Milan)
Title	Etymo (1994)
Instrumentation	For voices, instrumental ensemble, MIDI keyboard and live electronics
Tech. requirements	Two versions exist: one with electronics controlled in real time from a MIDI keyboard in the orchestra, the other with electronics recorded to tape. Performance handbook available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	Charles Beaudelaire
Duration	23′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Recording	To be released on EIC/IRCAM (2007)
Notes	Commissioned by IRCAM.

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[134] (Noted by Montanaro 2004, 91).

Composer	Gervasoni, Stefano (b. 1962, Bergamo, Italy)
Title	L'ingenuo (1993-94/2005)
Instrumentation	Voice, euphonium, horn and real-time live electronics
Tech. requirements	Performance handbook available online: http://mustica.ircam.fr/mustica/rendu/html/version.php?id=67
Text	Toti Scialoja based on a text of Voltaire
Duration	Approx. 18′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing (catalogue no: 136272) Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: http://www.bmgricordi.it/
Recording	Available online: http://www.stefanogervasoni.com/AIFF/L'Ingenuo-IRCAM20.1.06.aif
Notes	

Commissioned and realized at IRCAM. First performance of the final version, Paris, Grand Salle du Centre Pompidou (January 2006). Dedicated to Luisa Castellani et Toti Scialoja. More information available online :
http://www.stefanogervasoni.net/onthepieces/ingenuo.htm

Composer	Gervasoni, Stefano
Title	Projet Fado (at time of publication, *Projet Fado* in process of being composed at IRCAM)
Instrumentation	Double vocal song cycle for female voice, baritone, orchestral ensemble, Portuguese guitar, Spanish guitar and live electronics
Text	Text derived from the following traditional fados: *Barco negro, É Noite Na Mouraria. Fado Portugês, Fois Deus, Fria Claridade, Gaivota, Lagrima, Maria Lisboa, Medo, Meu Amor, Minha Boca Não Se Atreve, Nem à Paredes Confesso,* and *Primavera.*
Duration	70′
Composer contact	info@stefanogervasoni.net http://www.stefanogervasoni.net

Notes

"The female part is to be sung by a singer of fado. The second cycle is a kind of exploration of the Portuguese poetry of the 20th and 21st century, as well as contemporary poems that reference the ideals of "fado". This cycle is to be sung by a baritone. The two cycles are not presented one after the other, but instead are intertwined. Purely instrumental passages connect the various sections and comment upon the events of the singer's journey."[135]

Composer	Harvey, Jonathan (b. 1939, Sutton Coldfield, U.K.)
Title	One Evening (1994)
Instrumentation	Soprano, mezzo sop., chamber ensemble (8 players), two technicians, electronics
Tech. requirements	Two compact disc player units, two harmonizers, 8 microphones, mixer
Text	Han Shan, Rabindranath Tagore
Duration	35′
Publisher contact	Faber Music General and Licencing Enquiries: Faber Music Limited 3 Queen Square London WC1N 3AU Tel: +44 (0)20 7833 7900 Fax: +44 (0)20 7833 7939 Web: www.fabermusic.com Email: information@fabermusic.com
Recording	Universal 465 281-2 / CD available at www. ircam.fr (visit publications and CDs webpage)
Notes	Commissioned by the Electronic Studio of WDR, Cologne.

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[135] Stefano Gervasoni, personal email correspondence, 2006.

Composer	Harvey, Jonathan
Title	Wagner Dream (to be premiered April 2007)
Instrumentation	Opera with live electronics
Tech. requirements	(unknown)
Text	Libretto by Jean-Claude Carrière
Duration	(unknown)
Notes	

"The subject is Wagner's vision at death of the Buddhist legend of Prakriti and Ananda, 'Die Sieger'. The work was commissioned by Nederlandse Oper in association with the Grand Theatre de Luxembourg, the Holland Festival and IRCAM, and is a coproduction of De Nederlandse Opera, Holland Festival and Luxembourg Cultural Capital of Europe. *Wagner Dream* is to be premiered in the Grand Théâtre de Luxembourg."[136]

Composer	Kimura, Mari (b. 1962, Tokyo)
Title	Bucknerian (2001)
Instrumentation	Voice, interactive computer system (Note: optionally it is possible to add one more voice or instrumentalist)
Tech. requirements	Max/MSP
Text	None
Duration	5'30
Composer contact	marikimura@mac.com
Recording	Non-commercial recording available from composer
Notes	

"The work consists of 6 sections. Watch the timing displayed in the Max patch, and match it with the timing written in the score. The electronic part consists of two basic elements: 1) signal processing, and 2) soundfiles based on recordings from baritone Thomas Buckner's prerecorded soundtracks. The voice part is entirely improvised, with very loose suggested instructions. The most important element is to listen to the signal processing and soundfiles, [and] try to find the right improvisational vocabulary of your own. In sections 3 and 4, the pitches sung "F" above middle C may trigger percussion, but this is set randomly. Bucknerian could be performed with two persons (voice and an instrumentalist for example), by isolating left and right microphone inputs."[137]

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[136] As noted on the Netcells website: http://www.netcells.net/soundcell/cell.php?t=00037100000412

[137] Mari Kimura, personal email correspondence, 2006.

Composer	La Barbara, Joan
Title	Events in Elsewhere (1990)
Instrumentation	Interactive media opera for solo performer (mezzo soprano)
Tech. requirements	Pitch follower/pitch detector, MAC (G4 or G5) computer, Interactor® software, video (laser disc players), pitch generator, video projector, video projection screen, theatrical lights with computer board, sampler
Text	Extracts from Stephen Hawking's "A Brief History of TIme" and scientififc manuals
Duration	70'
Composer contact	joan@creatingmusic.com
Recording	Composer has video documentation of performances
Notes	

Contains extended vocal techniques: multiphonics, ululation, glottal clicks. The performer's voice triggers video sequences and sound samples. Pitch follower detects pitch range and sends that information to computer, which then sends message to laser disc players to play sequences, light board to trigger light events, samplers, etc.

Composer	Levin, Golan and Zach Lieberman with Jaap Blonk and Joan La Barbara
Title	Messa di Voce (2003)
Instrumentation	Audiovisual performance and instillation for voice and interactive media
Tech. requirements	Detailed information available online: http://www.tmema.org/messa/messa.html
Text	Abstract
Duration	unknown
Composer contact	golan@flong.com or zlieb@parsons.edu
Recording	Video docmentation available online: http://www.tmema.org/messa/messa.html
Notes	

"*Messa di Voce* (Ital., "placing the voice") is an audiovisual performance in which the speech, shouts and songs produced by two abstract vocalists are radically augmented in real-time by custom interactive visualization software. The performance touches on themes of abstract communication, synaesthetic relationships, cartoon language, and writing and scoring systems, within the context of a sophisticated, playful, and virtuosic audiovisual narrative. Tmema's software transforms every vocal nuance into correspondingly complex, subtly differentiated and highly expressive graphics. These visuals not only depict the singers' voices, but also serve as controls for their acoustic playback. While the voice-generated graphics thus become an instrument which the singers can perform, body-based manipulations of these graphics additionally replay the sounds of the singers' voices — thus creating a cycle of interaction that fully integrates the performers into an ambience consisting of sound, virtual objects and real-time processing. *Messa di Voce* lies at an intersection of human and technological performance extremes, melding the unpredictable spontaneity and extended vocal techniques of two master composer-improvisers with the latest in computer vision and speech analysis technologies. Utterly wordless, yet profoundly verbal, *Messa di Voce* is designed to provoke questions about the meaning and effects of speech sounds, speech acts, and the immersive environment of language."[138]

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[138] As noted online: http://www.tmema.org/messa/messa.html

Composer	lanza, alcides (b.1929, Argentina)
Title	Trilogy: Ekphonesis V (1979), Penetrations VII (1972), and Ekphonesis VI (1988)
Instrumentation	Actress-singer, lights, electronic sounds (tape), and electronic extensions
Tech. requirements	Voice processor (Digitech, Roland VP70), Lexicon LXP15 digital delay, mixer, sound system, special lighting requirements (similar equipment acceptable)
Text	alcides lanza
Score notation	Free, graphic
Duration	56′
Publisher contact	Shelan Publications
Recording	Shelan: eSp-9201-CD
Notes	

"*Trilogy* is an evening of music theatre for actress-singer, electronic sounds and electronic extensions with digital synthesizers and lighting effects. *Trilogy* is an autobiographical cycle of songs evoking the composer's youth, growing political awareness and mature reflections. The piece makes extensive use of multilingual texts – freely moving from English, to French, to Spanish, as well as invented languages. This song cycle represents ongoing research by the composer in the area of new approaches in writing for voice and electronic media."[139]

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[139] lanza, a. 1992. *Trilogy*. (Shelan, eSp-9201-CD)

Composer	lanza, alcides
Title	vôo (1992)
Instrumentation	Acting voice, electroacoustic music, digital signal processors
Tech. requirements	Wireless microphone with transmitter, vocal harmony processor
Text	alcides lanza (inspired by Gil Nuno Vaz's *No Olvido do Tempo*)
Score notation	Modern, free, graphic
Duration	12'41
Publisher contact	Shelan Publications
Recording	Shelan: eSp-9601-CD
Notes	

"*vôo* was commissioned by the Centro para la Promoción de la Música Contemporánea del Centro de Arte Reina Sofía [Madrid] to mark the celebration of the 500th anniversary of the first voyage to America by Christopher Columbus. While Spain celebrated this important event, many in the Americas deplored and condemned it as resulting in the devastation of the indigenous cultures. This piece seeks to address both sides of this controversy. While celebrating and acknowledging the gift of the 'asas da imaginação' which have carried so many explorers to the 'great beyond,' it also provides a caution to reflect where such explorations may finally take us. Columbus may not have discovered a new world, but this coming together of diverse cultures has certainly produced one."[140]

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[140] lanza, alcides et al. 1996. *New Music from the Americas, 3*. (Shelan, eSp-9601-CD)

Composer	Lanza, Mauro (b. 1975, Venice)
Title	Erba nera che cresci segno nero tu vivi (1999-2001) *from Nessun Suono d'Acqua*
Instrumentation	Soprano, live electronics
Tech. requirements	Max/MSP, trigger for soprano
Text	From Amelia Rosselli's *Prime Prose Italiane*
Score notation	Traditional, high rhythmic complexity, extensive use of microtones
Duration	14'30
Publisher contact	Ricordi BMG
Recording	Available from composer: <u>mauro.lanza@ircam.fr</u>
Notes	

"At the basis of this piece lies a reflection on the relationship between music and language. It is not a question of an analogical relationship. What interests me about language from a 'musical' point of view is not its rhetoric, but its form, its capacity to manage complexity with a reduced number of intelligible symbols. I was particularly influenced by the theories of generative linguistics; I find a lot of similarities between the model of language as a tree-like structure with several hierarchical structures, and the rhythmic idea that I developed in this piece. Indeed, in *Erba nera che cresci segno nero tu vivi*, the rhythmic component is preponderant (despite the idea of 'lyricism' that is always associated with solo voice), the superposition of different meters and speeds approaches the point of saturation. It is the principle of hierarchy derived from linguistics that avoids this saturation: all the patterns have a common ancestor, a veritable rhythmic skeleton that develops in an organic manner over the entire duration of the piece, making it pregnant with potential meanings and transparent, by giving an orientation to our perception of complexity. The richness of the rhythm contrasts with an extreme restraint in all the other parameters. Even the choice of text reflects this logic; all that is sung is the title, without consecutive repeats, expanded to the point of aligning its own form with the form of the piece itself. This fragment struck me by its obscure simplicity, a first attempt in Italian by its author, Amelia Rosselli, who grew up in France and England (the anthology from which it is taken is entitled *Prime prose italiane*); a couple of septenary verses, inserted into this prose collection, express a sober and mysterious tone."[141]

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[141] Mauro Lanza, personal email correspondence, 2006. Translated by Sean Ferguson.

Composer	Lanza, Mauro
Title	Mare, *from Nessun Suono d'Acqua* (2003-2004)
Instrumentation	Amplified soprano, amplified small ensemble, electronics
Tech. requirements	Stereo sound file triggering, two loudspeakers behind ensemble
Text	Amelia Rosselli
Duration	14′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Notes	Range is G#2-F4.

Composer	Lanza, Mauro
Title	Cane, *from Nessun Suono d'Acqua* (to be premiered March 2007)
Instrumentation	Soprano, ensemble, toy instruments, electronics
Tech. requirements	Stereo and 5 channel sound file triggering
Text	From Amelia Rosselli's *Prime Prose Italiane*
Duration	20′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Notes	The epilogue piece of Lanza's cycle *Nessun Suono d'Acqua*.

Composer	Leroux, Philippe (b. 1959, Boulogne sur Seine, France)
Title	Voi(REX) (2003)
Instrumentation	Soprano, ensemble, live electronics
Tech. requirements	Max/MSP, 8 channel sound diffusion. Performance handbook available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	Lin Delpierre
Score notation	Traditional and graphic
Duration	23′
Publisher contact	Gérard Billaudot Éditeur 14, rue de l'Échiquier 75010 Paris, France Tel: (33 1) 47 70 14 46 Fax: (33 1) 45 23 22 54 Email: info@billaudot.com Web: http://www.billaudot.com
Recording	Soupir NTCD 358
Notes	

Highly virtuosic vocal writing. Commission of IRCAM and the French cultural ministry, first performance January 2003. "Voice is here pure material - indeed, the piece never ceases to introduce new ways of singing - but never at the expense of the meaning of the poem. A rare achievement: creating space, setting up the stage, calling drama into existence by the sole use of tools which could have been considered neutral, Philippe Leroux gives life to compositional models, strategies and process."[142]

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[142] As noted on the Gérard Billaudot Éditeur website: http://www.billaudot.com/_english/compo_lero.html

Composer	Leroux, Philippe
Title	Apocalypsis (2006)
Instrumentation	Four voices, ensemble, electronics
Tech. requirements	Max/MSP, 8 channel sound diffusion
Text	Philippe Leroux
Score notation	Traditional and graphic
Duration	20′
Publisher contact	Gérard Billaudot Éditeur 14, rue de l'Échiquier 75010 Paris, France Tel: (33 1) 47 70 14 46 Fax: (33 1) 45 23 22 54 Email: info@billaudot.com Web: http://www.billaudot.com
Recording	N/A
Notes	Commission of BIT20 Ensemble and IRCAM. First performed on Radio France, June 2006.

Composer	Lévinas, Michaël (b. 1949, Paris)
Title	Concertations (1997)
Instrumentation	Four voices, flute, percussion, MIDI keyboard and real-time devices
Tech. requirements	Performance handbook available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	(unknown)
Duration	20′
Publisher contact	Éditions Durand-Salabert-Eschig / Ricordi Paris / Amphion (D. & F. 15403) 5, rue du Helder F-75009 Paris Téléphone : +33 (0)1 53 24 80 01 Télécopie : +33 (0)1 53 24 80 69 Web: www.durand-salabert-eschig.com
Notes	Commissioned by Citée de la Musique, *Concertations* can be performed as an installation or concert.

Composer	Lévinas, Michaël
Title	Les Nègres (2004)
Instrumentation	Opera in 3 acts for 13 voices, choir, orchestra and real-time devices
Tech. requirements	(unknown)
Text	From Jean Genët's play of the same name
Duration	105′
Publisher contact	Editions Henry Lemoine 41, rue Bayen 75017 PARIS Tel: 33 (0) 1 56 68 86 65 / Fax: 33 (0) 1 56 68 90 66 Web: http://www.editions-lemoine.fr
Notes	Commissioned by Opéra De Lyon.

Composer	Manoury, Philippe (b. 1952, Tulle, France)
Title	En Écho (1993)
Instrumentation	Soprano, interactive computer electronics
Tech. requirements	Real-time system (Max/MSP) and multi-channel sound system. Performance handbook available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	A series of erotic poems written at Manoury's request by French poet and novelist Emmanuel Hocquard (b.1940)
Duration	30′
Publisher contact	Durand Representative in US: Boosey & Hawkes, Inc. Universal -35 E. 21 St., New York, NY 10010 Web: http://www.boosey.com/ Tel: (212) 358 5300 ext. 2 Fax: (212) 358 5307 Email: hirelibrary.us@boosey.com
Recording	Premiere Music Distributors, ACRD465526-2
Notes	(see Chapter 6)

Composer	Manoury, Philippe
Title	60e Parallèle (1995-1997)
Instrumentation	Opera for voices, large orchestra, and electronic sounds
Tech. requirements	Real-time system (Max/MSP) and multi-channel sound system
Text	Libretto by Michel Deutsch
Duration	1 hour 30′
Publisher contact	Durand Representative in US: Boosey & Hawkes, Inc. Universal -35 E. 21 St., New York, NY 10010 Web: http://www.boosey.com/ Tel: (212) 358 5300 ext. 2 Fax: (212) 358 5307 Email: hirelibrary.us@boosey.com
Recording	Naxos: 8.554249-50
Notes	Commissioned by the Théâtre du Châlet and IRCAM.

Composer	Manoury, Philippe
Title	K... (2001)
Instrumentation	Opera for voices, orchestra, and real-time electronics
Tech. requirements	Real-time system (Max/MSP) and multi-channel sound system
Text	Written by Bernard Pautrat and André Engel, derived from Franz Kafka's *Der Prozess*
Duration	Twelve scenes
Publisher contact	Durand Representative in US: Boosey & Hawkes, Inc. Universal -35 E. 21 St., New York, NY 10010 Web: http://www.boosey.com/ Tel: (212) 358 5300 ext. 2 Fax: (212) 358 5307 Email: hirelibrary.us@boosey.com
Recording	N/A
Notes	Premiered at Paris Opera.

Composer	Manoury, Philippe
Title	La Frontière (2003)
Instrumentation	Chamber opera in four acts for six singers, nine musicians and real-time electronics
Tech. requirements	Real-time system (Max/MSP) and multi-channel sound system
Text	Libretto by Daniela Langer
Duration	90'
Publisher contact	Durand Representative in US: Boosey & Hawkes, Inc. Universal -35 E. 21 St., New York, NY 10010 Web: http://www.boosey.com/ Tel: (212) 358 5300 ext. 2 Fax: (212) 358 5307 Email: hirelibrary.us@boosey.com
Recording	N/A

Composer	Manoury, Philippe
Title	Noon (2003)
Instrumentation	Large work for soprano, choir, orchestra, and real-time electronics.
Tech. requirements	Real-time system (Max/MSP) and multi-channel sound system
Text	Emily Dickenson
Score notation	Traditional
Duration	47'
Publisher contact	Durand Representative in US: Boosey & Hawkes, Inc. Universal -35 E. 21 St., New York, NY 10010 Web: http://www.boosey.com/ Tel: (212) 358 5300 ext. 2 Fax: (212) 358 5307 Email: hirelibrary.us@boosey.com
Recording	N/A

Composer	Nicoli, Andrea (b. 1960, Torino, Italy)
Title	Nessun soffio d'ali (1997)
Instrumentation	Soprano, percussion, live electronics
Tech. requirements	Microphones, amplification, 2 speakers, Max/MSP
Text	G. Caproni
Score notation	Manuscript
Duration	11'40
Publisher contact	Ars Publica Web: www.arspublica.it Email: info@arspublica.it
Recording	Elettroacustica 1 (CD ARS 142-001)
Notes	Vocal writing includes microtonalities and extended vocal techniques

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Composer	Nicoli, Andrea
Title	Segni, cittá (1998)
Instrumentation	Soprano, contralto, cello, live electronics
Tech. requirements	Microphones, amplification, 2 speakers, Max/MSP
Text	From I. Calvino
Duration	11'
Publisher contact	Ars Publica Web: www.arspublica.it Email: info@arspublica.it
Recording	Non-commercial recording available from composer: adrnic@inwind.it
Notes	Vocal writing includes microtonalities.

Composer	Nicoli, Andrea
Title	Ni anverso ni reverso (1999)
Instrumentation	Female voice, 3 female choirs, live electronics
Tech. requirements	Microphones & radio-microphone, amplification, 4 speakers, Max/MSP
Text	J. L. Borges, A. Robbe-Grillet, E. Sanguineti, L. Ariosto, Ovidio, F: Dürrenmatt, A. Nicoli
Score notation	Manuscript
Duration	28′
Publisher contact	Ars Publica Web: www.arspublica.it Email: info@arspublica.it
Recording	Non-commercial recording available from composer: adrnic@inwind.it
Notes	Vocal writing includes extended vocal techniques, microtonalities, and recitation (if possible in non conventional space, the soloist should walk within the audience).

Composer	Nicoli, Andrea
Title	distrazione (frammenti 1) (1999)
Instrumentation	Soprano and live electronics
Tech. requirements	Max/MSP, microphone, 2-4 speakers
Text	Originally the poetry of Andrea Zanzotto. Has been rewritten by composer.
Duration	12-15′
Publisher contact	Ars Publica Web: www.arspublica.it Email: info@arspublica.it
Recording	Ars Publica ARS141-004 www.arspublica.it/catalogo_cd
Notes	Requires advanced extended vocal techniques.

Composer	Nono, Luigi (1924-1990, Venice)
Title	Quando stanno morendo, Diario Polacco nr. 2 (1983)
Instrumentation	4 female voices, flute, cello and live electronics
Tech. requirements	(unknown)
Text	Czeslaw Milosz, Endre Ady, Aleksandr Blok and Velemir Khlebnikov – selected and edited by Massimo Cacciari
Duration	c. 42′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano - 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 E-mail rental.ricordi@bmg.com
Recording	col legno WWE 1SACD 20603
Notes	Detailed information available online: http://d-sites.net/english/nonopolacco.htm

Composer	Nono, Luigi
Title	Prometeo – Tragedia dell'ascolto (1984)
Instrumentation	Two sopranos, two contraltos, tenor, mixed choir, two actors, four instrumental groups, live electronics
Tech. requirements	(unknown)
Text	Assembled by Massimo Cacciari, also uses excerpts from Benjamin (sung and recited in Italian and ancient Greek)
Duration	Over 2 hours
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Recording	EMI Classics: 7243 5 55209 to 11
Notes	

"In the form in which it was presented at its first performance in the deconsecrated church of San Lorenzo in Venice on 29 September 1984, Nono's *Prometeo* represented the first stage of a journey that had begun a long time previously and which culminated for the present in a monumental score lasting almost three hours in performance. As a result of a series of cuts following the dress rehearsal, the work finally lasted two and a quarter hours. For the performances in Milan a year later a new score was produced, some parts of which were newly composed, while others were thoroughly revised or taken over unaltered. It is this second version that has been used for all performances since 1985."[143]

Composer	Pahg, Sun-Young (b. 1974, Korea)
Title	La fenêtre de Rozalie (2005)
Instrumentation	Mezzo-soprano, percussions, timée and electronic real-time devices
Tech. requirements	Detailed information available online: http://mustica.ircam.fr/mustica/rendu/index.php?action=all#
Text	Two poems of Rozalie Hirs: *Responsorium* and *Focus*
Duration	15′
Composer contact	sypahg@yahoo.de
Recording	Available from composer
Notes	Created during the IRCAM composition course (2005).

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[143] Nono, Luigi. 1995. *Prometeo: Tragedia dell'ascolto.* (EMI Classics: 7243 5 55209 to 11).

Composer	Parra, Hèctor (b. 1976, Barcelona)
Title	Strette (2003)
Instrumentation	Monodrama for soprano, electronics, live video, and lighting
Tech. requirements	(unknown)
Text	Based on the poem *Engführung* by Paul Celan
Duration	13′
Composer contact	hectorparra2@yahoo.es
Recording	(unknown)

Notes

Created during the IRCAM composition course (2003). "The different elements of a dramatic piece (sound, human voice, text, image and scenography) are treated and related according to the idea that the dramatic nucleus is constituted by the sound flow itself and its live relationship with the image and the psycho acoustical space. The public is invited to perceive the drama in a polyhedral and abstract form, which is the pretended outcome of his perceptual immersion into acoustical and visual spaces that play an active roll."[144]

Composer	Pennycook, Bruce (b. 1949, Toronto)
Title	Amnesia, Praescio-II (1989)
Instrumentation	For soprano, flute, synth, violin, cello, interactive system
Tech. requirements	Technologies no longer exist (though composer indicates his willingness to consider reconstructing the piece with Max/MSP)
Text	Tessa McWatt
Duration	12′
Publisher contact	Bruce Pennycook/Penntech-Records.com
Recording	McGill Records / Tornado: Electroacoustic Compositions
Notes	Amnesia, Praescio-II recorded as a chamber version without electronics. Score available for sale online: www. penntech-records.com Vocal range from A3 to B5.

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[144] As noted on Hèctor Parra's website: http://hermes.ffn.ub.es/~jmparra/hector/

Composer	Radford, Laurie
Title	in the angle (1998)
Instrumentation	Amplified soprano, clarinet in Bb/bass clarinet, violin, piano, pre-recorded electroacoustic files, live digital signal processing
Tech. requirements	Present version uses manual control via Max/MSP to trigger audio files and perform all signal processing.
Text	Original text by Laurie Radford
Duration	17′
Composer contact	Laurie.Radford.1@city.ac.uk
Recording	Available from composer: Laurie Radford - 1st Floor Flat 70 Muswell Road London N10 2BE United Kingdom

Notes

"*in the angle* is the second in a trilogy of works for voice(s) and ensemble which seeks parallel expression in music and words. In addition to a solo voice and three instruments (clarinet /bass clarinet, violin, piano), *in the angle* adds the sonic elements of prerecorded and live manipulated sound via a unique MIDI controller, the AXiO ('alternative expressive input object') built and designed by Brad Cariou and David Eagle (a version employing playback of prerecorded sound files is also available). Each section of *in the angle* is a short, contrasting vignette presented by a solo, duo, trio, quartet or quintet of performers. In this respect, the work represents an attempt to construct a formal design that creates continuity and coherence over the course of the work while initially appearing to be highly fragmented. The text deals with fear, the confrontation of past and future, innocence and age, the dreamed versus the sensual, the ideal and the everyday. I had a distinct image of an individual thrust into the varying degrees of a threatening angle, forced to confront the near and far, the oppressive and the lonely. The intensity of the need to protect and provide nourishes my daily and finds in this work an outlet into which it pours and froths. The AXiO MIDI controller in this piece controls the triggering of prerecorded audio as well as signal processing effects. A mild form of interactive processing and event control is provided by the actions of the AXiO performer as translated by the MIDI generating and transforming software environment, Max. The prerecorded audio components were designed using software such as Peak, SoundHack, Waves, Csound, SuperCollider, HyperPrism, and Sample Cell II. *in the angle* was commissioned by Ensemble Résonance of Calgary with financial assistance from The Canada Council."[145]

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[145] Laurie Radford, personal email correspondence, 2006.

Composer	Radford, Laurie
Title	of circles and seconds (1999)
Instrumentation	Amplified soprano, soprano saxophone, violoncello, percussion, live digital signal processing
Tech. requirements	Present version uses manual control via MaxMSP to perform all signal processing.
Text	Laurie Radford
Duration	12′
Composer contact	Laurie.Radford.1@city.ac.uk
Recording	Available from composer: Laurie Radford - 1st Floor Flat 70 Muswell Road London N10 2BE United Kingdom

Notes

"*of circles and seconds* is the third in a trilogy of works for voice and a small ensemble of instruments. Each work in the trilogy seeks a parallel expression in music and words. Both the music and the text for each work were conceived simultaneously in an attempt to provide and maintain a close relationship between the two. The text deals with time and circularity, the sense of dizzying yet suspended momentum within circular movement. Metaphors derived from or utilizing these concepts probe, in fragmentary glimpses, various universal issues. The music also confronts time and circularity in its preoccupation with rhythmic devices and structure, the varied return and repetition of melodic and harmonic materials, as well as certain gestural elements that provide a sense of illusive direction. Live signal processing subtly transforms the instrumental and vocal timbres as well as various aspects of time and rhythm. *of circles and seconds* was commissioned by Productions Traquen'Art of Montréal with financial assistance from The Canada Council."[146]

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[146] Laurie Radford, personal email correspondence, 2006.

Composer	Radford, Laurie
Title	I was struggled…! (2002)
Instrumentation	Voice, piano, electroacoustic music, digital signal processing
Tech. requirements	Prerecorded electroacoustic audio materials and live signal processing of the voice and piano via manual control of Max/MSP
Text	Laurie Radford
Score notation	Standard, graphic indications of electroacoustic materials, graphic and verbal indications of suggestions for dramatic movement and interpretation
Duration	10′
Composer contact	Laurie.Radford.1@city.ac.uk
Recording	Available from composer: Laurie Radford - 1st Floor Flat 70 Muswell Road London N10 2BE United Kingdom

Notes

"*I was struggled…!* was written for pianist alcides lanza and singer/actress Meg Sheppard. Creating, writing, and composing seems to get more difficult not easier with time and experience, but rather, more demanding of self, of broader perspectives on the art and its practices, of intentions, objectives and expectations. This struggle serves as the dramatic origin for the mini-music drama for voice, piano and electroacoustic music of *I was struggled…!*. One part of the drama unfolds for the vocalist as she confronts the physical performance space, the acoustic space generated by the piano and electroacoustic materials, and her own personal creative space, struggling with lofty aspirations, emotional baggage and the very act of vocalization. A second drama occurs between the piano and the electroacoustic materials, most of which are transformed or extended piano sonorities. The piano engages these familiar sounds, gliding above them, giving way to them, finding an equal footing with them. For a few brief moments, the vocalist and pianist find themselves sharing the same musical space, only to veer off to explore their own private ruminations at the conclusion of the work."[147]

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[147] Laurie Radford, personal email correspondence, 2006.

Composer	Rovan, Joseph
Title	Vis-à-Vis
Instrumentation	Monodrama for voice, interactive computer music and interactive video
Tech. requirements	Two computers (one for the audio, one for the video), audio interface for the computer, headset microphone, video projector & screen, sound system and mixer
Text	Based on Rilke's *Notebooks of Malte Laurids Brigge*
Score notation	Standard notation, some rhythmic notation used for speaking
Duration	28′
Composer contact	Joseph_Rovan@brown.edu
Recording	DVD available from composer
Notes	

Range is from E below middle C to high B (ossia part for low register is possible). Detailed information available online:
http://www.soundidea.org/rovan/portfolio-text/vis-a-vis_BOOKLET.pdf

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Composer	Rowe, Robert (b. 1954, USA) with Nick Didkovsky and Neil Rolnick
Title	The Technophobe and the Madman (2001)
Instrumentation	Soprano, bass, piano, electric bass, organ, drums, interactive system and live electronics
Tech. requirements	Two computers with custom software, high-speed internet2 connection
Text	Tyrone Henderson, Valeria Vasilevsky, and Quimetta Perle
Duration	30′
Publisher contact	Composer: robert.rowe@nyu.edu
Recording	Performance can be viewed online: http://www.academy.rpi.edu/projects/technophobe/

Notes

The Technophobe and the Madman was a telecommunications video-music collaborative performance presented in 2001. Performers shared audio and video between two locations: Frederick Loewe Theatre, New York City and iEAR Studio, Troy, New York. The performance used Internet 2 connection, 12 channels audio and 6 channels full screen video.[148]

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[148] Robert Rowe, personal email correspondence, 2006.

Composer	Saariaho, Kaija (b. 1952, Helsinki, Finland)
Title	Nuits, adieux (1991)
Instrumentation	Soprano, mezzo, tenor, bass and live electronics
Tech. requirements	8 microphones, Yamaha SPX 1000 or similar, Lexicon LXP-15, digital reverberation, at least two loudspeakers, mixer, stereo amplification
Text	Jacques Roubaud,
Duration	10′
Publisher contact	Chester Music LTD - Head Office 14-15 Berners Street, London W1T 3LJ Tel: 44 (0) 20 7612 7400 Fax: 44 (0) 20 7612 7545 Web: www.chesternovello.com Email: promotion@musicsales.co.uk
Recording	RTVE Sibelia - 003
Notes	

"The general singing style should be, when possible, nearer to 'natural singing' than the typically trained, western style singing with its steady, well supported voice."[149]

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[149] Saariaho, K. 1991. *Nuits, adieux: For four singers and live electronics.* Copenhagen: Wilhelm Hansen.

Composer	Saariaho, Kaija
Title	Lonh (1996)
Instrumentation	Soprano, live electronics
Tech. requirements	Trigger for soprano
Text	(See below)
Duration	15′46
Publisher contact	Chester Music LTD - Head Office 14-15 Berners Street, London W1T 3LJ Tel: 44 (0) 20 7612 7400 Fax: 44 (0) 20 7612 7545 Email: promotion@musicsales.co.uk Web: www.chesternovello.com
Recording	Ondine – ODE 906-2
Notes	

"The title *Lonh*, meaning far away or distant, comes from the old Provençal language, in which the text is sung. The text itself, a poem about love from afar, famous among scholars of mediaeval poetry, is attributed to the mediaeval troubadour Jaufré Rudel. Formally, the piece loosely follows the form of the poem, and is thus divided into nine sections. Some of the symmetrical and repeating aspects are found in the solo soprano part, which as such uses rather freely the elements for the original text, so that the resulting text is rather a collage based on Rudel's song. In the electronic part, one can hear the text in three languages: Occitan (Provençal), French and English. The texts in Occitan were read by the poet Jacques Roubaud - who has intensively studied this poem and also translated it into French - and also by Julie Parsillé, a young French girl. The French version was read by Jean-Baptiste Barrière, and the English text by Dawn Upshaw, whose recorded singing voice is also part of the sonic material heard from the electronic part."[150]

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[150] As noted on the Chester Novello website:
http://www.chesternovello.com/default.aspx?TabId=2432&State_3041=2&workId_3041=7852

Composer	Sciarrino, Salvatore (b. 1947, Palermo)
Title	Perseo e Andromeda (1990)
Instrumentation	Opera for voice and triggered synthetic sounds
Tech. requirements	(unknown)
Text	Libretto by Salvatore Sciarrino
Duration	1 hour 10′
Publisher contact	Casa Ricordi - BMG Ricordi Music Publishing Music Rental Service Via Liguria 4 - fr. Sesto Ulteriano 20098 S.Giuliano Milanese (MI) Tel. (02) 98813.4220/4302 Fax (02) 98813.4258 Web: http://www.ricordi.com/ E-mail: rental.ricordi@bmg.com
Recording	BMG Ricordi B00005AMLW

Composer	di Scipio, Agostino (b. 1962, Naples)
Title	Sound & Fury (1995-98)
Instrumentation	Two actors, two percussionists, 8-track digital audio, interactive computer system, slide projection
Tech. requirements	(unknown)
Text	Based on excerpts from: Shakespeare's *The Tempest*, Auden's *The Mirror and the Sea*, and original lyrics by Eugenio Tescione
Duration	10′
Publisher contact	(unknown)
Notes	

A theatre of noise, sounds, and sometimes voices. Includes: (1) Natura allo Specchio (1998) – 8-track digital audio (2) L'Isola (1995) – 2 voices, 2 or more percussionists, interactive system, 8-track digital audio (3) Intermezzo - Intermittence (1998) – 2- or 8- track digital audio (4) Caliban, all'uditorio (futuro) (1997) – 2 voices, 2 or more percussionists, interactive system, 8-track digital audio (5) Specchio alla Natura (1996) – 8-track digital audio, interactive system. Slide projection by Manilio Prignano.[151]

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[151] As noted online: http://xoomer.alice.it/adiscipi/Sound&Fury.htm

Composer	Settel, Zack (b. 1957, New York)
Title	Hok Pwah (1993)
Instrumentation	Soprano, percussion, live electronics
Tech. requirements	Originally written for Max
Text	(see below)
Duration	19′
Publisher contact	(unknown)
Recording	CDCM vol. 23 CRC 2302
Notes	

"The text in the piece is modified via the singer's voice with the aid of special analysis and signal treatment software written in MAX… Using articulation recognition and rich signal processing/synthesis configurations, various elements of the text (syllables, inflection, etc.) can be treated or 'colored' in specific ways… The texts for the piece are chosen for their structural (phonetic) properties and onomatopoetic tendencies, both of which can be accentuated or brought out by the singer and electronics. Imbedded in the text are many elements which are brought to the surface during performance."[152]

Composer	Settel, Zack
Title	L'enfant des glaces (2000)
Instrumentation	Electroacoustic opera with real-time vocal processing
Tech. requirements	(unknown)
Text	Based on texts of Gérard de Nerval and Francisco Gomez de Quevedo
Duration	1 hour 10′
Contact	Chants libres Tel: (514) 841-2642 Email: creation@chantslibres.org
Recording	Atma classique 5000(DVD)
Notes	A production of the Montreal opera company Chants libres. Conceived by Pauline Vaillancourt.

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[152] Settel, Zack et al. 1996. *The Composer in the Computer Age.* (CDCM vol. 23 CRC 2302 - CD)

Composer	Subotnick, Morton, Joan LaBarbara and Mark Coniglio
Title	Misfortune of the Immortals (1994)
Instrumentation	Interdisciplinary, interactive media opera for voices, dancers, actors, video projections, MIDI instruments and interactive computer system
Tech. requirements	(unknown)
Text	"The title of the work is taken from a Max Ernst collage book and suggests the often fantastic, sometimes poignant and always ephemeral quality of our species' attempt at using technology to place us beyond nature."[153]
Duration	(unknown)
Composer contact	Morton Subotnick: morts@creatingmusic.com Joan La Barbara: joan@creatingmusic.com

Notes

In *The Misfortune of the Immortals* "… technologies extend the reach of the protagonists to the edge of their world: the stage space…and beyond. Sensors attached to the bodies of each performer establish a line of communication to the technological environment through MIDI Dancer, developed by Mark Coniglio, and a pitch follower which translates vocal material into information accessible to the computer for voice control of the environment, all programmed through Interactor, a software program developed by Coniglio and Morton Subotnick. By placing technology at the forefront as a dramatic device, allowing the performers access to specific realtime control of sound, video, lighting, the entire stage environment, we provide a vehicle fore the exploration of our relationship with technology."[154]

[153] As noted online: http://www.vasulka.org/archive/ExhFest6/Walker/MisfortuneImmortals.pdf
[154] Ibid.

Composer	Subotnick, Morton
Title	Intimate Immensity (1997)
Instrumentation	Four performers, electronically controlled pianos, computer-generated, digitally processed sounds, lighting and laser disc images
Tech. requirements	Technical information available online: http://www.creatingmusic.com/subotnick/ Immensity.html#COMPOSER%CCS
Text	Inspired by Gaston Bachelard's *The Poetics of Space* and David Rothberg's *Hands End*. Includes excerpts from Kafka's *Parables and Paradoxes*, and references to Marshall McLuhan and Lewis Mumford
Duration	(unknown)
Composer contact	morts@creatingmusic.com
Notes	

Developed at the California Institute of the Arts Center for Experiments in Art, Information and Technology. Premiered at the Lincoln Center Festival, New York. Subotnick states: "The work is a meditation on our love affair with technology."[155]

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[155] As noted on Subotnick's website:
http://www.creatingmusic.com/subotnick/Immensity.html#COMPOSER%CCS

Composer	Zwaanenburg, Jos (b. 1958, Bovenkarspel, Netherlands)
Title	The Longest Mauvais Quart d'Heure (2002)
Instrumentation	Voice & electronics, bass flute & electronics, contrabass recorder (Paetzold) & electronics and electronic keyboards.
Tech. requirements	Three Macintosh computers running Max/MSP, LiSa (live sampling software by STEIM Amsterdam) and BigEye (video-to-MIDI software also by STEIM Amsterdam (for more details see <http://www.steim.org/steim/products.html>), guitar effects for both flutes, reverbs etc., atomized via Max/MSP for all instruments, including the voice. Stereo amplification is required. Extra loudspeakers built in the singer's cell (see below) to define the speech of 'the machine' (see below). Video camera and digitizer required for the video-to-MIDI, which is operated by the singer (her movement in front of the camera trigger parts of her accompaniment). The projected close ups of her mouth refer to Samuel Beckett's *Not I* (1972).
Text	Written by the composer, inspired by E.M. Forster's short story *The Machine Stops*.
Score notation	Score mainly notated in 'lead-sheet' format. Extensive improvisation asked for in order to explore the interactive behavior of the electronics in a style similar to jazz or pop.
Duration	c. 50'
Composer contact	zwaanenburg@open.net
Recording	Available for purchase online at www.fmr-records.com (search for WATT?, the name of the ensemble)
Notes	

"Microtonal tunings (based on 'guslar' singing) used in some of the songs. Usage of extended vocal techniques encouraged in the improvisations, but is not compulsory. In order to make the video-to-MIDI work in a consistent manner, the staging is very important. The singer resides in a hexagonal cell during much of the show (built by the composer). She acts in front of the video camera, and the images are used to trigger MIDI sounds and are also projected on the front side of the cell, allowing the audience to wonder how a video projection can be completely synchronized with the 'real' musicians on stage."[156]

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[156] Jos Zwaanenburg, personal email correspondence, 2006.

Appendix C: Methods for learning contemporary and electronic music

I. OVERVIEW – BEFORE THE FIRST NOTE IS SUNG!
- Read any accompanying score notes (usually refer to contemporary notation)
- Read any available program notes or articles published on the piece
- Research the background of the composer, poet, and any relevant historical information
- Mark score with colored highlighters or pencils, clearly outlining…
    - Meter changes
    - Tempi changes
    - Dynamics
    - Extended vocal techniques
- Translate text
- Divide piece into sections based on changes of tempo, new material, etc.
- Identify difficult or potentially problematic passages
- Listen to recording once (when available) to get a global sense of the piece

II. GETTING STARTED WITH THE LEARNING PROCESS
- Pitches
    - Play notes on the piano (not adhering to strict rhythm)
    - Identify intervallic relationships
    - Work at a slow tempo!
    - Relate pitches to a tonal or chordal progression when possible
    - Sing pitches without specific rhythms on a neutral syllable, adhering to a general sense of rhythmic proportion (i.e. sixteenth note gestures sung faster than eighth notes or quarter notes)
    - Piece difficult passages together at a slower tempo

    When learning new music, <u>always</u> transpose higher pitches down an octave until the ear knows the intervallic progression exactly. This will save the voice unnecessary vocal fatigue.

- Rhythm
    - Tap or *ta* difficult rhythms
    - Play pitches in rhythm on the piano (when piano skills allow)
    - When rhythm is solid, begin to sing pitches in rhythm slowly and lightly, still on a neutral syllable
    - Use a metronome! Start very slowly, gradually work up to tempo

- Text
    - IPA the text (if unfamiliar with the language, work with a coach)
    - Speak text out of rhythm
    - Drone text in monotone
    - Drone text in rhythm
    - Incorporate text into pitches and rhythms

- Dynamics
  - Incorporate dynamics only when the piece can be comfortably sung up to tempo at a *mezzo forte*
  - Don't sing beyond individual vocal capabilities! A *fff* should only be as loud as it is vocally comfortable!

III. REHEARSING THE ELECTRONICS
- Be able to sing the piece comfortably and up to tempo *before* incorporating the electronics
- If other instruments involved, rehearse separately before incorporating electronics
- Understand the role the electronics play in the piece
  - Ex. types of vocal processing, interactive elements based on sung vocal material
- Understand the *performer's role*
  - Ex. triggering sound files, establishing tempi changes
- Work with rehearsal patch if available
- Work with click track if available
- If possible, listen to electronics while singing the piece *silently* to obtain an in-depth understanding of the accompaniment
- Leave ample time to rehearse with the full set-up!

IV. DIFFICULTIES UNIQUE TO SINGERS
- Learning to sing with a microphone / wear a headset
- Coordination of singing and using triggers simultaneously
- Extensive rehearsals often grouped close to the concert – danger of vocal fatigue
- Importance of balancing levels in the hall and with the monitors – Do not over-sing or compete with the electronics!
- **Maintain excellent vocal technique at all times, no matter what the conditions!**

CARDINAL RULE: IF YOUR VOICE FEELS FATIGUED OR WORN OUT AT ANY POINT IN TIME, STOP SINGING! RE-EVALUATE YOUR TECHNICAL APPROACH TO THE PIECE, AND SEEK PROFESSIONAL GUIDANCE IF NECESSARY.

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