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Stockholm University of The Arts

Extending Opera – Artist-led Explorations in Operatic Practice through Interactivity and Electronics

"The use of electronics in vocal music and opera is imperative." (1998)

Figure 1: Carl Unander-Scharin performing *The Silver Swan* by Orlando Gibbons (from 1612) with The Throat III. AUDIO: http://www.electronic-opera.com/a_2011_SilverSwanInTheThroatIII

Abstract

How can we re-empower opera singers, extending their control over accompaniment and vocal expressivity? To answer this question, I have opened a novel design space, *Extending Opera*, consisting of interactive artist—operated tools to be used on-stage. The research has its methodological groundings in Research through Design (RtD) and Research through the Arts (RttA). This particular method is coined "research-through-the-art-form-opera" — as I have worked within the realms and traditions of opera, probing its boundaries by designing, researching and creating through its own artistic toolbox.

Originally conceived for personal use, the artifacts were later used by other singers and incorporated in performances of opera in small and large scale. By composing and designing for the requirements in operatic productions, high demands on robustness were explored in and through custom-built interfaces.

The work resulted in ten novel artifacts and performances exploring the expressivity of these tools. Extending Opera is guided by and probed through three questions:

1. How can the design and creation of interactive, artist-operated instruments be informed by deep musical knowledge and be probed by the particular conditions surrounding an operatic production?

2. What impact can interactive, artist-operated instruments have on the opera singers themselves and on their vocal technique?

3. How can interactive, artist-operated instruments empower opera singers, thus challenging contemporary power hierarchies — thereby reconnecting to the explorative practice in opera's early days?

My knowledge contribution has surfaced through artistic practice and consists of the exemplars and the artworks, as well as three abstractions – one procedure, one requirement and one experiential quality.

Sensory Digital Intonation highlights how the fine-tuning of technologies and real-time interactivity is incorporated in a feed-back loop with artistic concerns and creativity.

Performative Stamina ("The Premiere-Factor") highlights how the traditional procedures leading up to a premiere in opera influence the demands on robustness and reliability within the components and the overall design of the novel artifacts.

Vocal Embodiment is an experiential quality that describes how the interactive artifacts change the singing itself.

In the conclusion, **Artistic Re–Empowerment** is discussed, proposing that power structures in opera have been probed through the use of the novel artist-operated interactive instruments.

Sammanfattning på svenska:

Hur kan vi ge operasångare mer inflytande över ackompanjemanget och öka deras uttrycksfullhet genom att ge dem mer kontroll över sin konstform? I forskningsprojektet *Extending Opera* har jag undersökt denna fråga genom att skapa interaktiva instrument för scenen som operasångare kan använda för att skapa sitt eget ackompanjemang och för att fördjupa och förhöja *(extend)* sitt konstnärliga uttryck. Forskningsmetoden är en kombination av *Research through Design* (forskning genom design) och *Research through the Arts* (konstnärlig forskning). Mer specifikt kallar jag den metod jag använt för *research-through-the-art-form-opera* (forskning-genom-konstformen-opera). Med det begreppet vill jag visa på att jag utgått från ramverk och traditioner från operakonsten vars gränser jag undersökt genom att designa, forska och skapa utifrån operakonstens egna villkor.

Ursprungligen skapades de interaktiva instrumenten för eget bruk, varefter de prövats och använts av andra sångare i operaföreställningar i både stor och liten skala. Den traditionella formen för operaproduktioner har utgjort den miljö där de skräddarsydda gränssnitten har testats och utvecklats – och därmed tvingats möta de krav på hållfasthet som hänger ihop med sceniskt arbete inför en annalkande premiär.

Arbetet har resulterat i tio nyskapande interaktiva instrument samt ett antal operaföreställningar som utforskar uttrycksfullheten i dessa verktyg. Tre forskningsfrågor har fungerat som riktlinjer under arbetet:

1. Hur kan musikalisk förståelse och konstnärliga behov påverka skapandet och designen av interaktiva instrument (utformade för att hanteras av operasångare) – och utforskas av kraven som följer av en scenisk operaproduktion inför publik?

2. Vilka konsekvenser får användandet av de interaktiva instrumenten för operasångarna själva och hur påverkar detta deras sångteknik?

3. Hur kan interaktiva instrument, utformade för att manövreras av operasångare, utforska operakonstens nuvarande maktstrukturer och konstnärliga hierarkier – och därigenom återknyta till den tidiga operakonsten då sångarna hade både större inflytande över det övergripande uttrycket och mer konstnärlig frihet?

Mitt kunskapsbidrag har uppkommit genom konstnärlig praktik och består av de tio interaktiva instrumenten samt av en rad operaverk. Från den empirin har jag extraherat tre generaliseringar: en är en procedur *(Process)*, en är en förutsättning eller krav *(Requirement)* som ställs på interaktiva instrument som ska användas i den här miljön, och en är en upplevelsekvalitet *(Experiential Quality)*.

Procedur - Sensorisk Digital Intonation
– belyser hur finjustering av teknik och realtids-interaktivitet återkopplar till varandra och hur konstnärliga insikter och kreativitet tillför ny kunskap.

Förutsättning/ Krav – Performativ Stamina ("Premiär-faktorn")
– belyser hur de traditionella förfaranden som leder fram till en premiär inom operakonsten påverkar krav på hållfasthet, robusthet och tillförlitlighet hos de ingående komponenterna och i den övergripande utformningen av de nya instrumenten.

Upplevelsekvalitet - Förkroppsligande av Rösten
– belyser hur de interaktiva instrumenten – utformade för att manövreras av operasångare – påverkar själva sången och hur dessa, steg för steg, genom övande och finjustering av instrumentens design kan ingå i en helhet som involverar sångarens hela kropp i framföranden av opera.

I slutet av avhandlingen diskuterar jag hur dessa interaktiva instrument utforskar maktstrukturer i operakonsten av idag, och hur de kan ge sångaren större inflytande över det övergripande konstnärliga uttrycket.

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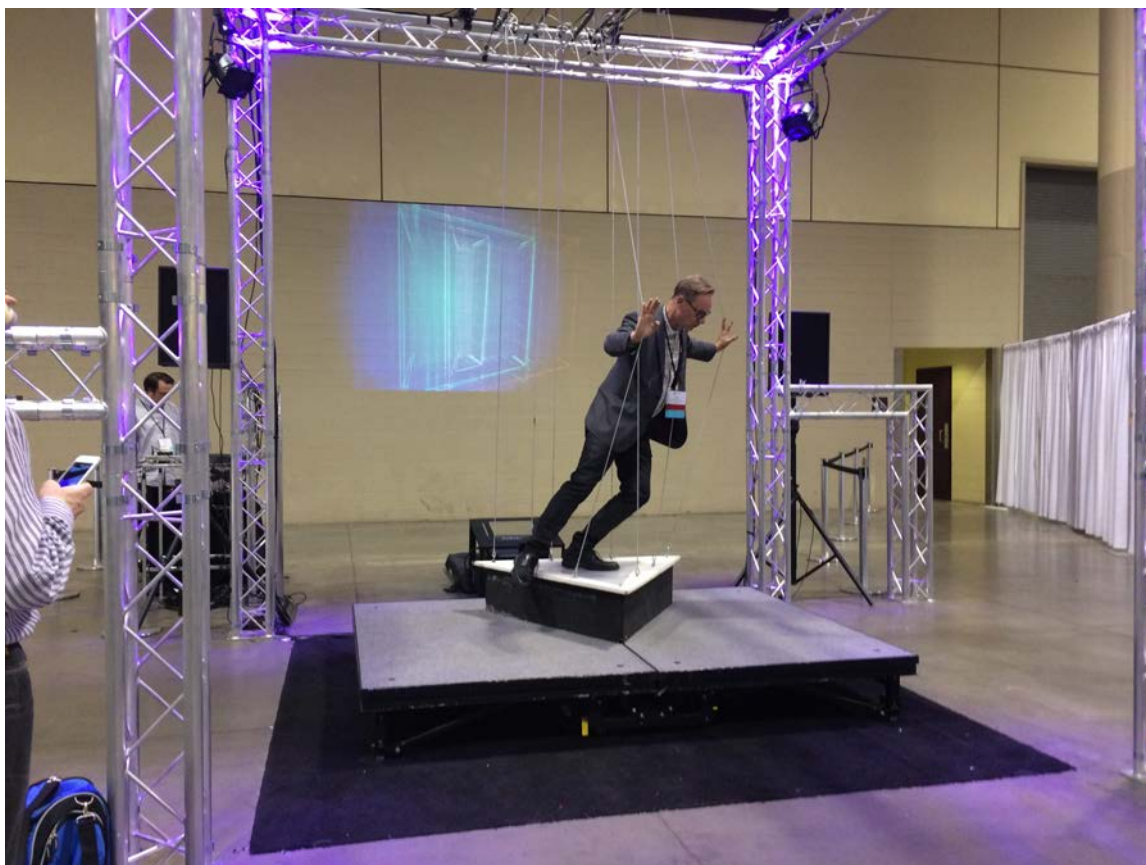**Appendix**

Papers I-VII

Matrix

Figure 2: Carl Unander-Scharin performing in The Vocal Chorder, Toronto, April 2014

Overview of the thesis

This thesis is divided into six chapters. The *Introduction* outlines the research program and describes the artist-researcher's autobiographical starting points. In chapter two, *Background – The Fundaments for Innovative Expression in Opera*, the thesis is situated in relation to opera's toolbox and early practice as well as to other interactive projects for the stage.

A third chapter called *Methodological Groundings for the Extending Opera Program* looks into the concepts of research through the arts as well as research through design. The autobiographical component in artistic practice and research is further discussed. Methods from these fields are combined into "research-through-the-art-form-opera" in this research program. The courses in Extended Opera are outlined.

The fourth chapter entitled *Exemplars: Extending Opera through Artist-Operated Interactivity* describes the ten artifacts that have been developed and deployed during the research project.

Then follows a fifth chapter, *Discussion and Results: a Procedure, a Requirement, an Experiential Quality and a series of Operatic Art-works*, wherein the resulting three abstractions are reflected upon and discussed in relation to the art-works they emanated from. In the closing chapter, the resulting overarching *Artistic Re–Empowerment* is discussed, posing that power structures in opera have been probed through the use of the novel artifacts.

Finally, after *Acknowledgements and Thanks* and *List of Illustrations*, the *References* and the *Appendix* are included. The Appendix concludes with a Matrix, containing artistic works and technologies from the period between 1991 and 2014. The Matrix lists technologies on the X-axis and works into which these technologies have been incorporated on the Y-axis. Furthermore, the seven publications are found in the Appendix.

A note regarding Audio and Video documentation:

As this thesis frequently refers to audio and video documentation, links to media are embedded in the text. The material found on the Internet (mostly on www.youtube.com and on www.electronic-opera.com) is accessible through clicking on the links when reading the thesis as a pdf-document.

The media links are either background material (such as recordings of performances of operatic arias and ensembles) or foreground material (such as videos and audio which constitute the material that this thesis disseminates).

Watch
VIDEO

In order for the reader to be able to navigate through these two kinds of references, the ones that are in the foreground are marked with a "Watch Video" or "Listen to Audio" mark as seen in the margin.

Listen
to
AUDIO

Back-
ground

When the referred audio or video documentation is in the background, this is marked:

In order to access media when reading the thesis in the printed version, a playlist with links is also found on:

www.electronic-opera.com/extendingopera_thesis

Papers included in the thesis

The thesis refers to seven papers. Below, my contribution to each publication is detailed as well as a short description.

Paper I

Unander–Scharin, C., Unander–Scharin, Å., & Höök, K. (2014).
The Vocal Chorder: Empowering Opera Singers with a Large Interactive Instrument. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 1001–1010). ACM, New York, © 2014.
 [VIDEO] http://youtu.be/oxUGb6rmFos?list=UUrCJwo2Rq_5goJ6jd_XhfEg

Builds on a long-term development work revolving around The Vocal Chorder, an instrument that was conceived in order to perform opera with it. The main contribution to the paper is written by Carl Unander-Scharin with additional work by Kristina Höök and Åsa Unander-Scharin.
The physical design was conceived by Carl Unander-Scharin during a composer-in-residence sojourn at Den Anden Opera, Copenhagen, in March 2004. It was built by the in-house technicians. The original programming for MAX/MSP/Jitter and for the Nord Modular was done by Carl Unander-Scharin, as well as the musical composition, *This is the Nucleus* – performed in the Vocal Chorder and composed specifically for this instrument.

– Appendix A to Paper I: The Vocal Chorder was presented in the "Demo Hour" section of the September–October 2014 issue of *Interactions.*
Demo hour. Interactions, 2014, 21.5: 6–9. ACM, New York, USA © 2014.

– Appendix B to Paper I: The Vocal Chorder was featured in the "How Was It Made" section of the November-December 2014 issue of *Interactions. How was it Made.* Interactions, 2014, 21.6: 14-15. ACM, New York, USA © 2014.

Paper II

Unander–Scharin, C., Unander–Scharin, Å., Höök, K., & Elblaus, L. (2014). Interacting with the Vocal Chorder: Re–Empowering the Opera Diva. In *CHI'14 Extended Abstracts on Human Factors in Computing Systems* (pp. 603–606). ACM, New York, USA © 2014.

With reference to Paper I, this paper focuses on the performative qualities that were exhibited in conjunction with The Vocal Chorder artifact during CHI'14 in Toronto. Additional programming was done by Ludvig Elblaus in 2014 for this iteration of The Vocal Chorder.

Paper III

Elblaus, L., Unander–Scharin, C., Unander–Scharin, Å. (2014). Singing Interaction: Embodied Instruments for Musical Expression in Opera. In *Leonardo Music Journal, LMJ24*, pages 7–12 © ISAST 2014 (All authors contributed in equal parts to the writing of the article)
 [VIDEO]
http://www.youtube.com/watch?v=HErrI6FhARM&list=UUrCJwo2Rq_5goJ6jd_Xhf
Eg&index=7
[VIDEO]
http://www.youtube.com/watch?v=feUxPitHZaY&list=UUrCJwo2Rq_5goJ6jd_XhfEg
[VIDEO] https://www.youtube.com/watch?v=Xw2eIEduIxU&feature=c4-
overview&list=UUrCJwo2Rq_5goJ6jd_XhfEg

This Journal Article discusses three novel interactive instruments and their artistic implementation into the opera "Sing the Body Electric! - a Corporatorio" (STBE). In STBE, artists from the disciplines of opera, dance and the development of new musical instruments collaborated to create an onstage fusion of different technologies and artistic practices that connected performer, scenography and instrument. The three authors have contributed in equal parts to the writing of the paper, and have in various ways contributed to the design work and the artistic work behind it. The interactive instruments that are

discussed in the paper are: The Vocal Chorder, The Throat III and The Charged Room.

Paper IV
Unander–Scharin, C., Höök, K., & Elblaus, L. (2013).
The Throat III: Disforming Operatic Voices through a Novel Interactive Instrument. In *CHI'13 Extended Abstracts on Human Factors in Computing Systems* (pp. 3007–3010). ACM, New York, USA © 2013.

Focuses on the artistic angles and interaction aspects of The Throat III. The main contribution to the paper is written by Carl Unander-Scharin with additional work by Kristina Höök and Ludvig Elblaus. The concept of Throat III, that builds on Throat I and Throat II, was conceived by Carl Unander-Scharin. However, The Throat III implies a major technological leap in comparison to the earlier versions to which Ludvig Elblaus contributed largely conceptually, artistically and technologically.
– The Throat III was demonstrated during performances as part of the Interactivity sessions of CHI'13 in Paris.

Paper V
Unander–Scharin, C. & Unander–Scharin, Å. (2013).
Sensory Digital Intonation. The impact of artistic intuition and experience when fine–tuning digital artifacts. In *Artistic Research in Action*, *Proceedings*, the 3rd colloquium on artistic research in performing arts CARPA 3, Theatre Academy, Helsinki 2013.

The paper was written collaboratively by Carl Unander-Scharin and Åsa Unander-Scharin. It proposes a term for the particular way of working with digital artifacts that the two authors have developed during their longstanding engagement in the creation of digital, interactive and mechatronic artworks. This term is further elaborated on in this thesis.

Paper VI

Elblaus, L., Hansen, K. F., & Unander–Scharin, C. (2011).
Exploring the design space: Prototyping "The Throat v3" for the Elephant Man Opera. In *Proceedings of SMC 2011 - 8th Sound and Music Computing Conference*, Padova, Italy 2011.

This paper revolves around the artistic and technological research related to The Throat III, initiated by Carl Unander-Scharin and carried out by Ludvig Elblaus and Carl Unander-Scharin with additional work by Kjetil Falkenberg Hansen. It focuses on the early prototyping development work on The Throat III in which the opera singer Håkan Starkenberg enters into the process and expands the designerly work in the design space from the early autobiographic and participatory stages. Ludvig Elblaus wrote the first version of this paper as his master's thesis, and it was further developed in collaboration by Elblaus, Unander-Scharin and Falkenberg Hansen.

[VIDEO](#)
http://www.youtube.com/watch?v=fEAkn3IZg88&feature=share&list=UUrCJwo2Rq_5goJ6jd_XhfEg&index=21

Paper VII

Elblaus, L., Hansen, K. F., & Unander–Scharin, C. (2012).
Artistically directed prototyping in development and in practice. In *Journal of New Music Research 2012*, Vol. 41, No. 4, pp. 377–387. © 2012 Routledge/ Taylor & Francis.

This journal article is an elaborated version of Paper VI wherein the text has been modified and extended. The article incorporates two more case studies with external singers, Gong Yinjia and Henriikka Gröndahl, participants in The Extended Opera Courses. Furthermore, the article describes the bridging between the early prototyping and the actual incorporation of the artifact into the world of operatic real-time performances.

1. Introduction

1.1. Starting points, research questions, and the autobiographical account

This thesis is the result of my long-term, first-person artistic involvement in the field of opera as an opera singer and as a composer. Throughout this research project, I have — in collaboration — explored opera through composing and performing new music as well as performing certain canonical works (such as particular arias by Claudio Monteverdi, Georg Friederich Händel, and Henry Purcell) with the ten novel bodily oriented interfaces that play the role of vehicles for these explorations and function as exemplars. Although the overall material is the result of artistic work I have pursued in collaboration with colleagues in various professions, the narrative is based on a personal engagement in the opera-environment, which forms the basis of the empirical material. When the engagements described are mostly seen from an autobiographical viewpoint, an "I" will be used in the narrative, whereas in procedures in which a group has been active, I will use "we". As I explore opera from within, the main focus of this text is the particular challenges that face the individual artist in opera as I have experienced them myself and as reported by fellow singers. As a consequence, I will use the pronouns *I* and *we* according to context.

Extending the artistic impact of opera singers through Interactivity
Extending Opera is engaged in the task of exploring operatic performance. This is done by probing performances of opera through developing novel technologies and through performing old and new operatic music with them. Therefore Extending Opera reconnects to the explorative practice in opera's early days and aims at empowering opera singers through offering them expressivity and a means of empowerment reminiscent of the role singers had in early small-scale opera.

Through developing novel interactive, artist-operated instruments, this research project aims at extending singers' expressivity and offer them more influence over artistic matters in order to explore and challenge boundaries that have developed alongside the industrialization and growth of hierarchies within opera.

The interactive, artist-operated instruments that will be introduced here were first developed through design explorations "that are typically self-initiated", testing "ideas and to ask 'What if?' questions through design" (Fallman & Stolterman 2010). Originally they were conceived for personal use – hence the reference to "autobiographical design" (Neustaedter & Sengers 2012). Later, however, the instruments were tested by participants in the *Extended Opera Courses* at the University College of Opera in Stockholm 2011-2014 and also by professional singers who took part in operas with music composed by me, namely "The King of Fools" (Figure 3) "The Crystal Cabinet" (Figure 4), "The Insomnia Clinic" (Figure 5), "The Elephant Man" (Figure 6) and "Sing the Body Electric!" (Figure 7).

Background

Figure 3: JohnErik Eleby and Mats Persson in "The King of Fools", at Vadstena-Akademien (http://www.electronic-opera.com/kingoffools)

Figure 4: Claudine Ulrich, Jan Vesala, Johan Christensson and Kristina Hansson-Unander in "The Crystal Cabinet", Piteå Kammaropera 2008.

(http://www.electronic-opera.com/thecrystalcabinet)

Figure 5: Kristina Hansson-Unander in "The Insomnia Clinic" at the Gothenburg Opera, 2009 (www.electronic-opera.com/theinsomniaclinic)

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Figure 6: Håkan Starkenberg and Lars Martinsson in "The Elephant Man" at Norr-landsOperan, 2012. (http://www.electronic-opera.com/elephantman)

Figure 7: Alexandra Zetterström Büchel, Maria Sanner and Staffan Liljas in "Sing the Body Electric!", The Reactor Hall at KTH, 2013. http://www.electronic-opera.com/singthebodyelectric

The artist-researcher's involvement in the Opera-environment

My background is permeated with opera, an art form that I have been involved in throughout most of my life. I started to perform as a child at the Royal Swedish Opera at the age of 11. Together with the choir and sometimes as a soloist, I appeared in many of the standard operas in the repertory at the theatre in those days, such as *Carmen*, *La Bohème*, *Boris Goudonov* and *Tosca*.

Figure 8: Carl Unander-Scharin (on the right) performing as Huckleberry Finn in "Tom Sawyer" by Jonathan Elkus at Maxim Teatern in Stockholm, 1977. Peter Brandt as Tom Sawyer is seen on the left.

Besides singing, I took lessons in piano, oboe and musical theory. As a child, I always enjoyed creating my own music, sitting at the piano, and later also on the electric bass as well as on simple home-made electronic equipment that allowed for synthesizing and multitracking of sounds. I took interest in the crafting of instruments and constructed a small synthesizer, *Osiris*, based on a chip from Texas Instruments in 1979, and also an electric bass, *The Thumb*, in 1980. In my late teens, I discovered the church organ, and decided to learn how to play it. The wealth of church music and particularly the counterpoint of J S

Bach fascinated me, and I decided to study music at a deeper level. Consequently, at the age of 20, I embarked on a Master's education at The Royal Academy of Music in Stockholm in 1984, where I studied organ, piano, singing, conducting and musical theory. I also took courses in electronic music at EMS, the Electronic Music Studio in Stockholm. Having completed my Master in Church Music in 1991, I decided to further develop my singing technique and try to become an opera singer (again!). The inspiration for this came through being invited to sing in an early opera in a production at the International Vadstena-Academy[1] — a venue where explorations in early opera are conducted in parallel with the commissioning and producing of new operas. During the summer of 1989, I sang the role Tullio in *Messalina* by Carlo Pallavicino from 1679, an experience that spurred my interest in early operas. Furthermore, this experience made me realize that a lively, down-to-earth specimen of opera existed beside the grandeur of the production of the operas that I had participated in as a child. The Vadstena-Academy would later on premiere two operas that they commissioned me to compose, *The King of Fools* (1996) and *Byrgitta* (2003).

Acquiring the technique of an operatic tenor was a quite hard task, and it took me about five years of intense studies to even begin to master the repertory that I wanted to perform. In parallel with my vocal education, I developed my compositional techniques as well as my interest in music technology. At the time, in the late 1980s, digital music technology was emerging and more and more proficient tools were becoming affordable. I started to build a digital studio where I could compose and explore musical technology[2].

Later, having achieved a singer's diploma at The University College of Opera in Stockholm in 1991, I embarked upon a parallel profession as a singing composer/composing singer. I wanted to develop both sides of my musical practice —

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[1] www.vadstena-akademien.org
[2] This work has been described in the essay "Den stora ackumulatorn och uppgraderingens kontrapunkt" (in Swedish), published in "Labbtanken" by StDH (ed. N. Claesson & M. Lempert) and available for download at http://www.electronic-opera.com/sites/elop.hammar.ch/files/Unander-Scharin_Carl_DenStoraAckumulatorn.pdf

performing as a singer and authoring as a composer — in order to acquire vocal, compositional and technological skills alongside each other.

Figure 9: Carl performing as Tullio in Carlo Pallavicino's *Messalina*, Vadstena, 1989

Since then I have composed and performed in parallel. As an operatic tenor, I have performed in approximately 40 operas, and as a composer, I have composed ten operas as well as a range of other works. In 1998 I stated that "The use of Electronics in Vocal Music and Opera is Imperative"[3] — a doctrine I have been trying to comply with and contribute to since then.

Even if I have composed a number of works without electronics — for instance when the poetical expression of the text chosen has not been compatible with the idea of using electronics — I have been in constant search for themes and texts that allow for a broadened expressivity in opera. These explorations have

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[3] See www.electronic-opera.com

resulted in a series of interactive, electronic and mechatronic artworks, created in collaboration with many artists from various professions on- and off-stage, where interactivity and electronics have been incorporated and developed in conjunction with the artistic expression.

My three areas of activity (singing, composing and the development of technology for the voice to be used on stage) often come together in projects in which singing and composing ventures coincide with technological experiments.

The aim of this thesis is to bring to the fore some of the knowledge gained when these three areas coincide — when they are *Extending Opera.*

As opera normally is rehearsed meticulously before the audience meets it, a rehearsal period is in fact an inquiry into the endurance of the materials during the quest for artistic expressivity.

Therefore, my hope is to share experiences from designing for the particular conditions surrounding operatic productions to the fields of Human-Computer Interaction (HCI) and Interaction Design (IxD); namely the search for robustness, stamina and durability through repetitions while rehearsing in preparing for a premiere in opera; as well as how an artistic search for expressivity has informed the development procedures.

1.2.   A Night at the Opera

What then are the common working conditions for an opera singer who partici-pates in a production of an opera in a contemporary, large opera house? As one of the main sources of the empirical material in this thesis is my own experi-ences, a narrative based on my practice as an opera singer will follow in order to present the boundaries for an opera singer of today. This framework is what the Extending Opera research program sets out to probe through opera's own artistic toolbox.

– *"Welcome on stage for tonight's performance of* The Magic Flute. *We start in 15 minutes. Tamino and the three ladies, please come to the stage. 15 minutes to curtain call".*

The intercom announcement from the stage manager catches my at-tention as I sit in my dressing room. Okay, I think, hopefully I am all set for my first performance of the role as Prince Tamino in The Magic Flute. I have my costume on, with those weird 18th century trousers and those impractical high-heeled shoes. I have done all the usual warming up of my voice, particu-larly checking that I am agile in the passaggio[4] and prepared for the top notes. As I gaze at myself in the mirror, I note that the make-up seems to be intact and after a last

Figure 10: Carl Unander-Scharin as Tamino. Roy-al Swedish Opera, December, 2000

[4] The Passaggio equals the "passage-tones" and designates a particularly tricky range of tones that need to be managed with extra care in order to reach the top tones in the voice. For a lyrical tenor like me, the passaggio ranges from f4 to g#4.

sip of water, I leave the dressing room. On walking down the stairs to the stage, I silently review the first instance of singing: "Zu hilfe, zu hilfe, sonst bin Ich verloren!" and the given stage instructions, telling me to run back and forth on the stage during the first lines while carrying a heavy piece of prop. Even if I can rely on the fact that I know my part very well after the recent five weeks of rehearsals and the many years of studies and preparations for this moment, I know that I need to be downright convincing even from the first tricky instance. The first entrance "sets the tone" for the rest of the performance, and in order to vocally and artistically reach out to a large audience in a big auditorium and to capture their attention, I need to be completely focused and ready. I feel quite tense but I am not really nervous. I know that I must master every tendency to get more nervous as that will disturb my vocal production and my capacity for remembering my part as well as sabotaging my ability to step inside my artistic rendering of Tamino. I try to enter a mindset that is a strange mixture of alertness and relaxation to get vocally and bodily ready for the surprises that always come up during a performance, no matter how thoroughly rehearsed it is. Throughout the premiere, the stamina in my voice and the robustness in my artistic preparations will be pushed to its utmost. I know that my overall artistic rendering of Tamino will be dependent on how well I can balance on the edge of alertness and relaxation, and that the reception by the audience and by all other stakeholders (conductor, orchestra, management, press, colleagues, friends, family etc.) will bear witness to how well I succeeded.

On entering through the sound proof doors to the stage, I say hello to my fellow singers, to the stage manager and to the prompter down in her little box in the middle of the stage. As the curtain is still down, I can hear the muffled sounds of the orchestra tuning and creating their usual buzz as they rehearse their privately chosen tricky passages in order to warm up before the conductor enters. I gaze through the peep-hole in the curtain as I see the audience take their seats. The house is full tonight as it is the premiere – what a pressure and comfort at the same time! Suddenly the light in the auditorium fades

and the conductor enters. He is greeted with warm applause, then he lifts his baton and commences Mozart's divine overture to The Magic Flute.

Soon, oh soon, the tricky start for me is imminent when the instrumental over-ture is over and the curtain rises. I still have a couple of minutes during the run of the overture to get vocally and bodily ready for the many challenges and surprises that a full evening performance of an opera entails. I do some minor and barely audible warm-up phrases to be ready to sing in a short while. I feel alert and ready, as I check my surroundings to be sure to be standing in the right place so that the light will hit me when the curtain rises.

Here we go! The overture has reached its end, and as the curtain lifts, I feel the light zooming in on me as I make my first move on stage, running. After a few bars of orchestral prelude, I take my breath through widening my rib-cage, settle the appoggio[5] and wait for the conductor's sign. On hearing the prompter whisper "Zu hilfe!", I sing: "Zu hilfe, zu hilfe, sonst bin Ich ver-loren!". I am completely immersed in the task of performing opera, and from now on I do not need to think much more about my whereabouts, about what to sing next, about how to manage my vocal technique or about looking at the conductor nor about communicating with the prompter. I just let myself go into the almost automatized and deeply gratifying task of performing Tamino in accordance with the many givens that constitute a performance of one of the most well-known operas in the repertory.

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[5] The Appoggio is the Italian term for support, denoting a thorough bodily awareness that embodies the vocal production in the breathing apparatus, thus creating for the strong and powerful singing that is associated with 'opera' by leaning on or *appogiare su* the muscles that surround and support the lungs.

Figure 11: Carl Unander-Scharin as Tamino in the opening aria "Dies Bildnis ist bezaubernd schön" Royal Swedish Opera, December, 2000

AUDIO http://www.youtube.com/watch?v=hYOWWIRreiY (here performed in Swedish)

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The autobiographical account

The narrative above is based on my own annotations from the opening night of *The Magic Flute* by Wolfgang Amadeus Mozart, and it describes a poignant moment in my career as a singer: my first performance at the Royal Swedish Opera in one of the most well-known tenor parts in the operatic repertory, Prince Tamino, in December 2000.

There are some twenty operas[6] that constitute the main stock in the repertory of most opera producers, educators and other stakeholders in the world of opera. Subsequently, the roles that these operas include are the main object of study for literally all singers of opera. Tamino (in *The Magic Flute* by Wolfgang Amadeus Mozart) is such a role for the tenors; as is Carmen (in *Carmen* by Georges Bizet) and Dorabella (in *Così Fan Tutte* by W A Mozart) for the mezzo-sopranos; Mimi (in *La Bohème* by Giacomo Puccini) and Violetta (in *La Traviata* by Giuseppe Verdi) for the sopranos; Figaro (in *Il Barbiere di Siviglia* by Gioacchino Rossini) and Wotan (in *Das Rheingold* by Richard Wagner) for the baritones; and Ochs (in *Der Rosenkavalier* by Richard Strauss) as well as Filippo (in *Don Carlos* by Verdi) for the basses – just to name a few. Although the professional singers commonly study new roles (in operas that are part of the standard repertory) and participate in first performances every now and then (in contemporary, newly composed operas), the basic material is already at hand in opera as the art form revolves around its canon of works. Even if this canon slowly changes, and even if occasionally a newly composed opera enters into it, the main stock of the most commonly performed operas were composed between 1750 and 1910. This historical focus is more or less taken for granted in the world of opera, a fact that influences the way opera is produced and thereby sets the frame for the educational situation and the working conditions for opera singers.

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[6] E.g., *Carmen* by G Bizet, *La Bohème, Tosca* and *Madama Butterfly* by G Puccini; *Figaro, The Magic Flute, Così fan Tutte* and *Don Giovanni* by W A Mozart; *Aida, La Traviata, Rigoletto* and *Othello* by G Verdi; *Il Barbiere di Siviglia* by G Rossini; *Eugene Onegin* by P Tchaikovsky; *Lohengrin* and *Die Ring des Nibelungens* by R Wagner; and *Der Rosenkavalier* and *Salome* by R Strauss.

The contemporary opera production in a large institution

The procedures involved in the production of a performance of opera within the institutions are formalized and streamlined to a great extent. The way opera is produced in larger opera houses around the world has long since been established and functions more or less as an industry. As the opera critic David Littlejohn puts it "The basic production elements of live opera as most people think of it today – what the French, and later the Americans took to calling 'grand' opera – were set in place between 1870 and 1920." (Littlejohn 1992, p. 15). He continues: "These productions frequently involve several elaborate sets, a great many custom-made costumes, intricately programmed lighting, and a corps of professional dancers. They may require the work of a hundred or more highly skilled musicians, as well as more than hundreds of technical personnel, administrators, and office staff. They are presented in purpose-built, often palatial auditoriums seating from one thousand to three thousand or more."

Within these kinds of institutions, approximately five weeks of rehearsals are allocated from day one to the premiere. On the one hand, this situation places high demands on the professionalism of the singers, who need to be well pre-pared at the outset of the rehearsal period as regards to knowing their parts well by heart and having an overarching conception of their roles. However, on the other hand, it leads to a working climate in which the singers tend to per-form 'their' version of these roles with only minor variations from production to production as the singers circulate, performing the roles they have specialized in. Apart from being a source of frustration for stage directors and manage-ment, this condition means that the contemporary professional opera singer operates within quite a narrow field of expressivity when appearing in the ca-nonical repertory in productions that will have strong resemblances to each other. Arguably, this is a situation that is typical of the current state of affairs in opera as it connects to the way the opera world has been functioning since about 1920, when the institution of the modern opera house had assumed its shape.

However, the current situation has not always been the case. Rather, the power hierarchies in the operatic biotope are in constant flux. Again according to David Littlejohn, he argues that singers' influence in artistic matters outside of sheer singing had already decreased at the end of the 18th century, when composers' influence increased. The composers in their turn lost power to the conductors during the early 20th century. Finally, the producers (agents, casting directors, stage directors and others) of opera today exert the main authority over major artistic decisions in opera to an overarching level. According to Littlejohn, the opera-world of today resides in "the Age of the Producer":

"Now a fifth age in the history of opera appears to be upon us: the Age of the Producer." (Littlejohn 1992, p. 51).

This argument is not to be confused with the fact that sought-after singers still command large salaries and enjoy high esteem — just like they did in the 18th century. However, the amount of influence in artistic matters have changed considerably since the days when singers were more or less expected to add their own embellishments, add-ons and cadenzas[7] to the music in the score. "The Age of the Singer", according to this viewpoint, [lasted] "through much of the eighteenth and early nineteenth centuries, when the services of uniquely gifted singers (including castrati[8]) were regarded as indispensable" (Ibid.). We know from the history of opera that the singers of this era constantly added to and amended the written scores, a habit that was not always appreciated by the composers but highly praised by the audiences.

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[7] A Cadenza, often performed at the end of an aria just before the play-out, is a passage in which the singer could display both technical skill and musical fantasy, performing an unaccompanied and personally embellished musical episode within the style of the composition. Today the Cadenzas in older music are seldom improvised but rather performed from printed versions in a similar, non-personalized way, e.g., in the music of Donizetti and Rossini.

[8] The tradition of castrating a boy who could sing well in order to turn him into a Castrato (or a "musici") was common in Italy between the late 16th and the late 19th century. Apart from being employed within the papal courts, these singers enjoyed increasing popularity in opera, probably even taking part in Claudio Monteverdi's "L'Orfeo" from 1607. The craze for castrati peaked around 1720, and the last known castrated singer in service to the Pope was Alessandro Moreschi (1858-1922), of whom recordings have survived: https://www.youtube.com/watch?v=KLjvfqnD0ws

The disempowered opera-diva of today

This ongoing shift in power hierarchies continuously changes the conditions for the singers. Consequently, there is an incongruity between the aura surrounding famous opera-singers, 'divas', supposedly mastering the end-result of their performances and the reality in which the contemporary opera singer has little influence over the essential creative processes. This situation stands in contrast to the very early days of opera, when there seems to have been less demarcation between creating and performing opera. It is clear that Jacopo Peri, composer of what is understood as the first opera ever, *Daphne*, from 1597, accompanied himself on the lute whilst singing, and many composers (indeed, most of the composers up the 19th century) were in fact singers themselves. Examples of other composers who also were singers are Giulio Caccini, Claudio Monteverdi, Gioacchino Rossini, Franz Schubert and Gaetano Donizetti. Many of these, like Monteverdi, Rossini and Donizetti, would even teach the singers of their operas the vocal and performance techniques that they required their singers to master in order to perform in their operas (Celletti & Fuller 1991). This practice then became less and less common throughout history, as the professions in opera became more and more specialized. It may well be posited that the coming of an industrialized mass society and therefore an ever increasing demand on specialists within various professions are the reasons for this development – in opera as well as in the society as a whole.

The current boundaries for the solo-singer in opera

Arguably, contemporary opera singers are well equipped to take part in operatic productions of old operas, as they are educated to do precisely that. But, as opposed to the practice in opera's early days, they are not trained – nor expected – to engage in the musical pace nor to take responsibility for the musical structure, but rather to concentrate on the singing and acting within the (to a large extent) predefined musical drama. Furthermore, as a side effect of mediation of opera since the early 1910s, the impact of famous and outstanding singers is

paramount, as every performance of opera may be compared to video and audio recordings of great stars – available online.[9]

The skills required for managing a role such as Tamino are manifold (see the narrative, *A Night at the Opera*, above for a brief outline) and opera singers need to acquire means to master them to be able to perform in a seemingly re-laxed way.

Prerequisites such as:
 • a given musical composition, commonly from the period between 1750-1910;
• a textbook upon which the music is built, called *libretto*;
• a repetiteur/coach, who is in charge of the preparations for the musical per-formance;
• a conductor, who is in charge of the musical flow of the musical performance;
• a stage director, who gives instructions, and who in collaboration with:
• a set designer has established an overall form and design of the production, as well as:
• a predominant vocal tradition (often referred to as 'classical western singing'), setting the standards for vocal quality as well as for the artistic framing of the overall interpretation[11] of the notated music;
• a hierarchical and highly industrialized organization that works top-down;
• physical constraints in costume, set design, and props;
• an orchestra, which can number up to 100 persons and which the singer needs to be heard through;
• a venue/stage that is quite large and in which the vocal production needs to be directed towards the audience in order for the singer to be heard;

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[9] Thomas Edison's famous recording of "Mary Had a Little Lamb", the first attempt to consciously cap-ture sound, was done in 1877. After that, an ever-growing river of recorded sound, and later of moving images, became available. The first known operatic voice to have been recorded is Enrico Caruso, per-forming *Studenti Udite* from 1902. (http://youtu.be/IHxyQsvZ1Ys). Using the recordings as a means for communication, Caruso became the first super star of the emerging Mass Society. However, the first recording of a human voice was done as early as 1860 by Parisian inventor Édouard-Léon Scott de Martinville on his Phonautograph. (see www.firstsounds.org/sounds/index.php)

[11] Interpretation connotates a wide range of procedures that concerns how the notated music is trans-ferred to acoustic music, or " The process by which a performer translates a work from notation into artistically valid sound." (Bunt 2002), often compared to the variations that would occur when different actors recite the monologue from *Hamlet* by Shakespeare.

These are some of the boundaries that form the framework in which the contemporary singers of opera ply their artistry. It may be argued that some of these boundaries are common to other performative arts and that they are not specific to opera. However, the full range of constraints in the opera world of today in comparison to opera's early days needs to be considered in order to understand how this research project aims at re-empowering the opera singer, namely through offering tools for extended artist-led musical accompaniment and vocal expression.

2. Background – The Fundaments for Innovative Expression in Opera

This chapter situates the particular arena in opera that this research project focuses on. Opera is a complex art form, and its many ingoing components are subject to research from various angles through a plethora of methods. Oftentimes, the term 'opera' seems to signify a large, somewhat heavy and pretentious art form. Possibly, this notion depends on the impact that the grand operas of the 19th century still have on the common conception of the art form, and also on ideas concerning opera such as C W Gluck's urge to reform opera in the 1760's[12] and R Wagner's notion of the *Gesamtkunstwerk*.[13] However, my aim here is not to reform opera through tackling all its components. My focus is on one, but quite basic, component in opera: the freedom and expressivity of the solo-singer performing musical drama live on stage. In this chapter, I will focus on how interactive, artist-operated instruments may change the practice of the solo-singer in opera in relation to the origins of the art form.

2.1.   The artistic toolbox and urge for innovation in opera

There are numerous ways to circumscribe and to denominate what is meant by the term *opera*. One source[14] tells us that opera is: "A staged drama in which accompanied singing has an essential function. Opera is the grandest and most expensive of musical entertainments, and in its fullest forms has almost invari-

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[12] Christoph Willibald Gluck was a composer who wanted to reform opera in order to serve the drama so that it would reinforce opera's emotional impact and rid it of "ridiculous" embellishments.

[13] Richard Wagner, apart from being an inventive composer and librettist, published essays on his work. Wagner coined the term *Gesamtkunstwerk*, which translates into "total-work-of-art" and advocated an artistic reform aiming at through-composed music serving the drama. Wagner and "wagnerianism" has had a large influence on the common conception of opera since then, often obscuring other kinds of opera on the smaller scale and more barren formats with its somewhat totalitarian claim.

[14] From the article on Opera in *The Oxford Companion to Music Online* by Nicholas Temperley. http://www.oxfordmusiconline.com:80/subscriber/article/opr/t114/e4847

ably required some kind of subsidy to survive, whether royal, national, local, corporate, or philanthropic."

This quote is rather typical in that it presupposes that there is a "full form" of opera and that this form is large. However, the article continues: "Such variety stems from the very mixture of elements in opera: music, drama, poetry, the visual arts, and (at times) dance." The author concludes with the following assertion in order to delineate opera: "A reasonable definition separating opera from other forms is that it is a work intended to be staged, in which singing plays a dominant part in portraying the actions and emotions of the characters."[15] This definition fits nicely with my aim here: to focus on the solo-singer performing on stage. It also motivates digging deeper into the vocal technique associated with opera in order to understand the discussion that follow in this thesis. Furthermore, the embodied nature of operatic performance and a focus on the singer who participates live on stage and who molds dramatic situations through the expressivity of the voice is in the foreground.

The origins of opera

There were precursors to opera in the ancient times when the Greek choir formed a mass of voices during the theatrical plays. During the Renaissance, traces of this ancient practice caught the attention of artists throughout courts in Italy and brought with it, among many other things, important changes in the musical practice in Europe (Donington 1981).

Since the days of Pope Gregory I (approx. 590-604 A.D.), the Roman Catholic Church only accepted *a capella*[16] *monophonic*[17] singing in the church for several hundred years. This way of singing is called *Gregorian chant* and denotes an unaccompanied sacred hymn, often performed by a group of singers in the monasteries inhabited by monks or nuns. Religious texts were sung through chanting the texts on long *melismas*, which means that one syllable is per-

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[15] From the article on opera retrieved from the online version of the *Oxford Companion to Music*, June 17, 2014. © Oxford Music Online.
[16] A Capella means singing without accompaniment.
[17] Monophony (as opposed to Polyphony) signifies a one-line melody that stands alone and that is not accompanied or embellished by harmony.

formed over an array of tones. In approximately 1200 A.D. composers Leoninus and Perotinus, the two first composers known by name, started to superimpose and juxtapose the Gregorian chants that created a wealth of *polyphonic*[18] singing in the churches. As the influence of the Roman Catholic Church was substantial, these explorations in music (as well as the oppression that had preceded them) exerted an important influence on artistic activity also outside of the religious practice.

When the Renaissance began to influence people's thinking, a more open mindset slowly emerged in regard to the practice of church music as well as the secular music. Particularly in Italy a new kind of musical life arose in certain courts. These courts started to engage artists who would sing and play for them. One of the findings that spurred the Renaissance movement was the spread of the ancient Greek texts such as the writings of Aristotle and Pythagoras. This in turn was dependent on the new technology of printing, invented by Gutenberg circa 1450. This new acquaintance with ancient Greek thinking and texts also made people curious about how the *mousikē*[19] of the ancient times may have sounded and may have been staged.

Also within the rituals of the church, the new strains of music were incorporated, and a form of sacred, liturgical mystery plays called *Sacre Rappresentazioni* evolved. These were initially performed inside the churches, but moved out onto the grounds outside the church. In parallel with the budding Renaissance, these plays were hosted by the emerging courts in Italy and they also assimilated elements from the folkloristic *Commedia dell'Arte*. The polyphonic choral singing from the liturgy of the churches developed into the *madrigal*, a profane style of music performed by a group of singers. The madrigal could include a dramatic story and would later be incorporated into operatic music.

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[18] Polyphony implies two or more independant melodies that are performed simultaneously, thus creating a complex musical texture.

[19] From Oxford Music Online: "The Greek mousikē refers to any art over which the Muses preside, but, in the Hellenic and Hellenistic periods, particularly to music. Music played a central role in the civic and religious life of the people as well as providing relaxation and entertainment; it was also the object of scientific and philosophical inquiry."

All of this development coincided with the bursting new focus on individualism and flourishing artistic independence associated with the Renaissance. In the late 16th century, the first steps towards a new art form, opera, were taken, inspired by an urge to revive the ancient Greek dramas and by connecting with the myths of ancient days. Mythical figures such as Orpheus and Euridice as well as Apollo form the basis of many of the earliest operas.

Figure 12: Jacopo Peri with his lute, in preparation to performing as Orpheus in *Euridice*, the opera composed by himself and Ottavio Rinuccini, a work which is the earliest opera that has survived to our days

A new technique of singing that evolved in parallel with new music

By the mid-15th century, there was still no notion of a particular profession called 'singer' nor that of 'composer'. Rather, a musician was commonly supposed to be able to play instruments, to sing and to author music of his own making.

In particular, the courts associated with the Duke of Mantua, Count Jacopo Corsi and the Count de Bardi are known in the history of opera, as they engaged artists such as Jacopo Peri, Giulio Caccini and Claudio Monteverdi. Specifically, one group of scholars consisting of poets, musicians and intellectuals that gathered in the court of de Bardi in Florens, who called themselves the *Camerata Florentina* have been credited with giving birth to opera.

These artists combined what we today would categorize as separate professions: they were singers, composers and singing teachers. Jacopo Peri, composer of *Daphne*, which is understood to be the first artwork called an opera from 1597, bears wit-

Figure 13: Giulio Caccini

ness to how this came about in the foreword to his second opera, *Euridice*, giving account of "what induced me to discover this new manner of song". Here he tells us that Count Corsi and the poet Ottavio Rinuccini suggested that he should "make a simple trial of what the song of our age could do. Whence, seeing that it was a question of dramatic poetry and that therefore, one should imitate in song a person speaking (and without doubt, no one ever spoke singing), I judged that the ancient Greeks and Romans (who, according to the opinion of many, sang their tragedies throughout on the stage) used a harmony which, going beyond that of ordinary speech, fell so short of the melody of song that it assumed an intermediate form." (Jacopo Peri in the Foreword to *Euridice*, from Strunk 1958, p. 659.)

Peri continues, in reference to the new knowledge on ancient musical practice and regarding his own interpretation of this: "And so (even though I would not be so bold as to claim that this was the type of song used in Greek and Roman plays) I have thus believed it to be the only type that our music can give us to suit our speech."

Figure 14: Claudio Monteverdi

The early operas, such as *Daphne* and *Euridice* by Peri, and *Euridice* by Caccini (to the same libretto by Rinuccini as Peri's opera) and a little later the masterly Monteverdi (with his influential operas such as *L'Orfeo* and *Il Coronazione di Poppea*) merged a range of musical ideas. Combining choruses with folkloristic melody with the *Monody*, a harmonically advanced piece of music on top of which the solo-singers would exert their vocal performance, the early operas already exhibited a highly advanced art form. An example of

Monteverdi's monodic musical style is the aria *Tu se Morta*[20] from *L'*
Orfeo. Here sung by the author of this thesis in conjunction with a
robotic choreography by Åsa Unander-Scharin from 1998.

Endeavors by composers such as Peri, Caccini and Monteverdi combined sing-
ing with dramatic representation in a staged setting, and signified a new kind of
artwork. Although *Daphne* by Peri has not survived, his second opera *Euridice*
has. I had the opportunity to perform in *Euridice* in a production at Drottning-
holm in 1997, a most fascinating experience. This opera was to my ears truly
exploratory, taking unexpected turns musically and completely building on the
dramatic tension in the words, very much like Peri himself had stated in the
foreword to the opera. I take the opportunity, here in this thesis, to quote an-
other passage from Peri's foreword even though, despite its contemporary Eng-
lish translation, it deals with musical matters on a somewhat esoteric level. Ar-
guably, in this passage, Peri exhibits his artistic intentions when trying to for-
mulate a new way of singing and performing, based on dramatic and musical
needs emanating from the material in the textbook (libretto), an endeavor that
led to the development of the Monody that later evolved into the Aria (See also
below under From the Toolbox for Artistic Expression in Opera).

"I realized, similarly, that in our speech some words are intoned in such a
manner that harmony can be founded upon them, and that while speaking one
passes through many other [words] which are not intoned, until one returns to
another that can be moved to a new consonance. And taking note of these man-
ners and those accents that serve us in grief, joy and in similar states, I made
the bass move in time to these, now faster, now slower according to the emo-
tions; and I held it firm through the dissonances and consonances until the
voice of the speaker, passing through various notes, arrived at that which, being
intoned in ordinary speech, opens the way to a new harmony." (Jacopo Peri in
the Foreword to *Euridice*, from Strunk 1958, p 660.)

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[20] The Lamentations of Orpheus. http://youtu.be/mC2LZcQVZ3k

Figure 15: Photo from a performance of Jacopo Peri's *Euridice*, at the Drottningholm Court Theatre, in 1997. Carl Unander-Scharin is seen in the right of the picture, performing as Radamante.

To sum up, we can conclude that opera was born at the end of the 16th century when a group of artists, the Camerata Florentina, were searching for new expressivity that would help them re-create what they understood as the antique drama. In this double procedure of both looking backwards to a presumably forgotten art and at the same time envisioning something new, the art form we now refer to as opera was born. However, in the very early days, there seems to have been less demarcation between creating and performing opera. In the earliest practice, the composers functioned as singers and sometimes also as musicians in the presentation of their work. In early opera, the solo-singer was commonly accompanied by only one instrument – a harp, a chitarrone[21] or a lute – creating a rhythmical and harmonic grounding on top of which the singer performed the vocal lines with a large amount of improvisation (indeed, this

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[21] A Chitarrone is a lute with a long neck that holds additional bass-strings, allowing for extended accompanient.

was sometimes accomplished by the same performer as in the cases of Peri and Caccini).

Orchestral instruments changing the conditions for the singers

The innovative and explorative search for new expressions continued in the history of opera. On an overarching level, as a result of the focus on vocal performance, the particular singing technique evolved which constitutes what we today understand as operatic, western classical singing.

Commonly, singers developed virtuosity, adding flavor and personality to the performance within the boundaries that composers and authors had set in the score, and in turn inspired composers to further extend the art form.

By the end of the 19th century the romantic orchestra had reached its full power, often numbering over 100 persons, each playing on instruments that were constantly developed to produce more volume. We see this fact for example, in how the gut strings of the violin were replaced by strings made of steel during the 19th century, empowering the violin section with a much louder sound. In parallel, the wooden flute evolved into a metallic version, and brass instruments such as the trumpet and the trombone improved likewise. These ongoing modifications in the orchestra required changes in vocal practice. One example is when the tenor Gilbert-Louis Duprez invented a means to sing the 'high C' with a full voice in 1837. Earlier, high tones in the tenor voice were managed through singing with the so-called 'head voice', whereas Duprez introduced his new technique to bring the 'chest voice' up to the high pitches as well (Diday & Pétrequin 1840), enabling louder and more heroic singing. In parallel, the vocal parts created by composers such as Wagner, Berlioz and Verdi stretched the boundaries of the human voice. In order to find and train singers who could manage the high-strung vocal parts, such as Wagner's *Tristan* – by contemporaries deemed as "unsingable" (Kloiber et al. 2002) – the German *Fach-system* emerged (McGinnis 2010). According to this now internationally established practice, an opera-singer's vocal career is structured in accordance with the available repertory fitting with his/her vocal abilities, allowing the artist to perform a rather narrow range of roles supposedly fitting for each type of voice.

For example, a female singer with a high voice fit for singing rapid tones will be advised early in her career to perform only a limited range of roles, supposedly fit for her voice type, in this case a *Lyric Coloratura Soprano.* This system emerged as a response to the constant need for new artists when opera was industrialized during late 18th century (Kloiber et al. 2002).

From the toolbox for artistic expression in opera

In order to be familiar with some of the on-stage instruments that will be presented later in this thesis, the reader needs to become acquainted with some of the tools in the opera-singer's artistic tool-box. Commencing with a brief outline of the predominant vocal technique, some of the important building blocks in opera (such as the aria, the recitativo and the fermata) are later described.

The Legato: The smoothing and binding within vocal lines, emphasizing singing on the vowels rather than the consonants.

The Vibrato: Personalizing the individual voice; most opera singers have continuous vibrato in their vocal presentation that is a function of the Appoggio technique.

The Appoggio technique: The breath management system that establishes the voice in a deep position, so that the vocal organs such as the larynx do not rise in accordance with a rise in pitch. Thereby:

The Chiaroscuro quality is created; the operatic voice is supposed to have a balance between shrillness (chiaro=clear/light) and darkness (oscuro=dark/damp) in its sound.

The Projection of the voice: Through years of training, the over-tones in the voice are projected (voice scientists call these clusters of over-tones *formants*) in order for the singer to be heard through orchestras and in large halls, without shouting.

The Sprezzatura: The subtle rhythmical freedom that singers exert within the ongoing overall pacing in the music.

The Rubato: The overall change in the pacing of the music often by the end of a phrase – common to all executants and normally indicated by the conductor.

The Coloratura: A typical way of composing for a particular kind of agile voices – the *coloraturas* (mostly in sopranos, mezzos and tenors). In a coloratura, the tones are somewhat "stuttered" – short and repeated tones are sung in *Staccato* (short, detached tones) in the high registers.

The Homogenous sound in all registers: The voice is constituted by different registers (the amount of which has been debated during hundreds of years[22]) that are smoothed out in order for the audience to hear the voice as a homogenous sound. Also called *Register Equalization.*

The Copertura technique: In order to blend the boundaries between the registers, the copertura technique is used in the *passaggio* – so that the tones that lie in between the registers are treated with particular care.

Important components in a typical opera:

The Aria: Performed by one solo-singer singing alone, accompanied by one or more instruments. Based on the Monody in the early operas. Since about 1650, the term *aria* has been used for this specimen of operatic music. The aria commonly revolves around an emotional peak, such as the love for someone, the loss of something or the urge for revenge. The music in an aria commonly reiterates the words in the libretto, as the composers give the words increasing impact while the music unfolds. The words in the aria are often sung on melismas, which means that one syllable may be sung on a range of tones. (See and listen to Figure 16 for an example of an aria with a preceding recitativo.)

The Recitativo: Often preceding the aria, the recitativo (or recit) has a more narrative function, carrying the story and drama on. In early opera, the recit is often accompanied by the Basso Continuo, a small group of instruments – commonly the harpsichord and the cello. The words within the recitativo are mostly put to music in a syllabic way, which means that the syllables are allocated to one tone at a time.

The combined Aria and Recit: Many compositions from the early days up to contemporary opera have smoothed the boundaries between aria and recit. Often, the two basic components can be traced behind the combination of them in

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[22] For a thorough discussion on registers, see chapter 3 in Stark 2003.

the way the ongoing pace of the drama is balanced with the holding back of the pace in order to let an emotional peak shine through.

The Ensemble: The duetto, trio, quartetto, quintetto, sestetto, septetto, and so on: When a group of soloists (n. b. that this does not equal the chorus) perform together, this section is given one of these names according to the number of singers participating in it. This component resembles the aria in that it contains dramatic and personal statements, however – as opposed to the aria – more than one singer perform at the same time. The words may be hard to discern for the listener as various lines of thoughts are sung simultaneously in the ensemble. (See and listen to Figure 18 and 19 for examples of duets.)

The Chorus: Larger operas include important parts sung by the chorus. Commonly, the chorus represents the mass of people that urges the drama on or expresses an inner collective feeling, emotion or wish. (Listen to figure 19 for an example of a chorus).

The Culmination and the Fermata. In opera as a whole and in particular within the aria, the emotional culmination is a focal point. Often a fermata (an extra prolonged tone) occurs at the end of an aria on a high tone signifying a particularly poignant moment. It also connects with the display of technical skill, *bravura*, executed by the soloist.

Back-
ground

Figure 16: Carl Unander-Scharin performing Nadir´s aria in "The Pearlfishers" by Bizet, Fol-koperan, 2009 (Here performed in Swedish)

VIDEO http://www.youtube.com/watch?v=dOqcv31sj9w

Figure 17: Carl Unander-Scharin and Elin Rombo as Nadir and Leila in "The Pearlfishers" by Bizet, Folkoperan, 2009

VIDEO http://www.youtube.com/watch?v=aWM-Zt58zT0

Figure 18: Jeremy Carpenter and Carl Unander-Scharin as Zurga and Nadir in "The Pearlfishers" by G Bizet, Folkoperan, 2009

VIDEO: http://youtu.be/cq1Ivrrdq-w?list=UUrCJwo2Rq_5goJ6jd_XhfEg

Figure 19: From The King of Fools (1996). Two examples: 1) Duetto 2) Chorus

AUDIO: http://www.electronic-opera.com/node/798

AUDIO: http://www.electronic-opera.com/node/795

2.2.   Related work: Interactivity and Electronics in Opera

There are numerous projects, both on the artistic side and within research, that explore the topic of interactive technologies and the use of electronics in opera. These originate from the fertile encounters between electroacoustic music and vocal performance both on and off the stage in parallel with the technological development since the birth of Elektronische musik (Eimert & Humpert 1977) and Musique Concrète (Schaeffer 1977) in the 1940s and 50s — gradually incorporated into the development of opera.

Commonly, real-time electronic processing of voices and/or amplification has been utilized, as well as the incorporation of electronically preprocessed voices, for example by composers such as Karl-Heinz Stockhausen, Luigi Nono, Luciano Berio, György Ligeti, John Cage, Trevor Wishart, John Adams and Kaija Saariaho.

Some of the most notable works are Stockhausen's *Gesang der Jünglinge* (1956) and *Stimmung* (1968); Nono's: *A floresta é jovem e cheja de vida* (1966); Berio's: *Coro* (1976); Ligeti's: *Le Grand Macabre* (1977); Cage's: *Roaratorio* (1979), Wishart's: *Anticredos* (1980), Adams' *Nixon in China* (1987), Saariaho's: *L´amour de loin* (2000), and Luca Francesconi's *Quartet* (2011).

Through the appearance of computerized interactive musical instruments, from about 1990 and onwards, technologies appeared such as Michael Waiswisz's interactive interface *The Hands* for controlling sounds through gestures (Waisvisz 1984); works such as Tod Machover and Joe Paradiso's *Brain Opera*, which explored opera on-line (Paradiso 1999); Philippe Manoury's *K...* (Ramstrum & Lemouton 2003), in which interactive technologies are used to liberate the singers on stage, as well as Jonathan Harvey's grand opera *Wagner Dream* from 2007 that utilizes electronic processing to convey Richard Wagner's interest in Buddhism towards the end of his life. An interactive gesture controller, The Voicon, was created by Park and colleagues (Park et al. 2012),

allowing singers to generate additional vibrato and other vocal effects through embedded sensors. In the opera *Death and the Powers* by Tod Machover, various real-time interactive technologies were deployed to create a 'disembodied performance' in order to portray a dystopic scenario (Jessop et al. 2011).

Research institutes in which vocal music and various forms of interactivity have been developed in particular are STEIM in the Netherlands, IRCAM in France and Opera for the Future Lab at MIT in the US, and work done in Italy (in particular at the Conservatory of Padova and the University of Genova).

There are several examples in which the audience can participate directly in the performance through various interactive technologies. For example, in The Humanaquarium musicians were placed in a large interactive glass box in public places and people walking by could change the performance through touching the glass box (Taylor et al. 2010). Examples of how to use movement sensors to allow audiences to influence both music and imagery are The Web (Krefeld & Waisvisz 1990) and Touchstone (Norman et al. 1998). On stage, digital interactivity in different forms has been introduced to put artists, musicians and singers in charge of the overall aesthetic form of their performance, for instance in the Virtualis Virtual Opera (Bonardi & Rousseaux 2002), in the Vocal Augmentation and Manipulation Prosthesis (Jessop et al. 2011) and in The Crackle Box and The Hands by Michel Waiswisz (Waisvisz 2004).

Apart from the development engaging interactivity and electronics in opera, important work has been done in the realm of interactive dance and in interactive music performance – such as The Biomuse/The Global String and Soundnet, (Tanaka 2000), the DIEM system (Siegel 2009), and the A20 musical interface (Bau, Tanaka & Mackay 2008)

3. Methodological Groundings for the Extending Opera program
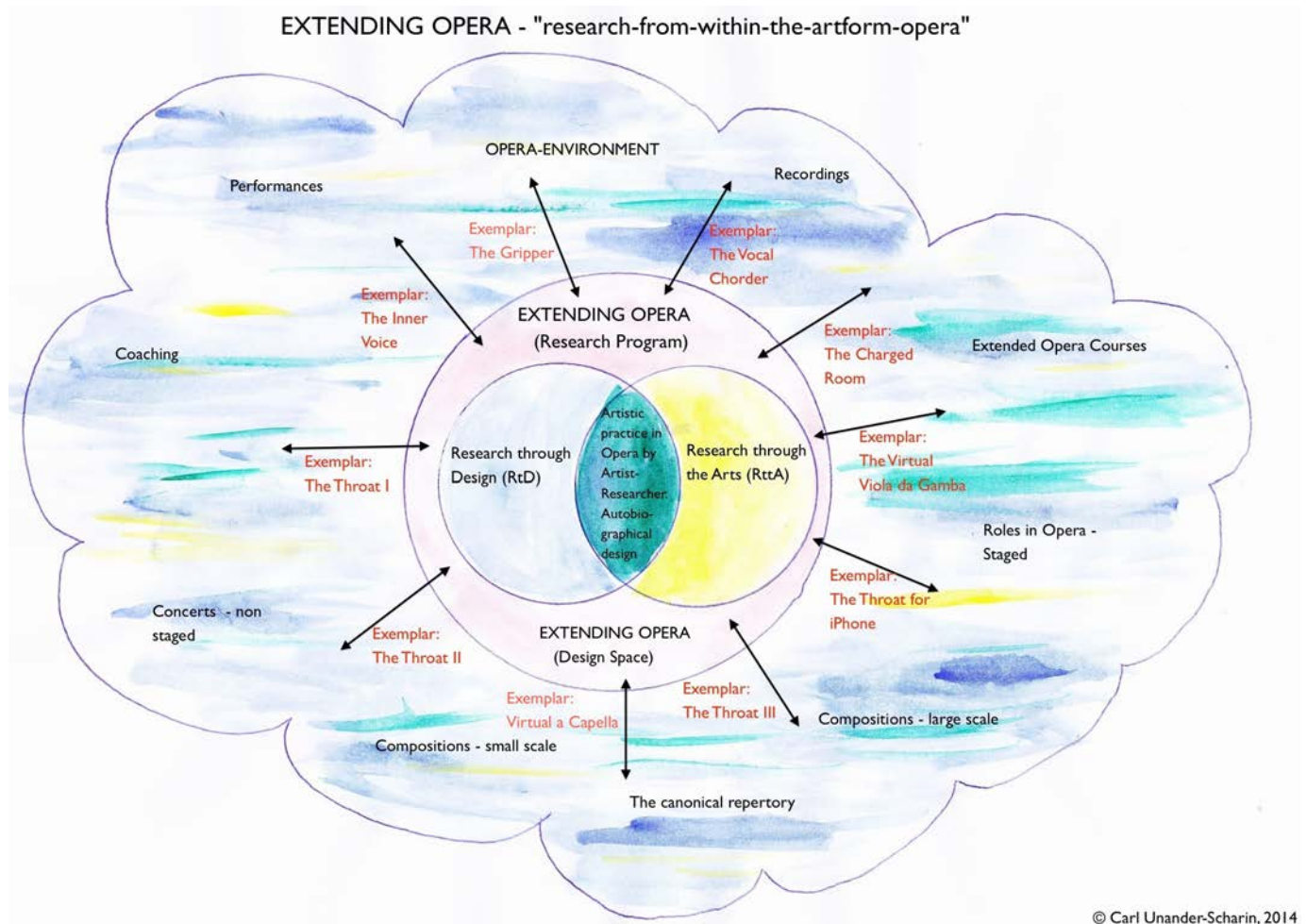
Figure 20: Graphical representation of the research program Extending Opera

The graph in Figure 20 describes *Extending Opera* framed as a *research program* (Binder & Redström 2006), aiming to open and populate a new *design space* (Westerlund 2009) in opera. Extending Opera is engaged in re-empowering opera singers and at exploring operatic practice through offering tools for artist-led musical accompaniment and vocal expression. The same aim can of course be achieved in many different ways: through combining genres to create new expressions, such as improvisational jazz with opera, training opera singers to sing in new styles, the incorporation of other singing techniques in

traditional operas, the many fruitful cross-breedings between rock, opera and musical theater, and so on. I have chosen to work with this design space through combining three areas of activity: singing, composing and the development of technology to be used onstage, in real-time performances of opera.

3.1. Research through the Arts (RttA) and Research through Design (RtD)

The Extending Opera design program has its methodological groundings in *Research through Design* (RtD) and *Research through the Arts* (RttA). More specifically, combining ideas from these fields, I have framed my work as "research-through-the-art-form-opera" — that is, I have worked within the realms and traditions of opera, probing its boundaries by designing and researching through its own artistic toolbox.

The research was carried out in a transdisciplinary way, and revolves around the development of and the performance with ten novel artifacts, or as they are sometimes called in the 'research through design literature': *exemplars* (Binder & Redström 2006). The exemplars are the vehicles that probe the opera-environment and thereby connect it to the research program and design space.

According to Binder & Redström, a research program in an interactive design research setting consists of three steps: 1. formulation of a program, often starting through extensive exploration of the qualities of the material at hand — whether electricity, interactive textiles or, as in this case, the artistic expression in opera; 2. realization of the program through design experiments — exemplars; and finally 3. articulation of the experiments through reflection. The latter often leads to reformulation of the overall program. Of key importance in a designerly research exploration is to let the particular exemplars both explore possibilities and inform the overall research program. That is to say, through the actual design process, the key knowledge is gained. In a recent article, the two authors frame such knowledge as a *strong concept*, categorized as, "having

the following properties: is generative and carries a core design idea, cutting across particular use situations and even application domains; concerned with interactive behavior, not static appearance; is a design element and a part of an artifact and, at the same time, speaks of a use practice and behavior over time; and finally, resides on an abstraction level above particular instances" (Höök & Löwgren 2012).

Through the development of and performance with the ten exemplars, The Gripper, Virtual a Capella, The Vocal Chorder, The Charged Room, The Throat I+II+III, The Throat for iPhone, The Inner Voice and The Virtual Viola da Gamba, the articulation of a research program investigating new artistic expressions for opera has been done. A main defining and generalizable property of the exemplars in this design space is the emancipation of the singers and the exploration of the impact on their artistic practice through the use of interactive instruments.

There are many expressions for research that concerns practitioners in the artistic field. In the foreword to a recent publication, STM 2013, Sverker Jullander lines up an array of expressions currently in use: " 'art research', 'art-based research', 'research in and through the arts', 'practice-based research', 'practice-led research', and 'practice as research'. To these terms could be added 'practitioner research', 'research through practice', 'research by practice' and 'research in the arts' — the term chosen for the authoritative *Routledge Companion to Research in the Arts*" (Jullander in Biggs et al. 2010). The author concludes that "Attempts have been made to distinguish between different meanings of such terms, but none has won universal acclaim". (Jullander 2013)

Maybe a way of understanding why there is this plethora of terms concerning artistic research methods is to acknowledge that there is a multitude of ways to see what an artistic knowledge contribution actually is, and thus which research methods follow. To let such heterogeneous perspectives surface is cumbersome, but nonetheless important, particularly in quite novel research domains such as RttA and RtD.

The philosopher Donna Harraway stated "Only partial perspective promises objective vision." (Haraway 1988) and she proposed the concept of *situated knowledge* and warned researchers about trying to do *The God Trick*, thereby neglecting the situatedness that is inevitable in every human activity. Arguing that it is impossible to detach our perspective from the world we live in, in order to try to see it 'from above', she points out the necessity of situating one's own perspective in order to be able to claim knowledge of any kind. In reference to Haraway's line of thought, I make an effort to situate my knowledge contribution surfacing through artistic and designerly practice within the opera-environment.

More on terminology

In a seminal article from 1993 published by the Royal College of Art in London, Christofer Frayling puts forth the idea (based on ideas from his colleague Herbert Read) that research in the realm of art and design can be categorized into three distinguishable paths (Frayling 1993). The categories proposed are:
• Research into art and design
• Research through art and design
• Research for art and design.

Frayling exemplifies the second category – research through art and design – which among these three is the category that the Extending Opera research program most closely connects to, as: "Development work – for example customizing a piece of technology to do something no-one had considered before, and communicating the results". He continues: "Research where the end product is an artifact – where the thinking is, so to speak, embodied in the artifact, where the goal is not primarily communicable knowledge in the sense of verbal communication, but in the sense of visual or iconic or imagistic communication" and contrasts this way of conducting research with research into art and design, which is "the more straightforward" and "by far the most common" way to go about it. According to Frayling, examples of this method are Historical Research, Aesthetic or Perceptual Research and "a variety of theoretical per-

spectives on art and design". The third category, research for art and design, is categorized as what the artist (exemplified by Pablo Picasso and an interview with him) does in preparation for an artistic project, preparing materials and colors in order to be able to commence the artistic work. In the interview quoted by Frayling[23], Picasso exhibits quite a few reservations regarding the notion of research in connection with artistic practice, and says: "In my opinion, to search means nothing in painting. To find is the thing". Frayling understands this quote as Picasso's way of saying that the preparations done in order to be able to create art are something that differs from the actual artistic practice and thereby Frayling frames it as research for art.

Moving on to the second category, research through art and design, Frayling claims that there is a common stereotype in making a dichotomy between practice and research. He puts this thought forward as, "Research is practice, writing is a practice, doing science is a practice, making art is a practice". This line of thought has affinities to another seminal publication published ten years earlier, namely Donald Schön's *The Reflective Practitioner* (Schön 1983). This book outlines certain principles such as *knowing-in-action*, *reflection-in-action* and *having a conversation with the materials* that have had quite an impact on education and research. Schön formulated the up to then often neglected fact, at least within academia, that professionals, in Schön's words "think in action" — which signifies the less clean and more hands-on procedure that actually takes place in the professional life outside of preset academic conditions. Schön noted that practitioners relate to a *repertory of examples* in their actual work, in order to solve problems and to find solutions in their practice. According to another researcher, Nigel Cross, the "designerly way of knowing" resides in three sources 1) People, 2) Processes and 3) Products — namely the artifacts. (Cross 1999).

In parallel with a growing interest, understanding and open-mindedness regarding how creative processes actually take place, the notion of practice-based

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[23] Pablo Picasso: an interview (reprinted from The Arts, New York, May 1923, in *Artists on Art*, (eds). Robert Goldwater & Marco Treves, John Murray, London 1985, pp. 416-7).

research through the arts has attracted more and more attention. For instance, in the book *Interacting: Art, Research, and the Creative Practitioner*, this fact is formulated as such: "in practice-based research any claims of originality and contribution to knowledge may be demonstrated through artifacts created during the research process. Textual description is not enough." (Candy & Edmonds 2011a). In another article, the same authors have proposed that "Research in the arts is frequently about the nature of artifacts or the processes used in their generation" (Candy & Edmonds 2011b).

The similarities between research through the arts and research through design, (what could be called the quest for embodying knowledge in an artifact by an inventing agent and the dissemination of the findings both through the artifact and a textual component) can be noted in the following quote: "An artist changes their artistic medium into a medium of research" and the result is "not only a research outcome, some kind of artistic invention, but also a new kind of artistic agent, an inventor, an artist-researcher, the primary expert of the medium that they themselves have created" (Kirkkopelto 2011). This statement—pinpointing an inventive agent called 'the artist-researcher' — can also be held true for the design researcher, as both are probing their medium through creative work with something that prevails in the materials they explore — such as a work of art or a prototype.

Thus, the areas of *research through the arts* and *research through design* overlap in many ways. In particular, the idea of letting the research be embodied in an artifact — whether a work of art, a novel technology or even the two intermingled in one artistic-technological artifact and disseminated through an accompanying text. The combination of several artifacts originating from the same research program together with an accompanying text has been referred to as the *Annotated Portfolio*. As William Gaver puts it: "Beyond single artefacts, however, annotated portfolios may serve an even more valuable role as an alternative to more formalised theory in conceptual development and practical guidance for design. If a single design occupies a point in design space, a collection of designs by the same or associated designers — a portfolio — establishes

an area in that space."

He then continues: "Comparing different individual items can make clear a domain of design, its relevant dimensions, and the designer's opinion about the relevant places and configurations to adopt on those dimensions" (Gaver 2012). John Bowers summarizes the connection between Research through Design and the procedure of Annotating Portfolios in this way: "Treating this collection as an annotated portfolio highlights, formulates and collates interaction design issues in this work in a novel manner." (Bowers 2012). In another recent article, Jonas Löwgren further adds to this discussion, and concludes: "I strongly support Gaver and Bowers in claiming that design practice has a place in HCI research today, and that the researcher can add knowledge value by providing annotations in addition to the artifacts" (Löwgren 2013).

What then distinguishes Research through Design from Research through the Arts? In the Extending Opera research program, the designerly and the artistic processes take place in a symbiotic procedure in which they are hard to discern from one another, a process called Sensory Digital Intonation (Unander-Scharin & Unander-Scharin 2013). However, one answer may be the differences in the nature of the artifact and thereby the differences in the procedures leading up to the artifact — be it a work of art put to music or a snippet of user-friendly software. Working with artistic goals in mind is synonymous with working with a great deal of open-mindedness towards the often surprising findings that occur as a result of the urge to create a viable piece of art. The procedure and the requirement that the Extending Opera research program formulates for the creation of functioning artist-operated, interactive artworks — Sensory Digital Intonation and Performative Stamina ("The Premiere-Factor") — are examples of procedures that are singular to an artistically guided research trajectory.

Let us therefore have a look at the autobiographical engagements that are connected with an artistic process.

3.2.   Autobiographical engagements in art and design

The method I used when setting out to create the new electronic instruments for opera to be used on stage can be loosely characterized as *auto-biographical design*, where the practitioner is both designer and user, engaging in "intensive self–usage as part of the design research" (Neustaedter & Sengers 2012). The advantage of an auto-biographical design process is, according to them, a system that really works already from the start. Furthermore, recent work in interaction design discusses the role of exploring and exploiting the material to its fullest (Fernaeus & Sundström 2012). This attitude resonates with my work process. In their paper, the focus on materials in design research is described as an "extended focus on how systems are crafted from and together with properties of digital materials, and how new knowledge gained from those processes can be shared" (Ibid).

Through my auto-biographical exploration into opera singing, composing and in creating novel instruments, I have arrived at artistic works, novel artifacts and embodied knowledge. As I argued above, this particular strand of research may be denominated *research-through-the-art-form-opera*. Importantly, the view that the research is undertaken with a deep knowledge of this particular art-form and that it has a direction from the core of the practice of that art form is proposed by this term. The research in the Extending Opera program is conducted through opera and is a systematic investigation in order to gain knowledge through practice.

3.3.   The Extended Opera Courses 2011-2014

Between September 2011 and January 2014, four iterations of a course for advanced singers were presented by the University College of Opera in Stockholm. As a part of my assignment as Visiting Professor, I led the courses in collaboration with choreographer/researcher Åsa Unander-Scharin and with artist/ researcher Ludvig Elblaus. The courses were hosted by researcher Leif Handberg

in The Reactor Hall at KTH, The Royal Institute of Technology. Two of the courses were arranged in cooperation with the students in theatre technique at StDH (the Stockholm School of Dramatic Arts) and their course leader Anders Larsson.

The courses in Extended Opera offered:
```
"A course that aims at a broadening and critical discussion
of the concept of opera, by performing old and new music in
a staged and technologically enhanced concert/ installa-
tion/ performance."[24]
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Opera singers, some of whom had more than ten years of professional experience, applied for the course. The singers were chosen according to their overall skill as singers and their bodily performance awareness. We were looking for participants with an urge for experimenting with – and taking part in – development of new technology for opera. All in all 18 singers attended the course during the run of the four iterations. [25]

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[24] From the course syllabus by Carl Unander-Scharin for The Extended Opera Course, September 2011.
[25] During fall 2011 the singers were: Rickard Laby, Staffan Liljas, Randi Røssakk, Maria Sanner and Gong Yinjia. During spring 2012 the singers were: Henriikka Gröndahl, Kristin Gornstein, Signe Lind, Matilda Wahlund and Anna-Sara Åberg. During spring 2013 the singers were: Lisa Gustafsson, Staffan Liljas, Maria Sanner and Alexandra Zetterström Büchel. During fall 2013 up to January 2014, the singers were: Emilia Feldt, Annika Hudak, Annastina Malm and Erika Tordéus.
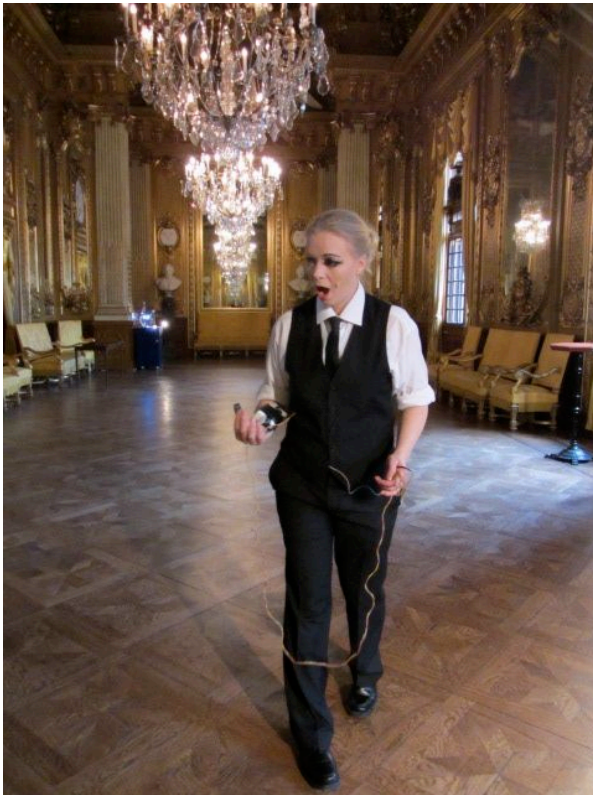
Figure 21: Henriikka Gröndahl performing G F Handel's "Piangerò" with The Throat III in the foyers of The Royal Swedish Opera; as part of the Extended Opera course in May 2012. Rickard Laby performing G Verdi's "Di Provenza il Mar" with handheld accompaniment in The Reactor Hall, September, 2011

These courses came to function as a soil and empirical grounding for my research on Extending Opera that evolved as a result of the preceding long-standing, primarily auto-biographical artistic procedure. When new, external singers encountered the auto-biographically conceived technologies, a new cycle of thorough probing, discussing and further developing of the novel interactive and artist-operated instruments took place. These cycles of validation came to empirically support my original ideas to empower opera singers through interactive technologies at the same time as informing and extending on it. The auto-biographical accounts of how I brought forth the instruments that I will describe below, together with these new cycles of testing and changing in dialogue with the external singers, constitute the validation of my research claims.

The Extended Opera courses attracted international attention, and were presented in Holland (at Operadagen Rotterdam in May 2012), in South Africa (at the Cape Town Opera in June 2013) and in Hungary (at the Liszt Academy of Music in Budapest in January 2014), as well as in Sweden.

Figure 22: From the tour with Extended Opera to Operadagen Rotterdam, June, 2012. From left: Ludvig Elblaus, Henriikka Gröndahl, Kristin Gornstein, Anders Larsson (at the back), Signe Lind, Matilda Wahlund, Anna-Sara Åberg, Åsa Unander-Scharin, Carl Unander-Scharin

The presentations in Sweden took place in The Reactor Hall at KTH, at Scenkonstbiennalen in Jönköping and at The Royal Swedish Opera. A team from SVT (The Swedish Public Service Television) followed our work during one day, which resulted in a feature report on "Sverige!", broadcast in May 2012. Also, a variety of articles, reviews and reports appeared[26].

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[26] See Opera Mecatronica Live web-special
http://www.youtube.com/watch?v=Ok3p2YMaarU&list=UUrCJwo2Rq_5goJ6jd_XhfEg
See Sverige! on Opera Mecatronica Live
http://www.youtube.com/watch?v=gkzPG2aGnp8&list=UUrCJwo2Rq_5goJ6jd_XhfEg
See "Nya Tekniker utvecklar Operakonsten" in Scen & Film", May 2013

Figure 23: From Extended Opera course, in September, 2011. Maria Sanner and Åsa Unander-Scharin working with The Virtual Viola da Gamba

http://www.electronic-opera.com/sites/elop.hammar.ch/files/%22NyaTeknikerUtvecklarOperakonsten%22_Scen&Film_Maj_2013..pdf

See Forskning och Framsteg on The Throat III: http://www.electronic-opera.com/sites/elop.hammar.ch/files/ThroatF&F.jpg

See Månadens Innovatör in M3
http://www.electronic-opera.com/sites/elop.hammar.ch/files/MånadensInnnovatör_Throat_M3_maj13.jpg

See The sound of one-hand singing in Science Nordic: http://www.electronic-opera.com/sites/elop.hammar.ch/files/The%20sound%20of%20one%20hand%20singing%20|%20ScienceNordic.pdf

See "Sånghandsken du vill höra mer av", frontpage at kth.se, may 2013.
http://www.electronic-opera.com/sites/elop.hammar.ch/files/KTH%20-%20Sånghandsken%20du%20vill%20höra%20mer%20av%20-%20Mynewsdesk.pdf

Figure 24: Annika Hudak and Emilia Feldt performing in The Vocal Chorder in The Solti Hall at The Liszt Academy of Music in Budapest, as part of The Extended Opera Course, in January, 2014

Figure 25: Gong Yinjia with The Throat III and Staffan Liljas in The Charged Room. Extended Opera course in The Reactor Hall at KTH, September, 2011

Figure 26: Extended Opera in the foyers of The Liszt Academy of Music in Budapest, January, 2014

Figure 27: Maria Sanner and Ludvig Elblaus, rehearsing "How Strange is the Lot of us Mortals?" with The Throat III in the Reactor Hall at KTH in during the Extended Opera Course in May 2013

Figure 28: Jimmy Svensson, Carl Unander-Scharin and Ludvig Elblaus, preparing for a performance of "Sing The Body Electric!" in Cape Town, South Africa, June 2013, as part of the Extended Opera Course
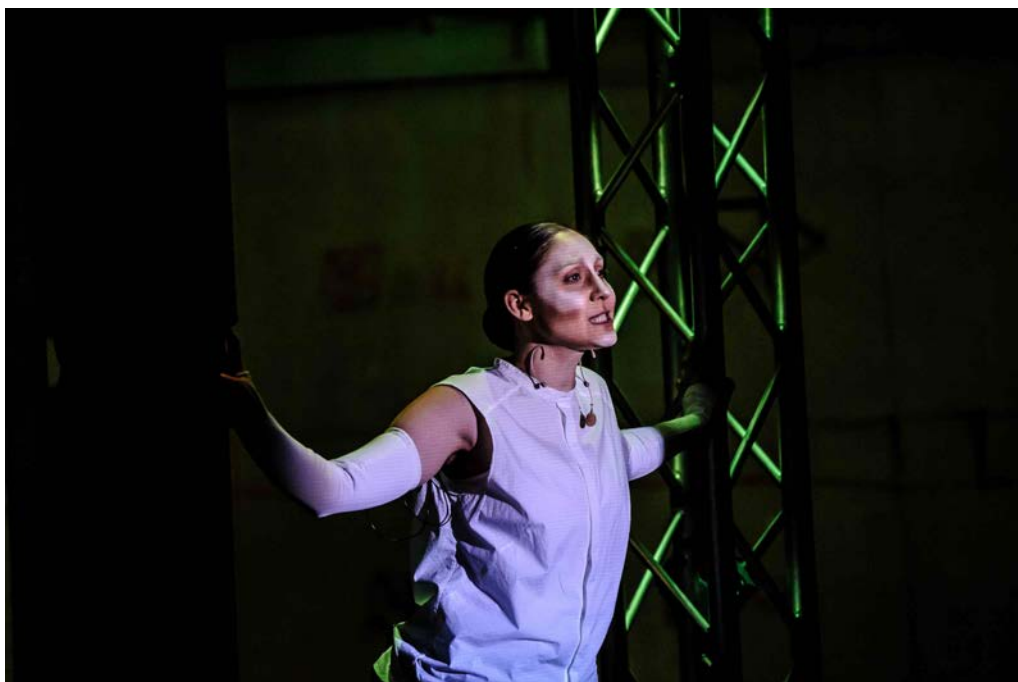
Figure 29: Alexandra Zetterström Büchel performing "Oh my Body! I dare not desert the likes of You" in The Charged Room, in The Reactor Hall at KTH, May 2013

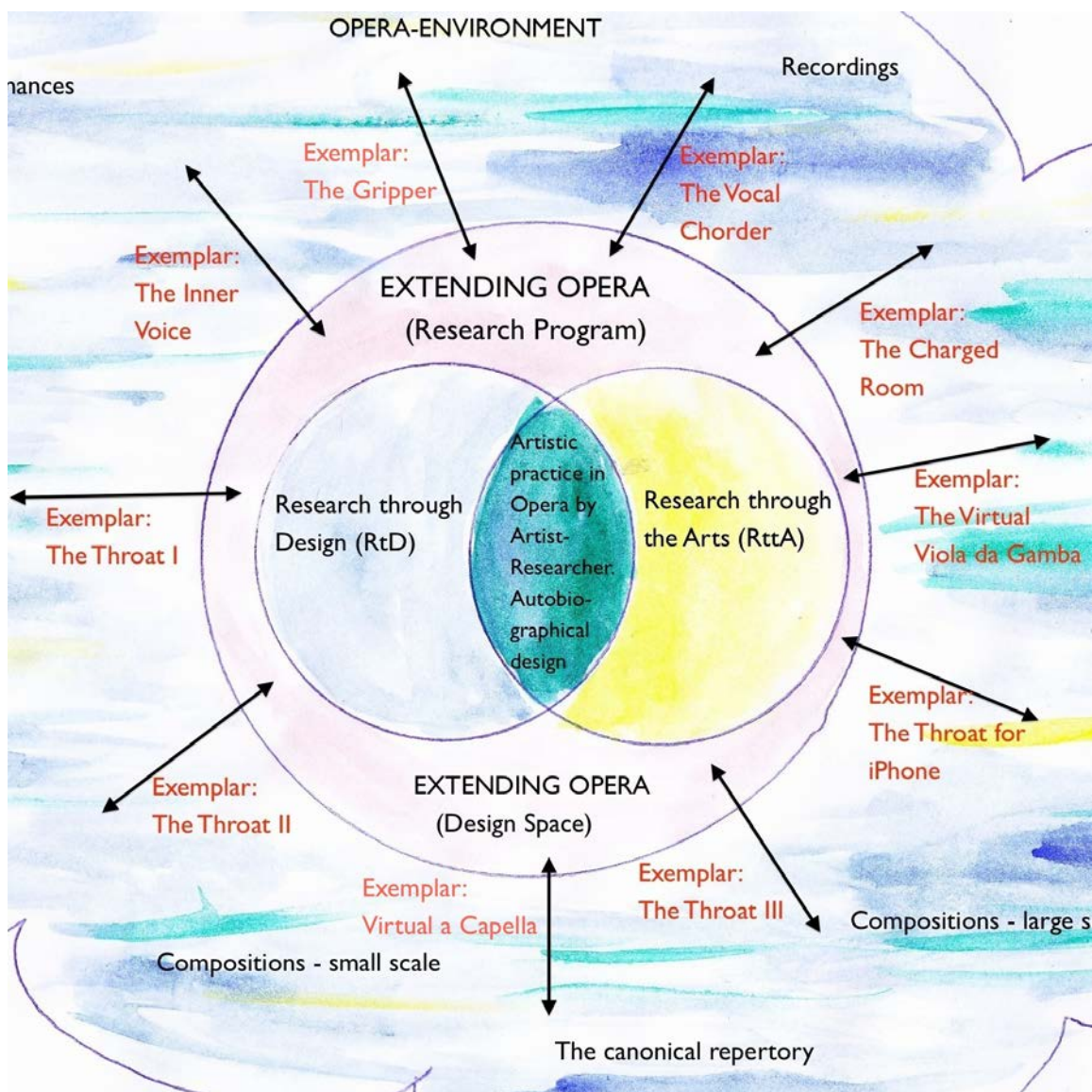## 3.4. Summary: Extending Opera – "research-through-the-art-form-opera"

Figure 30: Detail from the graphical representation of Extending Opera - research-through-the-art-form-opera

Having thus outlined the environment that this research project is situated in, and having described the trajectories wherein the ten exemplars function as vehicles for communicating back and forth between the research program and the opera-environment, we arrive at Chapter 4, the point at which the exemplars will be further described.

In summary, this research project – in accordance with Frayling's categorization as outlined in section 3.1 – the overall framing are Research through the Arts (RttA) and Research through Design (RtD). This choice is based on the fact that the preposition *through* signifies a close contact with the material at hand.

However, as there exists a variety of RttA-forms I delimit my work to only that which concerns the art form opera. My research through opera resides at the intersection of RttA and RtD in *research–through–the–art–form–opera.* As suggested by this term, this particular stance of research assumes deep knowledge of the particular art form opera. Furthermore, the term suggests that this research is carried out *through* opera by probing its environment in utilizing its own artistic toolbox.

# 4. Exemplars: Extending Opera through Artist-Operated Interactivity

Let us now turn to the different instruments we have been building throughout the years. This is an account of my portfolio – in a sense following the *annotated portfolio* concept (Bowers 2012; Gaver 2012; Löwgren 2013) as mentioned above. Accordingly, I will describe the development of each of the artifacts in the setting from which they originated. Through describing the totality of the artwork in which they appeared, I aim to provide a richer picture of how their designs originated and why they were configured the way they were. By this somewhat lengthy listing of the works in which the interactive artifacts have been involved, I aim to show the progression between each of the instantiations and how they started out through a procedure similar to the concept of *auto-biographical design* (Neustaedter & Sengers 2012). This progression is of course partly due to technological development, but it is also based on the knowledge that we (sometimes painstakingly) obtained from deploying the instruments on stage – in front of real audiences – sometimes in quite prestigious and therefore demanding venues. Together with the seven papers, the following descriptions constitute the core of my empirical work.

4.1.　Introduction: Early work with The Gripper, The Inner Voice and Virtual a Capella

The interactive, artist-operated technologies discussed in this section have been developed in various contexts and projects in small and large scale. The common denominator for these technologies is that they are operated by an artist performing on stage in real-time. However, as the artistic processes that are incorporated in this research project stretch over a quite long period of time, the affordances of the technologies at hand at the time have had great impact on what has been possible to achieve throughout the years. For example, cord-

less interactivity was hardly available for our explorations in the early 1990s, but is commonly available in consumer electronics of today.

Early work: The Gripper
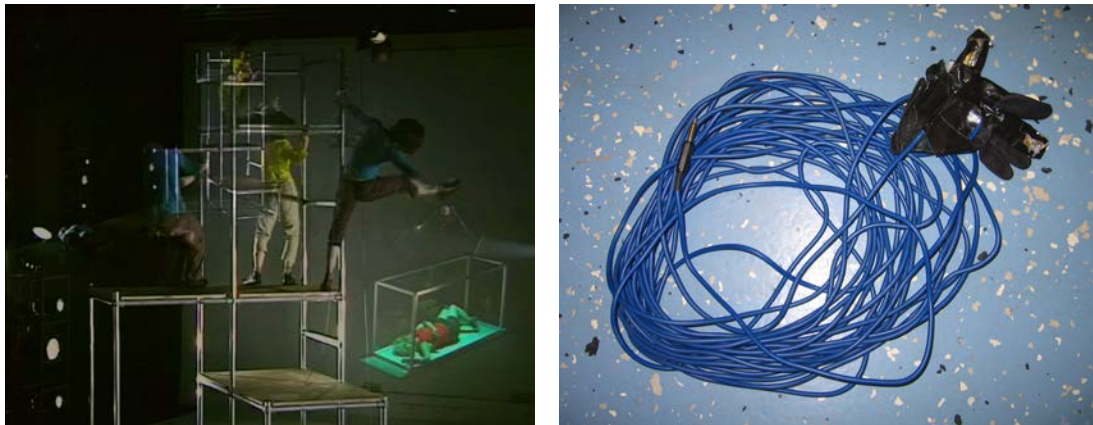
Figure 31: Dancer Petra Wormbs using The Gripper (detail to the right) in *Patterns, Thoughts and Empty Space*, Moderna Dansteatern in Stockholm, second version of the piece in 2000

A particular strand of the development work started with *The Gripper* in 1998, a rather basic switch mounted on a glove, created for the work *Patterns, Thoughts and Empty Space*[27].

To this performance, I composed an a capella aria built on a stanza from W. Blake's *The Marriage of Heaven and Hell* from 1790 which takes the form of a first-hand narrative of an animated conversation with an angel:

```
I answered: "All that we saw was
owing to your metaphysics; for when
you ran away, I found myself on a
bank by moonlight, hearing a harper.
But now we have seen my eternal
lot, shall I show you yours?" He
laughed at my proposal; but I by
force suddenly caught him in my
arms, and flew Westerly through the
night, till we were elevated above the
earth's shadow; then I flung myself
with him directly into the body of the
sun; here I clothed myself in white,
and taking in my hand Swedenborg's
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[27] www.scenochsinne.com/index.php?option=com_content&view=article&id=54%3Atanke-moenster-och-tomrum-2000-01&catid=54%3AKoreografiska+verk&Itemid=83&lang=en

```
volumes, sunk from the glorious clime,
and passed all the planets till we came
to Saturn. Here I stayed to rest, and
then leaped into the void between
Saturn and the fixed stars.
```

The composition was performed by me singing a capella with only the accompaniment created through the interactive modifications by The Gripper maneuvered by the dancer. In order to depict Blake's esoteric vision, the voice was processed through metallic resonating filters and manipulated by the movements of the dancer.

The Gripper consisted of two pieces of metal mounted on a glove at the index finger and the thumb respectively. The glove was connected via a cable to two sound processing units, a Nord Modular and a PCM-80 manufactured by Lexicon. The cable was inserted into the inlet in which normally the pedal of an electronic piano should be inserted in the PCM-80. Thus the Gripper moved the functions of the foot to the hand. Furthermore, I programmed the PCM-80 in order to enable the performer to capture and manipulate the sounds that were processed within the unit with the movement created when the thumb met the index finger, hence the name The Gripper. Thus a dancer (Petra Wormbs) could 'scratch' the voice of a singer (Carl Unander-Scharin) through her bodily movements (see Figure 31). A strange and metallic composition was the artistic result of this body-vocal-machine interaction.

The development concerning Patterns, Thoughts and Empty Space also included the first version of another of the interactive tools incorporated in The Extending Opera Program — *The Charged Room*. These early ventures into the use of wireless interactivity on stage were starting points for later explorations, based as they were on the technology then available.

Early work: The Inner Voice
Earlier in the 1990s, another important point of departure for this research project was the development of *The Inner Voice* for the two operas *The Man on*

the Hill-Side (radio opera from 1991)[28] and *The King of Fools*[29], staged opera premiered in Vadstena in 1996.

These two works have a common factor in that they, in an operatic setting, deal with how a human is torn and thrown between outer and inner voices and conflicts. In composing the music to the The Man on the Hill-Side, I utilized the 'patch buttons' on an Ensoniq ASR-88 synthesizer to allow for fast variations in the accompaniment and in the processing of the voice of the singer. In this way, a kind of inner dialogue was created in which an operatic strain between outer and inner urges could take place.

The King of Fools, from 1996, is an opera that is built on an autobiographical account by Elgard Jonsson. The narrative describes how a young man has a breakdown in his mid-teens and subsequently is diagnosed with schizophrenia. In the 1960s this diagnosis was commonly perceived as a terminal condition and patients were offered little or no hope for a cure. However, thanks to Barbro Sandin, who was then an apprentice at the hospital, a long journey out from the darkness into the light towards a new life started for Jonsson. This engaging story forms the basis of the opera; in particular, the clash between the inner world and outer world that is described captured my musical fascination. The material was highly inspiring for the composition of an opera, but some aspects were particularly hard to deal with: How to put the inner conflicts to music? How to create a dialogue between inner and outer urges and voices? Could music technology offer a means in this endeavor?

Even if a 'conversation with self' is a recurring component in operas – particularly in the arias[30], this was an unusual task. In the molding of the libretto, the part of the title role had come to incorporate not only his inner voices but also

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[28] The Man on The Hill-Side was created in close collaboration between poet Katarina Frostenson and Carl Unander-Scharin, the latter composed the music and performed the tenor part as well as played the synthesizers. See www.electronic-opera.com/manonthehillside

[29] The King of Fools, opera in two acts with music by Carl Unander-Scharin. See www.electronic-opera.com/kingoffools

[30] Examples of inner dialogues in arias are Gilda's aria "Caro nome" from *Rigoletto* by G Verdi, Tamino's aria "Dies Bildnis ist bezaubernd schön" from *The Magic Flute* by W A Mozart, and Filippo's monologue "Ella giammai m'amò" from *Don Carlos* by G Verdi.

included the struggle between an outer and inner urge – as the main character is troubled with conflicting inner voices at the same time as the outer world tries to uncover these.

In parallel with the composition process, I started to experiment with earlier ideas and technologies at hand – and realized that a developed version of The Inner Voice from *The Man on the Hill-Side* might be a possible way of depicting the inner conflicts of the main character. Again using the Lexicon PCM-80 processing unit, the voice of the singer was captured by a cordless microphone and manipulated through the sound processor at certain instances in the score. As the Swedish word for a cordless microphone is "mygga" – which translates into "mosquito" – the icon was chosen as seen in Figure 32.

Figure 32: Excerpt from the vocal score of "The King of Fools", indicating electronic processing of the voice in order to create an inner voice, intimately conveyed to the audience

AUDIO: http://www.electronic-opera.com/node/791
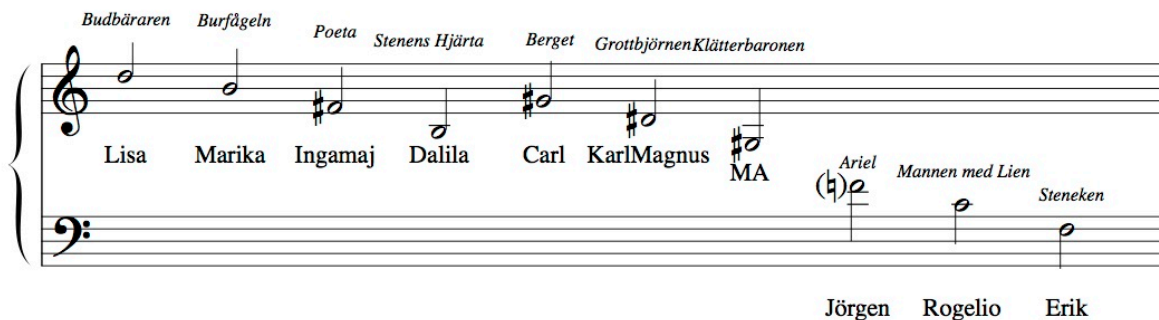
Listen
to
AUDIO

In this way, a fast oscillation between the inner and outward directed voices of the main character was created.

However, even if the processing in combination with the fact that the voice was amplified (which made a strong impact as the immediate changes back and forth between non-amplified versus processed amplified voice further enhanced the schizophrenic character), it was still an undynamic process that was not really modified by bodily interactions by the singer on stage. In the mid-1990s

such a process was not conceivable, given the affordances of the technology then at my disposal. It would not be possible to achieve until the development related to The Throat III in 2010.

Early work: Virtual a Capella

My next full-scale composition, *Figures in a Landscape*[31] from 1997 was labeled as a 'song cycle for the radio'. Here, playing with the term song cycle (as known from the famous ones such as "Die Schöne Müllerin" by Franz Schubert, "Liederkreis Op. 39" by Robert Schumann and "Lieder eines fahrenden Gesellen" by Gustav Mahler), I wanted to move the arena for this particular art form from the concert setting into the radio medium. Also, I let the nine songs in the song cycle be performed by nine singers from different vocal traditions as opposed to the common setting with one (classical) solo-singer performing a song cycle accompanied by one piano-player. Here, the fact that the nine singers never met in reality and were juxtaposed thus forming a choir only as a result of procedures made possible in the music studio, the concept of the Virtual a Capella was conceived.

Figure 33: The tones that form the first version of The Virtual A Capella in "Figures in a Landscape" from 1997 were recorded separately. The choir was formed through work in the studio

AUDIO http://www.electronic-opera.com/virtualacapella

Listen to AUDIO

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[31] Figures in a Landscape (Figurer i ett Landskap), song cycle for the radio by Ingamaj Beck and Carl Unander-Scharin. Singers in the songs, who formed the virtual a capella, were: Rogelio de Badajoz, Karl-Magnus Fredriksson, Lisa Gustafsson, Marika Lagercrantz, Jörgen Lantz, MA Numminen, Erik Saedén, Dalila da Silva Costa, and Carl Unander-Scharin. See www.electronic-opera.com/figuresinalandscape

These tones were recorded separately by the singers, and then I created a full chorus out of that chord which embeds the nine separate songs in the song-cycle. The singers sing the name of their characters on their tone, thus creating a Virtual a Capella-choir.

The idea of Virtual a Capella was later developed and incorporated into the interactive, artist-operated instruments Throat III, Throat for iPhone and The Vocal Chorder.

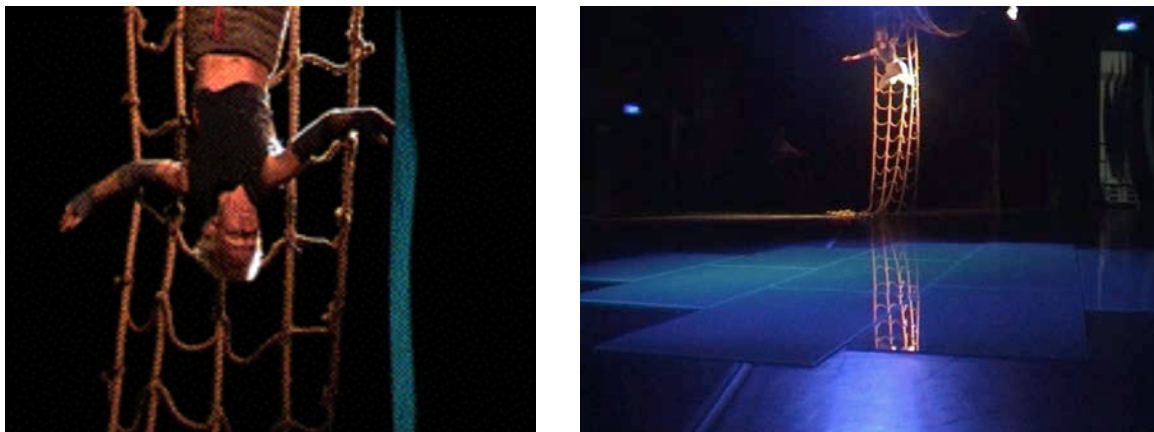## 4.2. The Virtual Viola da Gamba as used in *Qivittoq* and in *Lasciatemi Morire* (2002)

In 2002, Åsa Unander-Scharin and I created the interactive dance work *Qivittoq*[32]. This work was dedicated to our recently deceased friend, the author Ingamaj Beck, who earlier had participated in the creation of *Figures in a Landscape* as author and narrator. She grew up on Greenland and later spent parts of her life in Florence, Italy. Her partly autobiographical novel *Qivittoq*[33] revolves around passion and death in these two quite different cultures. Through a personal and minimalistic language, Beck depicts how passion is common to us all and how our physical surroundings influence and change the way we live our lives. The mythological Inuit character *Qivittoq* is a carrier of souls between worlds and persons and in the dance-work this character was depicted by the dancer and choreographer Åsa Unander-Scharin.

In our rendering of Beck's book, we wanted to merge the passion in her text with the cold and barren emptiness of the mythological creature of Greenland by using specific scenography and cold electronic interactive soundscapes in combination with an italianate and operatic artistic expression.

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[32] www.scenochsinne.com/index.php?option=com_content&view=article&id=51%3Aqivittoq
&catid=54%3AKoreografiska+verk&Itemid=83&lang=en
[33] Ingamaj Beck: *Qivittoq*. Symposion, Stockholm, 1999.

Figure 34: Åsa Unander-Scharin performing with the Virtual Viola da Gamba in "Qivittoq", Moderna Dansteatern, Stockholm 2002

Therefore, we decided to incorporate an aria by Claudio Monteverdi, *Lasciatemi Morire*, in the performance. As one of the most famous arias in the repertory of opera, this aria is the only surviving part of Monteverdi's lost opera "Arianna" (from 1608), and it is often referred to as the "Lamento d'Arianna". We sought a means to let the dancer (Åsa) accompany the singer (Carl) with interactive tools in this aria.

**Chord progression forwarded by movement**

The aria has a beautiful and very distinctive chord progression[34] that I simplified so that it could be performed with simultaneously sounding tones, allowing for sensory interaction.

We started to explore an interactive, cordless performance system: the DIEM system. This system was constructed and sold during the turn of the century 1900-2000 by the Danish Institute for Electronic Music in Aarhus, Denmark. We created the Virtual Viola da Gamba through the use of four bend sensors from the DIEM system that we placed on the dancer's wrists and elbows. The sensor system, consisting of these sensors connected to a sender placed on the dancer, transmitted continuous data from the sensors over air. At the mixing console, a receiver forwarded these signals via a MIDI-interface to a computer,

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[34] A chord is the simultaneous sound of tones that can either create a consonance or a dissonance. In early baroque music like Monteverdi's, chords commonly consisted of four to five tones, and were supported by a bass tone, giving the chord its root.

running Max/MSP software[35]. This in turn processed the data and forwarded it to a Nord Modular Synthesizer[36] that created the actual sound that then was played through loudspeakers. (See Figure 35)
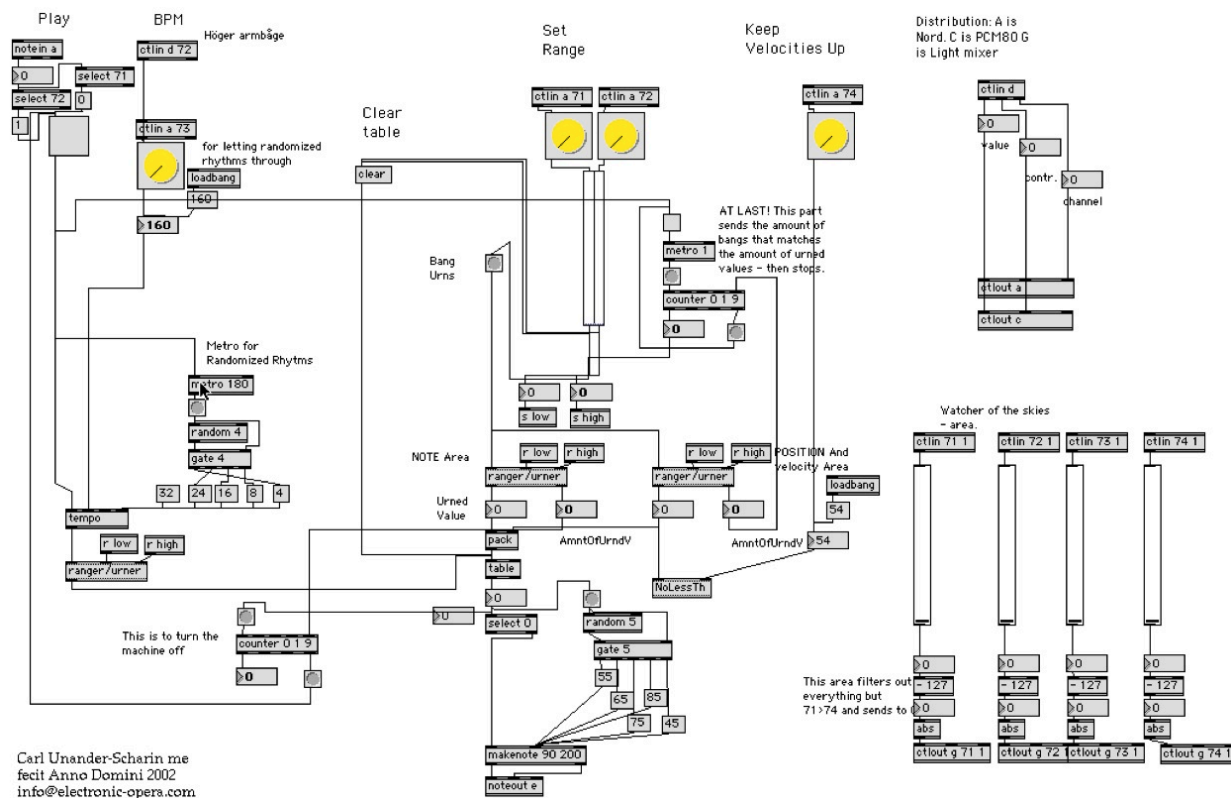

Figure 35: Screen dump of software for "Qivittoq" (2002), created in Max/MSP

While experimenting with the sensors, the software and the synthesizer, I shuffled the sensor data around in the synthesizer, trying various ways to let the aria be accompanied by the dancer. After many different versions in which we discarded overly complex solutions such as having chords individually allocated to a particular limb of the dancer's body, I found a solution where the synthesizer was programmed to have four parallel tracks of pitches. These parallel tracks could be simultaneously forwarded by the turning of one knob on the synthesizer or indeed by the bending of one of the sensors within the cordless sensor system. Thus the dancer, Åsa, was able to forward the chords in order to accompany the singer, Carl, through her bodily movements when dancing.

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[35] www.cycling74.com

[36] www.nordkeyboards.com/products/nord-modular
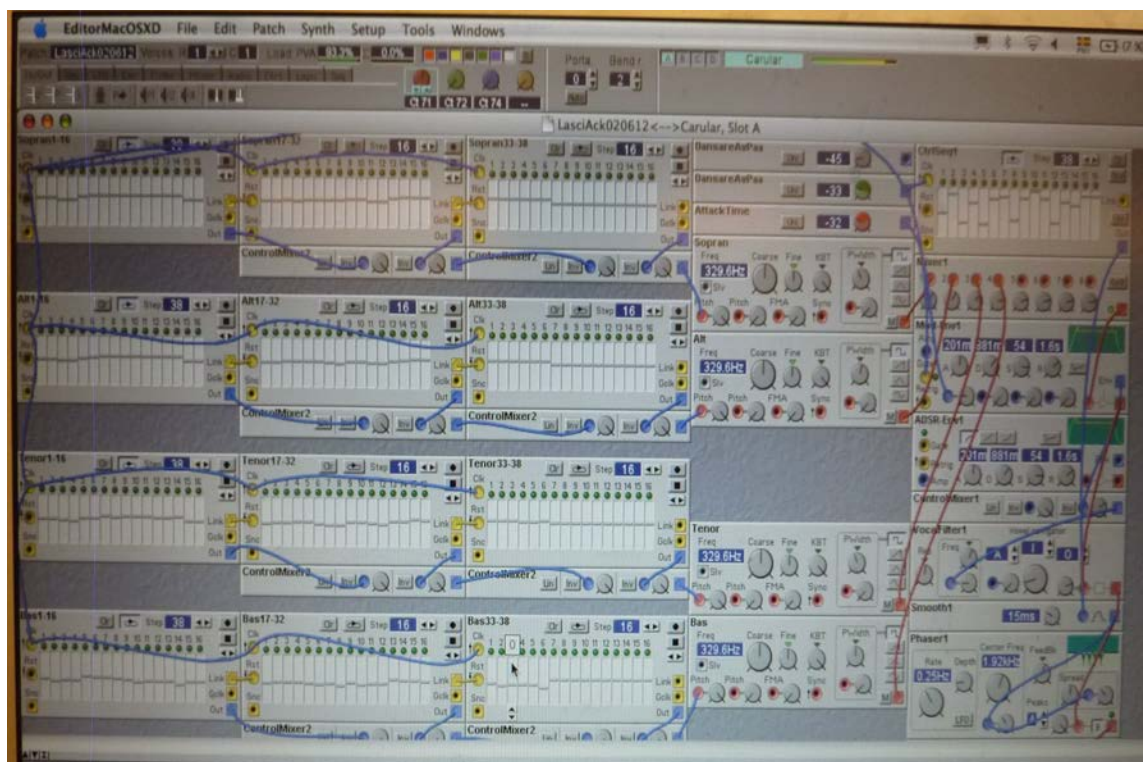
Figure 36: Screen dump from 2002, showing the software configuration in The Nord Modular Synthesizer. The four horizontal rows of boxes show the four arrays of tones that constituted the musical material

By simplifying the commanding of the forwarding of the chords, other artistic parameters could surface, such as incorporating other limbs that through other sensors could impose changes in other sound parameters. We chose to let the dancer change the timbre of the synthesized chords and the loudness of the accompaniment as well as the forwarding of the chords through the movement of her wrists and elbows. As the dancer, Åsa, had experiences from playing the renaissance/ baroque instrument the Viola da Gamba[37], which is a bowed instrument that allows for the playing of chords, we decided to call the artifact "The Virtual Viola da Gamba". As the movements she used in order to play the virtual instrument resembled those that are used when playing the Viola da Gamba, this was an appropriate and inspiring term. A choreography was devised by Åsa in which she could accompany the vocals sung by me through her movements in a bodily enacted series of movements, parts of which were per-

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[37] The Viola da Gamba (bass version) is an instrument that has similarities to a Violoncello but has seven strings and is equipped with frets that make the playing of chords possible.

formed upside down as she was hanging with her feet in a net (as seen in Figure 34).[38]

Returning to The Virtual Viola da Gamba in 2011-2014

Nine years later, in 2011, a new opportunity for performing with The Virtual Viola da Gamba surfaced in conjunction with The Extended Opera Course. In this context, the alto Maria Sanner was given the task of performing the aria by Monteverdi and at the same time accompanying herself through the movement of her limbs. Thus she would be performing as a singer as well as managing the accompanying function that the dancer had earlier performed in the version from 2002.

A lengthy rehearsal procedure took place during August and September 2011, exploring the complexities that arose when such different activities occurred at the same time. There were three tasks that needed to merge in order for Maria to be able to perform with The Virtual Viola da Gamba. Firstly, the vocal production, an area in which Maria was already an expert and which was simplified by the fact that she had performed the aria by Monteverdi before, accompanied by a pianist. Secondly, she needed to get used to the technology as such, in order to be able to rehearse with it in a comfortable setting behind closed doors. Thirdly, she needed to learn how to interact with the sensors in order to create her accompaniment through them whilst singing. In a series of rehearsals that focused either on the musical/technical side, or on the bodily/performative side, a pattern for how to master the tasks slowly surfaced. After five weeks of rehearsals (see also Figure 23), Maria succeeded in mastering the instrument at the same time as she sang the aria.

VIDEO:

http://www.youtube.com/watch?v=K1XHBQdLf6Q&list=UUrCJwo2Rq_5goJ6jd_XhfEg

Watch VIDEO

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[38] (See also chapter two in the thesis *Mänsklig Mekanik och Besjälade Maskiner/Human Mechanics and Soulful Machines*, in which The Virtual Viola da Gamba is described from a choreographic perspective. (Unander-Scharin, Å, 2008, in Swedish).

Figure 37: Maria Sanner performing "Lasciatemi Morire" with The Virtual Viola da Gamba, in the Reactor Hall, September 2011

In the second and fourth iterations of the Extended Opera Courses, Anna-Sara Åberg (Figure 39), and Erika Tordéus (Figure 40) respectively, performed with The Virtual Viola da Gamba, during which the procedures for rehearsing and interacting with the artifact were further refined. A rehearsal outline was added to the heading of the arrangement of Monteverdi's music, in order to simplify the work for each individual singer (Figure 38).

Figure 38: Arrangement for singer and The Virtual Viola da Gamba, with detailed instruction for personal rehearsals

Figure 39: Anna-Sara Åberg performing "Lasciatemi Morire" with the Virtual Viola da Gamba, Operadagen Rotterdam 2012

Figure 40: Erika Tordéus in preparation for performing with The Virtual Viola da Gamba in the foyers of The Liszt Academy in Budapest, Hungary, assisted by Åsa Unander-Scharin

4.3. The Throat I as used in *Hybrid, Creatures and Labyrinths* (2005)

The Throat is a series of real-time on-stage systems built for gestural interaction with an operatic singer's vocal performance, allowing for both artist-led accompaniment and manipulation of the quality of the resulting sound.

Common to the four versions is that that they consist of a. signal-processing software running on a computer (or on an iPhone) and that b. wearable interaction technologies impose changes in the processing of the voice through bodily engagements of different kinds.

Figure 41: Left: A glove mounted on a Nostromo Gamer Pad, thereby functioning as the hand-held controller in The Throat I as used in *Hybrid, Creatures and Labyrinths* from 2005. Right: Carl Unander-Scharin with Throat III in his right hand and the earlier Throat I in his left hand

The first version, The Throat I, was developed in 2005 for *Hybrid, Creatures and Labyrinths*[39] by Carl Unander-Scharin, who programmed and devised it. It was based on a gamer pad and a microphone headset connected to Max/MSP software. It enabled the singer to digitally process vocal lines and layer multiple copies of the voice in polyrhythms[40]. The gamer pad was mounted on a glove worn by the singer (allowing for quick touch interaction with the system while performing on stage, see Figure 41). This part of the dance work was based on a

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[39] www.scenochsinne.com/index.php?option=com_content&view=article&id=48%3Ahybrid-vaesen-och-labyrinter&catid=54%3AKoreografiska+verk&Itemid=83&lang=en
[40] Polyrhythms signifies multiple, simultaneously performed rhythmical layers that are not related to a common tempo or "beat".

text from *The Futurist Manifesto*[41] that was put to music and vocalized by me. However problematic in a historical context, this text is striking in its belief in a mystical connection between creativity and machinery, and it functioned as an inspiration for the work with the interactive technologies that we were exploring.

```
La Macchina non è forse oggi il simbolo più esuberante
della misteriosa forza creatrice humana?
Della macchina e nella Macchina si svolge oggi tutti
il dramma humano
(from Manifesto dell'arte meccanica, 1923)

Isn't the machine today the most exuberant symbol of
humanity's mystical creative powers? From the machine,
and in the machine, the full human drama now unfolds
(Translated by Carl Unander-Scharin, 2005.)
```

Through the use of the hand-held controller, an interactive vocal counterpoint[42] was created, while a complex choreography was performed in an on-stage labyrinth.

However, one limitation in this first version of The Throat was the long cable that connected the glove to the computer. It posed problems not only in securing that the machinery was connected properly but also in the fact that the long cable hindered movements and therefore obscured stage presence. A need to develop a wireless version was identified and would be realized in the work related to Throat III from 2010 and on.

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[41] Filippo Tommaso Marinetti, The Futurist Manifesto, in Robert Willard Flint, ed., *Marinetti: Selected Writings* (Farrar, Straus and Giroux, 1972). The futurists and in particular Marinetti, were fascinated by machines and technology and by changes in society brought about by the use of them. Unfortunately, this fascination later turned into a proto-fascism, and these texts are therefore quite problematic.

[42] Counterpoint is the artful combination of tonal themes that, according to certain rules, are put together in musical composition. Masters in counterpoint were e.g., G P da Palestrina, J S Bach, and A Schönberg, all in their own musical universes.

4.4. The Throat II as used in *The Insomnia Clinic* (2009)

A year later, in 2006, I was commissioned to create an opera for the Gothenburg Opera House in collaboration with author Alexander Ahndoril, *The Insomnia Clinic*[43]. The opera premiered in 2009. The story of the opera revolves around Isabella, who due to sleeping problems undergoes therapy in a hospital. In the beginning of the opera, Isabella leaves her former fiancé, the doctoral student Jim, to start a new life with her lover Gunnar. At the moment of departure, Jim abuses Isabella during a drug-induced coma. From that moment on, Isabella cannot sleep properly and her new life with Gunnar becomes more and more problematic.

In a desperate attempt to solve her sleeping problems, Isabella agrees to undergo treatment in an insomnia clinic, but as it turns out during the course of the opera, the clinic hides dark secrets. The abuse that she fears the most reoccurs as Jim shows up in the least likely of places: at the Insomnia Clinic itself – as an assistant physician.

Preparation of Throat II in relation to sleeping patterns

In the preparations for this opera, I contacted a clinic for the cure of people with insomnia problems at Sahlgrenska Sjukhuset in Gothenburg. I was very fascinated by the machinery used for tracking the sleeping patterns of the patients, called Electroencephalography (EEG), and started to wonder if this would be an opportunity to further develop the ideas of an artist-operated operatic instrument. The initial idea was to transform The Throat I into an instrument that was operated by the singer herself while preparing for the sleeping sessions, thus utilizing the machinery for the EEG as a metaphor for an artist-operated on-stage procedure.

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[43] www.electronic-opera.com/theinsomniaclinic
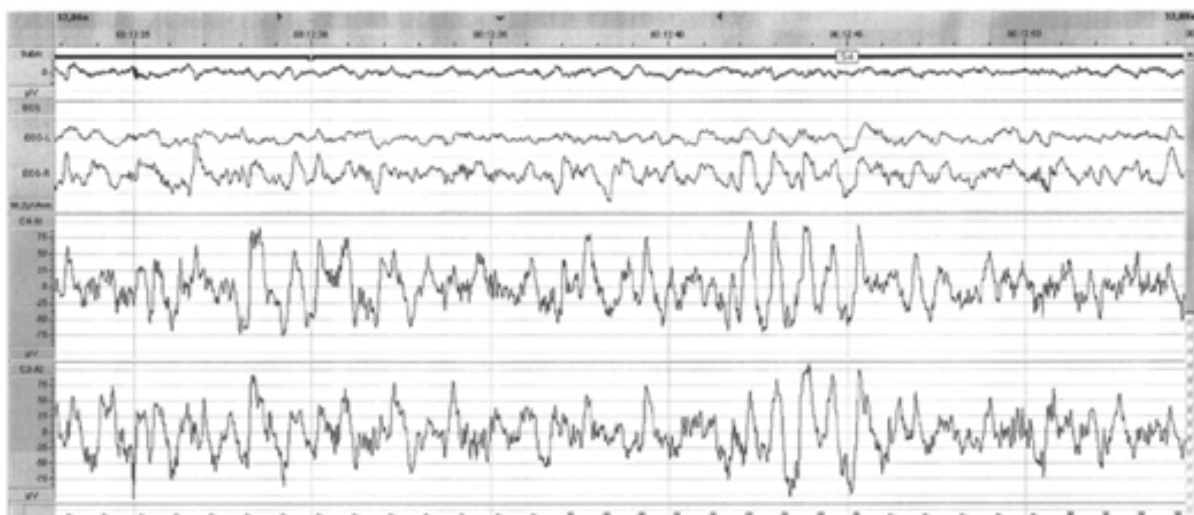
De två understa kurvorna visar EEG under djupsömn (steg 4)

Figure 42: The plotting of brain activity during deep sleep by Electroencephalography (EEG)

Figure 43: A patient at the insomnia clinic, wearing sensors for plotting sleep patterns via EEG.
Photo retrieved from the Internet, courtesy of Sahlgrenska Sjukhuset, 2008

The overall form of the opera included four distinct dream scenes in which the soprano, Isabella, was completely alone on stage as her sleeping patterns are analyzed through the EEG sensors on her head, as seen in Figure 45. Numbers from actual sleeping curves were used to create the tonal series used for these portions of the opera. However, the initial idea of letting the singer herself manipulate the machinery had to be abandoned due to practical constraints in the available technology, as it was not feasible to house the controlling machinery in the props as my original vision had been. Therefore, in Throat II, a sound engineer handled the processing of the voice by following special notations in the score as seen in Figure 44.

Figure 44: Notation from one of the Dream Scenes in The Insomnia Clinic. The part for the soprano is notated on the upper line and the part where the sound-engineer finds instructions on how to operate The Throat II is found on the lower line

Figure 45: Kristina Hansson-Unander during a Dream Scene in "The Insomnia Clinic", Gothenburg Opera 2009

The Throat II was employed to create vocal landscapes based on the voice of the soprano — performing in real-time and captured by microphones hidden in the props — during sleeping sessions, creating a haunting and nightmarish atmosphere.

This is an example of a Dream Scene in which Isabella (here performed by soprano Ann-Christin Larsson) interacts with The Throat II.

| Listen to AUDIO | AUDIO http://www.electronic-opera.com/node/965 |

4.5. The Throat III as used in *Artificial Body Voices* (2011), *The Elephant Man* (2012) and in *The Extended Opera Courses* (2011-2014)

The development work related to The Throat III has been detailed in the included publications numbered III, IV, VI and VII. The idea of accompanying and changing the voice through movements with the hand and/or other limbs, combines ideas from The Virtual Viola da Gamba with those from The Throat I and II. However, in Throat III the idea of using artist-operated, interactive technology (as explored in Throat I and Throat II) as a metaphor for an artistic idea could finally be realized in the work concerning *The Elephant Man*[44] opera. The Throat III has also been extensively used in the artistic works Artificial Body Voices, as well as in the Extended Opera Courses.

In 2010 Ludvig Elblaus and myself started the development of the third iteration of the system, The Throat III, for the opera *The Elephant Man* (Unander-Scharin & Williams, 2012), in which we set out to provide an interactive sonic palette for the vocal depiction of the title role. Since the historical person portrayed, Joseph Merrick, had severe health conditions that must have affected his voice and breathing system, keywords such as *mucus*, *tuberculosis*, *coughing* and *strain* were chosen as guidelines during the development process. The opera premiered in 2012, with the singer in the title role using the Throat III throughout the entire performance (as seen in Figure 46).

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[44] See www.electronic-opera.com/theelephantman
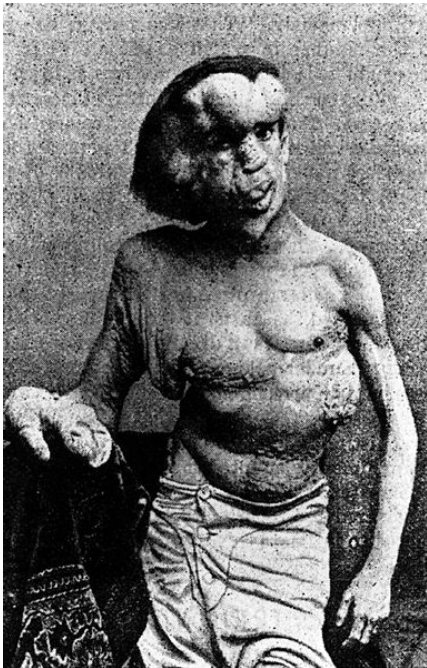
Figure 46: Left: The historical person Joseph Merrick as photographed in 1877, and Right: Håkan Starkenberg performing as Merrick in the opera "The Elephant Man", NorrlandsOperan, 2012

Joseph Merrick was born with a physical condition that made his skeleton grow to exceptional proportions, particularly the right arm and hand, as well as the head. In order to make a living, he exposed himself to audiences under the name of 'The Elephant Man'. In our artistic interpretation of his unfortunate condition, we let the singer manipulate his voice by movements of his 'monstrous' hand. In order to accomplish this, the hand-held controller in this version was mounted inside the prosthetic hand (See Figure 47).

Figure 47: The controller for The Throat III during the development work

In the early try-out sessions with The Throat III, the discussions revolved partly around the development of the interactive modifications of the sound in the resulting voice, inspired by disturbing sounds that are not commonly associated with operatic singing. While developing this function, the idea of a Virtual a Capella choir consisting of transposed vocals emanating from the singers voice came about, and was incorporated in the software by Ludvig Elblaus. In order to prototype this function, we decided to explore a madrigal by Orlando Gibbons from 1612. The textual component has a deep connection to the roots of opera as it concerns singing on the verge of dying:

```
The silver swan who living had no note
When death approach'd unlocked her silent throat
Leaning her breast against the reedy shore
thus sung her first and last – and sung no more

Farewell all joys, o death come close mine eyes!
More geese than swans now live, more fools than wise.
```

A recording of the first successful attempt to perform with The Throat III is found here (also indicated in the first page of this thesis):

AUDIO: http://www.electronic-opera.com/a_2011_SilverSwanInTheThroatIII

Listen
to
AUDIO

Later on in the fall of 2011, this aria was incorporated into the dance work *Artificial Body Voices*, premiered in Acusticum in Piteå and later transmitted on SVT (The Swedish Public Service Television) as seen in the video:

[VIDEO.] http://vimeo.com/52078586

Back-
ground

The Throat III as used in the Extended Opera Courses 1 and 2

In the fall of 2011 the first Extended Opera course was given. The use of the Throat III was explored through the performance of the aria "Curly Locks" from the forthcoming opera *The Elephant Man*. The tenor, Gong Yinjia performed the aria in a full version with the Throat III — as seen in Figure 48.
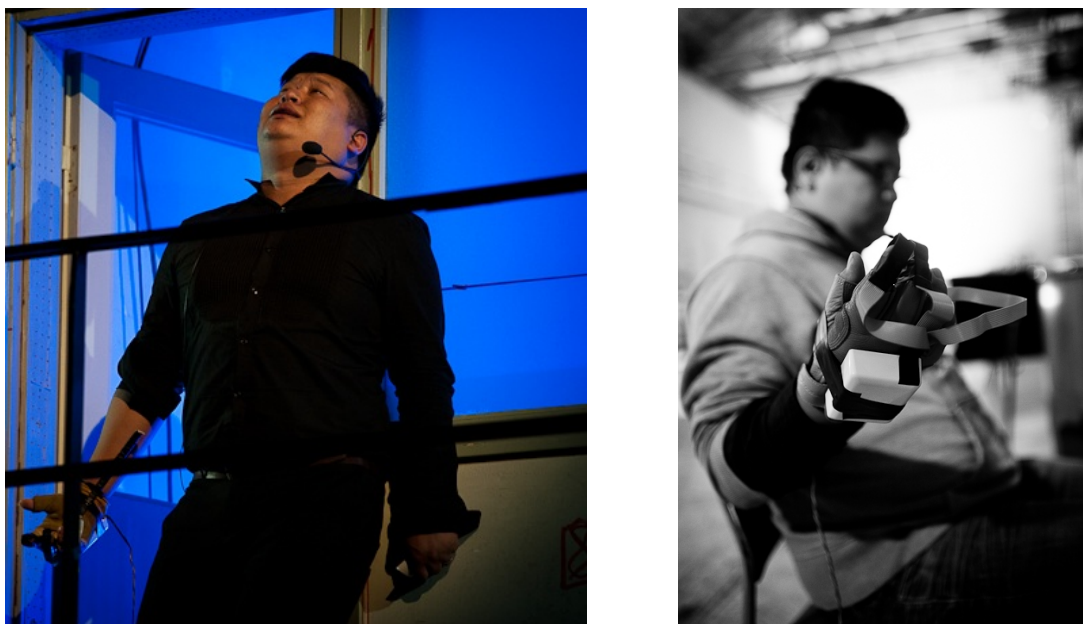
Figure 48 Left: Tenor Gong Yinjia performing the aria "Curly Locks" from the forthcoming opera *The Elephant Man* **and Right: with The Throat III (as seen in his right hand)**

As detailed in paper VII, the working sessions with Gong differed from the ones with myself that had preceded them. Gong's profession as an opera-singer, being used to working within larger constellations and contexts, influenced his approach in a way that led Ludvig and me to realize that we needed to present the instrument to him as a 'ready-made' piece of equipment. In other words, two parallel processes had to be taken care of; one being the development procedure that Ludvig and myself took care of, and the other being more straightforward musical rehearsals with Gong when technical issues had been rectified. This was an important lesson. We realized that each learning curve will be different from the other and to a great extent colored by each artist's individual background.

During spring 2012, the second iteration of the Extended Opera Course was given, and here the soprano Henriikka Gröndahl performed with The Throat III. On a more technical side, this work is also detailed in Paper VI. During this phase the cordless version was further developed, and the drawbacks in the then chosen solution became more and more obvious. Dropouts in the cordless communication led to a heavy strain on both the singer, Henriikka, and on the developer, Ludvig, who had to supervise every single change in the chord pro-

gression from behind the computer. This was very much the situation that we had originally wanted to avoid – but due to flaws in the radio communication in the construct chosen we found ourselves probing the stamina in the artifact in front of an audience. The performances during May 2012 were conducted in rather prestigious venues, such as the Royal Swedish Opera and the International Festival for Opera in Rotterdam, Operadagen. These performances led us to probe the artifact in the light (or shadow) of an approaching premiere, probing stamina under heavy strain, thereby identifying the particular requirement called *Performative Stamina* (*"The Premiere-Factor"*).

More on the Throat III as used in The Elephant Man opera

The tenor Håkan Starkenberg auditioned for the role of Merrick some two years before the premiere was to take place. During the time up to the premiere in 2012, a series of workshops with Håkan were conducted, in which material from the upcoming opera was used. The workshops functioned as tests, providing understanding on how the prototype would function in the artistic frame in which it was to be used later on. In co-operation with the performer, we could now explore the process of preparing signal processing suited to the artistic material, testing both the usability of the software as well as the possible artistic expressions that could be achieved. These workshops provided important information about the instrument's capacity for interaction, and made a promising impression that the interaction itself could be integrated into operatic stage performance. One of the workshops was also filmed:

[VIDEO](https://www.youtube.com/watch?v=fEAkn3IZg88&list=UUrCJwo2Rq_5goJ6jd_XhfEg)
https://www.youtube.com/watch?v=fEAkn3IZg88&list=UUrCJwo2Rq_5go
J6jd_XhfEg

Watch
VIDEO

Figure 49: Carl Unander-Scharin and Håkan Starkenberg during the rehearsals of "The Elephant Man" at NorrlandsOperan, October 2012. The Throat III is seen on Håkan's right hand

The Elephant Man opera starts with a pre-show in which the audience experiences the featured 'freak' of the evening – who shows off his hand and voice to his audience. This presentation enabled the audience not only to experience the technology used, but also at the same time to grasp the opera's main theme: the antagonist conception of the good-natured interior and the monstrous exterior. In this opening scene, the Elephant Man is hidden behind a veil, and the audience hears his disformed voice while seeing the shadow of the hand modulating the voice. The singer creates his own accompaniment based on qualities and tones in his voice, and simultaneously provokes the audience with 'monstrous' and - in an operatic context - highly disturbing sounds such as coughing and gurgling. (See Figure 50).

In this opera, it was of key importance to enable the artist performing the title role to operate his own voice inside the large operatic machine of singers, orchestra and stage machinery. Only then could he create an artist-operated disformed vocal expression that helped both audience and creators to a deepened

understanding of some of the hardships and severe aspects of the human condition and existence.

Figure 50: To the right the shadow of 'The Freak' can be seen during the opening scene of the Opera at NorrlandsOperan 2012, showing off his hand and voice to the audience

The new ScenOchSinneSensor

The premiere of The Elephant Man opera, the ten subsequent performances at NorrlandsOperan in Umeå, and the tour to Luleå in November 2012 gave us

some clues to the possible reasons behind the flaws with the cordless communication. The problems that had been paramount in Norrlandsoperan's home stage in Umeå were hardly noticeable on tour to Luleå. How so? It turned out that Norrlandsoperan used a wireless communication system for the light design, operating with high energy at frequencies close to the ones used in The Throat III. In concluding the very intense artistic and technological work during 2012 we realized that we needed to redesign the cordless communication within the artifact. A new step was taken in creating the new ScenOchSinneSensor, an apparatus built according to the specifications as written by Carl, Åsa and Ludvig, based on our experiences from working with The Throat III during 2010-2012.

Excerpts from the Specification for wireless sensor, December 2012[45]

"The system will consist of a combination of sensors, a transmitter and a receiver. The sensors should be connected to the transmitter that wirelessly transmits readings of the sensors to the receiver. The receiver then sends via cable the received data to a computer. The transmitter must be battery operated while the receiver should not be such.

The transfer between transmitter and receiver can be done either by radio or WLAN. If radio is selected, we must be absolutely sure that the system does not disrupt other stage-related radio systems such as wireless microphone systems, and wireless lighting control system. Possibly one must then be able to change the frequency at which the signal is transmitted. The system shall be capable of transmitting at a distance of 100 meters.

The transmitter should be able to connect 8 sensors simultaneously. The transmitter should be enclosed in a durable casing and it must be able to withstand some damage such as being dropped on the floor. The size should be approximately 10x4x3 max."

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[45] Specification written by Ludvig Elblaus, Carl Unander-Scharin and Åsa Unander-Scharin

A contact was established with two master students at KTH, who started to develop the ScenOchSinneSensor in accordance with this specification. The sensor was later completed by Evothings[46].

Third iteration of The Extended Opera Course: Sing the Body Electric!
During spring 2013 the third iteration of the Extended Opera course was given. Now we could return to exploring the Throat III with original material in the production of the new work "Sing the Body Electric!"[47] that was premiered in Jönköping at Scenkonstbiennalen in May 2013. For this occasion, I composed new music for the alto Maria Sanner, entirely built on her voice and on her interactions with The Throat III.

The aria used The Throat III for singer-operated accompaniment and was specifically composed for this singer's voice. The text, by Albert Einstein, centers on the phrases "Each of us is here for a brief sojourn, for what purpose we know not." By movements of her arms, the singer creates a five-part chorus derived from her own voice. With her elbow movement, she moves through the chord sequence of the song, while the movement of her hands varies various qualities of the sound.

The fourth iteration of The Extended Opera Course: Electric Body Songs
In the fall of 2013 (leading up to a tour to Budapest and the Liszt Academy in January 2014), two new singers started to learn how to perform with The Throat III. Having acquired two fully functional systems during spring 2013, we decided to let two of our singers in this course have arias of their own. Turning our attention back to the canonical repertory, we asked soprano Emilia Feldt to perform the aria Piangerò by Händel (in accordance with Henriikka Gröndahl's performance of the same aria one year before.)

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[46] www.evothings.com
[47] www.electronic-opera.com/singthebodyelectric

Figure 51: Emilia Feldt performing "Piangerò" by G F Handel in the foyers of The Liszt Academy, Budapest, January 2014

Figure 52: Annika Hudak performing R Wagner's "Wie alles War" from Das Rheingold, Liszt Academy, Budapest, January 2014

We wanted our second Throat III system to be used by alto Annika Hudak, and in conversation with her we decided to develop an aria by Richard Wagner for her to perform with the novel instrument. One of the arias that she had sung during her application to the course was "Wie alles war" from Wagner's opera *Das Rheingold.* Looking closer at it, I realized that this music could be rearranged so as to make it possible to incorporate it into an interactive setting, letting the singer forward the chords through the movement of limbs similarly to how I earlier had arranged music by Handel and Monteverdi as well as compositions of my own to the same interactive setup.

Wie Alles War - Erda´s Aria. Arrangement for performing with Throat III,

This is an arrangement with simplified chords in order for singers to accompany
themselves. The chords are numbered, and every chord is place in a "chord sequence" in The Throat III.
The singer forwards the chords with sensors at the right elbow. The chords are then produced from the voice
through synthetic processing of the voice. When the singer is silent, there is no sound. When the singer sings
a corresponding chord will sound. After chord 55 chord 1 will sound again.
Prepare also the B-part which will be accompanied by a separate pianist.
Rehearse the aria in this way: The pianist plays the chords - only when the singer moves the right Elbow. In that
way the singer will get used to the idea of being in charge of the ongoing rhythmical pace.
You are welcome to ask questions to carl.unander-scharin@telia.com

R Wagner/ Arr Carl Unander-Scharin

Figure 53: Arrangement for performing the aria "Wie alles war" with The Throat III - including instructions for the singer on how to rehearse and manage the task to perform it

4.6.   Throat for iPhone as used in *When I am laid in Earth* (2012-2014)

Throat for iPhone is a spin-off from Throat III, developed by Ludvig Elblaus and me. The fundamental idea, the processing of voice creating for real-time accompaniment and manipulations in the sound of the voice dependent on bodily engagement remains the same. However, in Throat for iPhone, the whole artifact is wearable. An iPhone 4S is fed with vocals from a microphone that is connected to a small soundboard. The gyroscope of the iPhone transfers movements in space to chord changes, whereas movements of fingers on the touch screen can change the quality of the processed sound. Importantly, the singer can thus distort the voice with the iPhone by changing the position of the handheld unit, a feature that is used ad-lib in different ways by the various singers – as seen in the short video. (The sound quality is poor at the end of this video, unfortunately).

Watch VIDEO   VIDEO: http://youtu.be/pp1ZiCaotwo

The development started in early 2012 and was premiered in public at The Royal Swedish Opera in May 2012. In June 2014 it was shown at Operadagen Rotterdam, and in 2014 both at the Liszt Academy of Music in Budapest and at the inauguration of Stockholm University of the Arts in combination with the conference "Loitering with Intent" by the Society for Artistic Research.

The singer's voice is the only source of sound, processed through an iPhone 4 and heard through a carry-on speaker held in the hand – or carried in a backpack. Thereby, the singer can move freely in the room and is completely in charge of the musical flow.

In the first version, developed for mezzo-soprano Kristin Gornstein, the chords were forwarded with the twisting of the wrist. With our second singer, Annastina Malm, this turned out to be ergonomically challenging, so we moved this

function so that the chords were forwarded through tapping on the telephone instead. Thus a different kind of performance and artistic expression was made possible, fuelled by input from the singer arising from artistic practice.
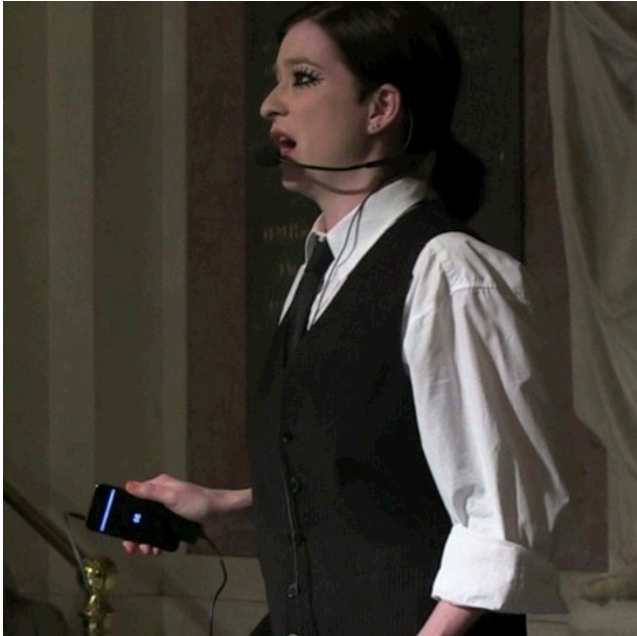
Figure 54: Kristin Gornstein performing "When I am laid in Earth" by H Purcell, with the Throat for iPhone, in the foyers of The Royal Swedish Opera, May 2012

Figure 55: Annastina Malm performing with The Throat for iPhone in the foyers of the Liszt Academy in Budapest, January, 2014

4.7.   The Vocal Chorder as used in *Sing the Body Electric!* (2004+13) & *The Extended Opera Courses* (2011-14)

The Vocal Chorder is detailed in publications I, II, III and appendices Ia and Ib, in which the concept of the instrument as well as the idea of empowering opera singers is pursued. The instrument is a large bodily interactive artifact, allowing for immersive embodied performance. It has been employed in various instances during the years since it was first constructed during a composer-in-residence sojourn at Den Anden Opera, Copenhagen in 2004. It is a large-scale tangible interaction system, consisting of wires sensitive to pushing, pulling and leaning movements. The wires connect floor to ceiling, running at the upper end over wheels that encapsulate potentiometers (electrical components that can read rotational positions). They are fixed by large rubber bands, flexible enough to let the wires be pulled and then retract on their own while repositioning the wheels with the potentiometers to create measurable changes in electrical current. Thus, the wires connect with software that can produce a variety of pre-recorded or synthesized sounds in real time.

VIDEO: http://youtu.be/oxUGb6rmFos?list=UUrCJwo2Rq_5goJ6jd_XhfEg

Watch VIDEO

The performer enters the large musical instrument to create soundscapes and accompaniment through bodily engagement with the wires. While the software producing the sound and the visual output has changed throughout the years, the basic principle of the wires and the rotating wheels has proven reliable and remains the same. The Vocal Chorder has been used in dance performances, opera performances and audience interactive installations at the Royal Opera, The Dance Museum, Malmö Konsthall, the Reactor Hall KTH and Musikaliska Akademien in Stockholm as well as at Operadagen Rotterdam, The Cape Town Opera and at The Liszt Academy in Budapest.
The Vocal Chorder has to this date three versions of the artist-operated mode. (Versions 1 and 2 are accessible for audience interaction as well).

1. One singer/performer interacting with synthesized accompaniment and interactive visuals, with chord progression allocated to one wire; 2. One singer/performer interacting with chords recorded by opera singers. Seven chords allocated to seven wires. The eighth wire functions as a 'disturber';
3. Two singers, handling four wires each, interacting with synthesized accompaniment, allocated to seven sounding wires and one disturber.

Version 1: One singer, chord progression on one wire and visuals
When I originally conceived the Vocal Chorder, the main goal was to enable me to establish an autonomous, interactive embodied performance, in which visuals and accompaniment created a homogeneous gestalt. In order to do that, I composed the aria *This is the Nucleus*, based on a text by Walt Whitman. The music was devised for the artifact so that it would be possible to accompany myself with bodily interaction. In doing this, I built on ideas from developing The Virtual Viola da Gamba in 2002. In addition, I programmed an interactive pyramid that was projected in front of The Vocal Chorder and me (See Figure 56). Its size, color and movement in space is dependent on the interactions by the performer as it visualizes the child in Ray Bradbury's short story "Tomorrow's Child"[48] — perceivable by its parents only as a pyramid.

In 2014, Ludvig Elblaus created new software for the Vocal Chorder for the performances at the CHI2014 conference in Toronto, including a novel version of the interactive pyramid, as seen in Figure 56.
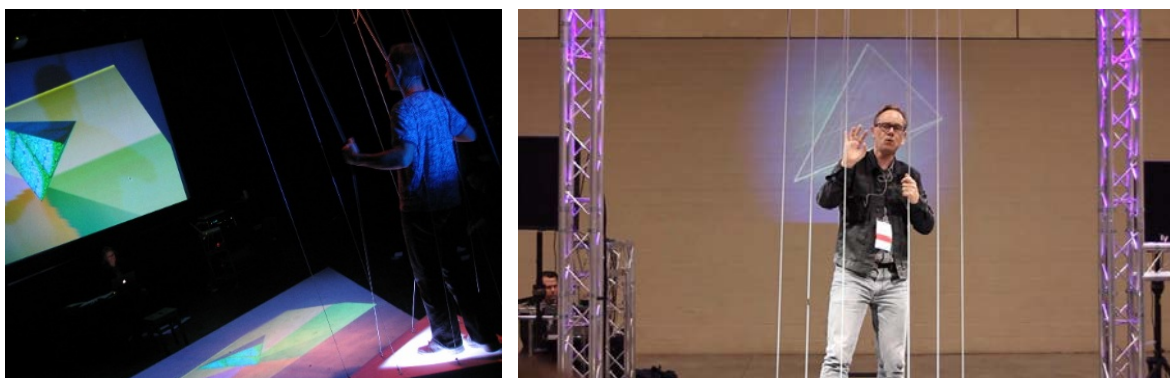
Figure 56: Two photos from Carl Unander-Scharin performing "This is the Nucleus" in The Vocal Chorder. Left: from Den Anden Opera Copenhagen 2004, and Right: from CHI2014 in Toronto

[48] Bradbury, R. (1998). *I Sing the Body Electric and other stories.* Avon Books.

Version 2: One singer, seven chords on seven wires, no visuals

In connection with the first and second Extended Opera Course, we developed a new version for interacting with The Vocal Chorder. The music chosen for this iteration was a composition by 17th century composer Orlando Gibbons called *The Silver Swan* – the same music that I had performed with The Throat III in 2011. The singers first learned to sing the song with ordinary piano accompaniment, and then they were introduced to a reduced score for The Vocal Chorder with only seven chords. These chords were recorded by the singers themselves, and implemented in the software. This time, the wires were allocated to one pre-recorded chord each, adding up to seven chords. The eighth wire was now used as a *disturber*, not having a sound of its own but rather transposing the sound of the other wires, allowing more variation in the accompaniment. The sounds were allocated along the wires so that the chords were not triggered on a specific break point as earlier. Rather, the sounds were 'scratched' by precise interaction by the user carefully pushing and stretching the wires of the artifact. Here the verb 'scratch' is to be understood as somewhat similar to what DJ's used to do with analogue LPs in the early days of the hip hop movement. The procedure of physically scratching sounds out of the LP by manually turning it and creating new sounds based on the information inscribed in the plastic surface has similarities to the bending and pushing procedure that the Vocal Chorder allows for.
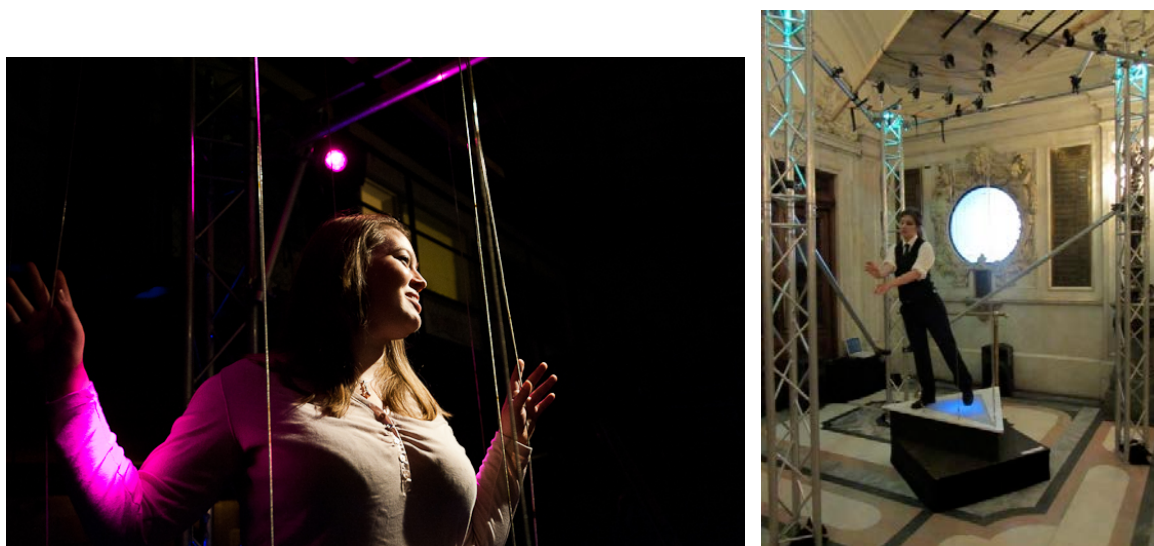
Figure 57: Randi Røssakk and Matilda Wahlund performing in The Vocal Chorder (2011 and 2012)

Version three: Two singers singing a duet, seven chords on seven wires, no visuals.

In the corporatorio *Sing the Body Electric!* (2013), we extended the use of The Vocal Chorder from the singular accompaniment of one performer to the complex interactions that arise when two singers in cooperation accompany both themselves and each other while singing a duet. In this scene, as seen in Figure 58, two singers stand on opposite sides of the stage. The soprano is elevated on a small platform, while the bass stands on the floor. For the singers to master the complex musical and interactive interplay, rehearsals had to be designed for them to get used to having the responsibility for certain chords, while relying on the other singer to play the other chords. A duetto version of the aria was composed, in which the chords were marked in the score. The bass, Staffan, was responsible for playing chords 1, 3, 5 and 7, while the soprano, Lisa, was responsible for playing chord 2, 4, 6, as well as the disturber on wire #8.
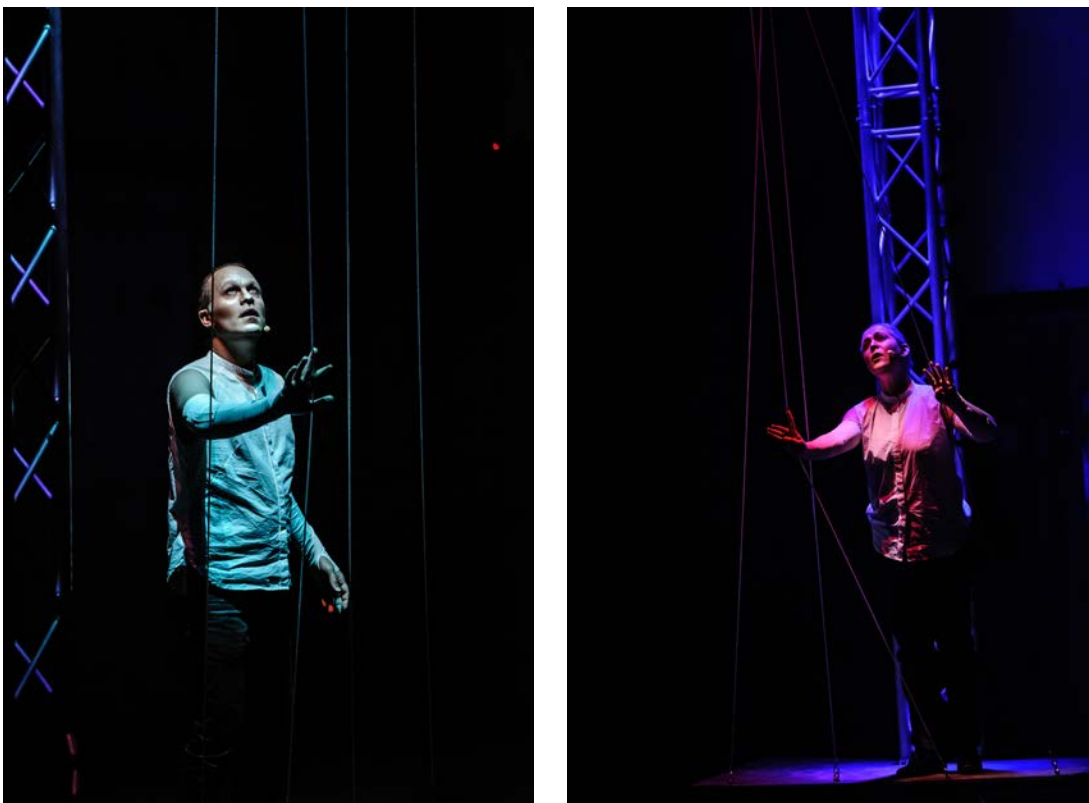
Figure 58: Staffan Liljas and Lisa Gustafsson performing "This is The Nucleus" in The Vocal Chorder, Reactor Hall KTH, May, 2013

4.8. The Charged Room as used in *The Crystal Cabinet* (2008), *Sing the Body Electric!* (2013) & *The Extended Opera Courses* (2011-2014)

Originally devised for the dance work *Patterns, Thoughts and Empty Space* (Unander-Scharin, Unander-Scharin & Wahl 2000), this technology is built on the idea of a video camera that transforms X- and Y-axis movement to information that informs the playback of sounds according to position. The Charged Room has three versions: A. 'The performer as Joystick', B. 'The Performer Scratching Sound', and C. 'The Stage as Sample Player'.

Figure 59: C:'The Stage as Sample Player': Bass Staffan Liljas trigging and bodily responding to his own pre-recorded voice in The Charged Room, Extended Opera Course, The Reactor Hall KTH, September, 2011

Having been built on technology then quite novel, today the idea of letting a camera track movement through discerning colors or movements from the background has become ubiquitous. Nevertheless, our system that enables opera singers, dancers or even audiences to manipulate the sound of their voices through movement in space has constantly proven its artistic value, and has

been reiterated through various hardware changes and software versions (as detailed in Paper II).

The Charged Room is a full-body interactive stage space that uses an overhead camera for real-time tracking of the performer's position in a two-dimensional plane. By moving across the interactive area, the performer can control real-time synthesis of sound and trigger pre-recorded samples. The camera is connected to software that extracts objects in the video image. In The Charged Room, the movements in lateral axis control which fragment of a sample is looped, while displacements in depth change the loop-length of that same fragment. This enables the interactor to create rhythms of smaller or larger vocal fragments by moving across the stage.

The Charged Room instrument was originally developed by Åsa Unander-Scharin, Mateusz Herzcka and yours truly for the dance performance *Patterns, Thoughts and Empty Space* and later used by dancers and singers in the opera *The Crystal Cabinet*, as well as in the Extended Opera Courses. The original software was developed in Max/MSP, using STEIM's Big Eye[49] for movement tracking. Ludvig Elblaus migrated and developed the code in 2013, in order for us to deploy The Charged Room in the Extended Opera Course.

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[49] http://steim.org/2012/01/bigeye-1-1-4/

Figure 60: Left: A: 'The Performer as Joystick' in The Charged Room: Dancer Jan Vesala mixing a pre-recorded voice with a synthesizer sound in The Charged Room as part of "The Crystal Cabinet"[50], Piteå Acusticum, October 2008. Right: B: 'The performer scratching sound' – Mezzo-soprano Annastina Malm singing an aria by G F Handel while simultaneously interacting with her pre-recorded version of the same aria through her bodily interaction

One example of how The Charged Room has been used in order to Extend Opera is a scene from *Sing the Body Electric!* In which a soprano interacts with a recording of her voice while performing the coloratura segment of the aria "Oh My Body, I dare not desert the likes of you", composed by me based on a text by Walt Whitman. Using The Charged Room as described above, a nonlinear performance of the music is created – called The Coloratura Machine – in which rhythms from her own voice are fed back into her live performance – thereby again influencing her bodily performance of a series of choreographed gestures. The interaction rule was that when hearing the repeated loop of a fragment, the soprano had to oscillate the rhythm of the gesture corresponding

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[50] See www.electronic-opera.com/thecrystalcabinet

to that fragment. Close to the audience, the played-back voice performs loops of several tones. The further back she moves, the more chopped and stuttering the loops of played-back voice become. In the front of the stage, pleasurable loops and rhythms are transformed into similar meandering movements in her body, whereas in the back of the stage, the shivering voice makes her body tremble.
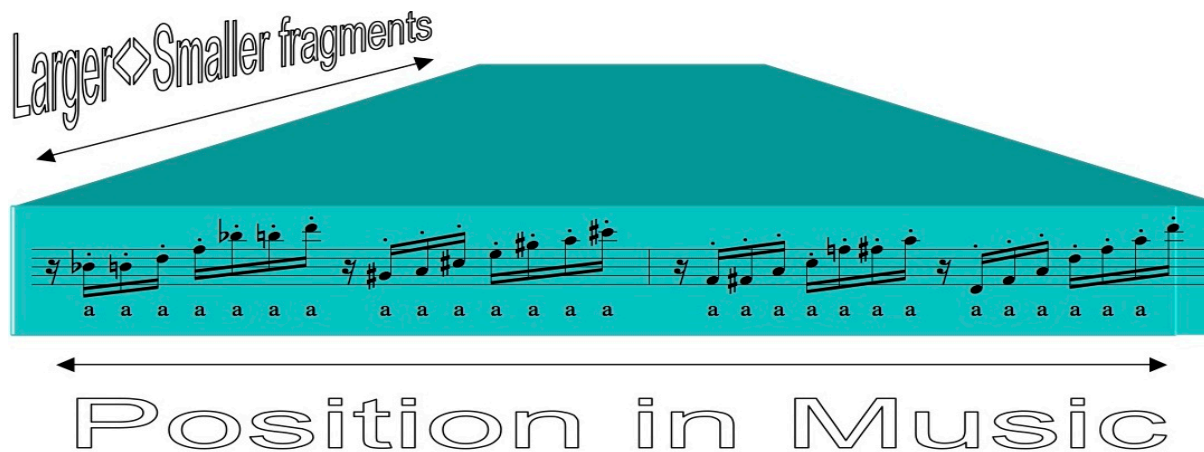
Figure 61: Interactional features in The Charged Room B. The green box symbolizes the stage, over which a camera is fixed. The position in music as well as the size of the looped fragment are maneouvred by the singer's position on stage. The music is the coloratura section of the aria "Oh my body! I dare not desert the likes of you"

The interaction constitutes a flow from bodily to vocal rhythm, and vice versa, in which neither is fixed but rather in constant exchange. When visiting the room the second time, she also sings live in dialogue with the looping vocal fragments. Throughout the scene, she moves back and forth through the coloratura segments in a non-linear way. At the end of the scene, she moves up stage left to reach the first tones of the coloratura machine. The trembling movements of the voice spread through her body, and from this position she continues her shaky playing and 'singing' of the entire coloratura by moving sideways across the charged room.

Figure 62: B. 'The performer scratching sound': Alexandra Zetterström-Büchel interacting with her own voice in The Charged Room – also called 'The Colorature Machine'

[VIDEO](https://www.youtube.com/watch?v=HErrI6FhARM&list=UUrCJwo2Rq_5goJ6jd_Xhf):

https://www.youtube.com/watch?v=HErrI6FhARM&list=UUrCJwo2Rq_5goJ6jd_Xhf

5. Discussion and Results: a Procedure, a Requirement, an Experiential Quality and a series of Operatic Art-works

What then have we learned through probing opera with the artist-operated, interactive instruments described above - and what was there to find?

Returning to Pablo Picasso and the interview he gave as quoted by Christofer Frayling (see Chapter 3.1), we see that the artistic urge towards fulfilling an endeavor is phrased thus: "In my opinion, to search means nothing in painting. To find is the thing."

As a reader of this thesis, you might at this point be asking accurate questions about my work – the most profound perhaps being something like "did this long endeavour produce interesting, high-quality, evocative, aesthetically compelling works of art in opera?". It would take more than one thesis to sort out each of the concepts introduced in such a question. However, this thesis was never aimed at answering questions on how audiences, critics, commissioners, producers and other stakeholders reacted to the work presented here. Rather, this thesis focuses on opening a novel design space and on designing novel electronic instruments that can re-invigorate and re-connect opera to its explorative origins. My overarching aim has been to re-empower singers in order for them to take control over certain factors regarding their work on stage, in order to experience vocal embodiment together with the instruments and the performances. Thereby, by main focus was on the one hand on my own experiences, on-stage with the novel instruments through the autobiographical account, and on the other hand on the external singers who came to use these instruments later. The empirical accounts above show that after many struggles, re-designs, fine-tuning and training, we often – but not always – succeeded in creating for the re-empowerment I sought.

At the outset of the research project, I posed three questions that guided the explorations, and I repeat them here:

1. How can the design and creation of interactive, artist-operated instruments be informed by deep musical knowledge and be probed by the particular conditions surrounding an operatic production?

2. What impact can interactive, artist-operated instruments have on the opera singers themselves and on their vocal technique?

3. How can interactive, artist-operated instruments empower opera singers, thus challenging contemporary power hierarchies – thereby reconnecting to the explorative practice in opera's early days?

In this closing section, I intend to discuss the findings – often surprising – that have surfaced repeatedly during this research project. The Extending Opera program therefore functions somewhat like a catalyzer, spurring events within a biotope through the mediation of something unforeseen. These findings accommodate new knowledge that may be of use for future ventures into similar projects.

Knowledge contributions surfacing through practice

The knowledge contribution forwarded by the Extending Opera research program has surfaced through artistic practice and consists of the exemplars and the artworks, as well as of three abstractions – one procedure, one requirement and one experiential quality. These abstractions partially overlap and mutually influence each other in a dynamic manner.

One underlying aim of this long-standing research and probing of opera is based in my urge for re-empowering opera singers. Now, is this really necessary – or is it a one-man 'Don Quijote'-ian venture biased by my life-long personal engagement in opera?

One of the surprising findings throughout the Extending Opera Research Program was that the feeling of disempowerment was more widespread among my colleagues than I would have imagined. For example, in a conversation regarding this research project, a professional baritone used the metaphor of prostitution when he described the feeling he has when moving between new venues for performing his particular specialty in the canonical repertory.

In "The Design Way", the authors express the quest for envisioning "that-which-does-not-yet-exist", through formulating "that-which-is-desired", as *Desiderata*. (Nelson & Stolterman 2003). In accordance with the concept of Desiderata, my findings are driven by an urge towards "that-which-is-desired" — and so Extending Opera viewed as Desiderata can be said to correlate with the desire of emancipating the opera singers in relation to the overly top-down structures that dominate the contemporary opera-environment.

Apart from my own experiences as a professional singer (as outlined in my autobiographical account in Chapter 1.2 — A night at the Opera), the work with the participants in the Extended Opera Courses (Chapter 3.3) turned out to be a source of information that I would not have expected it to be. I designed the courses so that the major component would be the artistic project based on the co-development of music and technology and the task of performing interactively. However, at the outset of each iteration of the course, I supplied the participants with a reading and writing assignment. This was outlined in a memorandum, as:

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"The main material is your own experience during the run of
the course. Being an opera singer, it will be natural for
you to write something about your own voice and your crea-
tive stage work during the course. All the other components
within the course could be incorporated in your essay [...]

Bear in mind the difference between to judge (in a negative
spirit) and to estimate/assess (in a positive spirit) your
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own work as well as the work of others. Avoid judging your-
self and others in the text.

To get started with your own writing:

Write down continuously – at least once a week – your own
experiences of the course in a private document. Here you
can be emotional and personal, and let both positive and
negative feelings be present. Don't avoid the personal as-
pects.

At the end of the course, you will devote two working days
to restructuring and rewriting the material into an intro-
duction, an essay, and a summary. Thus you will reshape
your personal document into something that can be read by
others."[51]

Unsolicited information surfacing through the singers own reflections

These personal diaries turned out to be a rich source of inspiration and valida-
tion of my empowerment aims. In other words, the reading and writing assign-
ment as described to the participants, was not originally aimed at supplying
material that was to be incorporated into this research program. I did not pro-
vide the singers with a range of questions or issues that I wanted them to ex-
plore in order to use them as informants in my research.
Rather, when reading what the authors themselves chose to report in their
texts, I realized that the experiences of the participating singers added im-
portant knowledge to my research exporations. Therefore, in agreement with
the singers, some of their writings are incorporated in the empirical material I
use to support my research insights.

On outlining the reasons for applying to the course, one of the singers wrote:
"After studying in London and a few years of freelancing with Paris as a base
with both good and bad experiences, I felt a little lost in my professional capaci-
ty. I had many questions about my own future activities: what is a singer's task

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[51] Carl Unander-Scharin: PM Skrivuppgift Extended Opera 2012_01_14.

and professional role, how can one find a way to take more control of one's own artistic activity? Should I continue to freelance as a 'singer for rent' in France, or should I be seeking new ways to create my own jobs and take control of the direction and of the kind of aesthetics within which I operate? How can I as a singer more generally affect my activities and take greater artistic responsibility for the productions I participate in? Because we as professionals are in such a position that we are dependent on being 'chosen', I thought about how to reverse these conditions and how to be in charge of choices myself to a greater extent and not be so dependent on pleasing a particular director/ conductor/ opera director/ employer. The purpose for joining [The Extended Opera Course] was for me to get a respite, time for reflection partly about my own role as a singer, and partly about the art form itself."

She continues, after having read Paper I (called "The Vocal Chorder – Empowering Opera Singers with a Large Interactive instrument") that was part of the course material:

"Even when I was an unpaid on-looking trainee at the Royal Opera shortly after I had finished high school, I reacted to the strange situation that the singers were in – I perceived it as that even I, the unpaid student without any active part in the artistic process, had a stronger position just by my sitting at the 'right' side of the stage director's table. The singers were not treated in a particularly bad way, but I felt that they were regarded from the outside, as objects, and they had not much say regarding the actual processes of creation. This is something that I have observed in my own profession as a singer, that to be a singer, often at your own initiative, you let go of the personal artistic responsibility, perhaps because you think that it is expected of you to be like a blank sheet for the director/composer/conductor to write on, an 'executant', perhaps because you do not want to cause inconvenience by putting yourself in the artistic debate, perhaps because it is more comfortable to let others take responsibility. Whatever it is that is behind this attitude, it leads to a kind of artistic neutrality ("I'll do as you say") that is neither fruitful for the singer, nor for your own self esteem. Being involved in and experimenting with these electronic instruments, and as a singer to have complete control over the execution

have been educational and exciting – giving power back to the performer and in doing so returning to opera's original format, in which the singer was co-creator in the creative process and even in charge of the actual execution. That the singer is allowed to exercise control over tempo, dynamics and musical interpretation in its entirety is an aspect of the work with these electronic instruments that I find very appealing. " (Annastina Malm, mezzo-soprano, participant in the Extended Opera Course, fall 2013).

Another mezzo-soprano, Kristin Gornstein from the USA, expressed her professional experiences as follows: "If I have learned one thing especially, it is that I have a vision for creating performances. In the past, I had been coached by my mentors to consider creating more of my own shows, but I did not take this advice seriously. I thought at the time that I wanted to 'play by the rules' and succeed in opera through more typical pathways. After this semester I have come to realize that there is no one path to success, and that I need to follow my instinct to create, and see where that takes me, instead of waiting for someone else to give that to me. What a gift that is, and what an experience this has been." (Kristin Gornstein, participant in the Extended Opera Course, spring 2012). And she continues: "I learned that there is more to opera than just learning a score, showing up to a rehearsal and singing it – we are musicians. Each of these parts of the class added up to a whole experience for which I am beyond grateful."

Before turning back to the topic of empowerment in the closing section, I will discuss the three abstractions – a procedure, a requirement and an experiential quality – that emerged during the run of the research program.

5.1.   Sensory Digital Intonation & Performative Stamina/ ("The Premiere Factor")

What then is it that signifies a well-working piece of technology, developed for artistic purposes? Is there something in the procedure leading up to the artifact

itself that is particular to artistically conceived technology and that singles it out in comparison to other fields? Drawing on experiences from working on stage, and in restructuring that knowledge in order to extend operatic practice, three abstractions surfaced. The first is a procedure and the second is a requirement, both of which turned out to be crucial to creating the artifacts for artistic on-stage purposes. First, let us have a look at the former, the procedure of Sensory Digital Intonation.

During the development of the exemplars, we identified a particular phase, functioning as a mediator between the artistic vision and the technological progress – a phase wherein the seminal artistic-technological elaborations takes place in a circular and almost symbiotic manner.

When combining evolving technology with artistic ideas, there is on the one hand the danger of emphasizing the more technological aspects of the development work and being constrained by the demands and the limits of technology. On the other hand, as an artist may want to extend the limits in the material at hand in previously unimagined ways, artists may be expecting technology and the developers of it to supply them with a magic wand.

However, as has been noticed throughout this research trajectory, when an artistic vision guides the emerging artifact, and the object is to take the outcome beyond merely commanding and controlling the matter, novel artifacts may surface. As put forth in Paper V, a conference proceeding (Unander-Scharin & Unander-Scharin 2013), Sensory Digital Intonation can be defined as: "The impact of artistic intuition and experience when fine-tuning digital artifacts".

We began to notice how the seminal development work took place in a process in which artistic experiences continuously influenced the technological development and vice versa. The notion of Sensory Digital Intonation emerged through identifying the particular phase that occurs when artistic vision and adjustment of technology coincide and mutually interact. The actual identification of this phase was an important achievement in itself. Before acknowledging

this phase as a particular and identifiable procedure, the often lengthy and troublesome work with the fine-tuning of technology and artistic vision sometimes felt dull and uninspired. After having realized that this was a particular phase – maybe even the most fruitful phase despite its exhausting nature – working with the forthcoming artifacts was somehow more straight-forward and easy-going.

Sensory Digital Intonation in relation to musical knowledge

The term Sensory Digital Intonation combines three words into one. The word *Intonation* is used in both phonology and music. In phonology, intonation relates to the melodic content of speech, while in music it relates to the fine-tuning of tones within chords, voices and musical instruments – the real-time adjustment of pitch by musicians and ensembles when performing music. When a group of musicians are performing together, the constituent instruments and voices produce tones that in one way or another will form a body of sound. Each performer will somehow situate her/his tones by a very precise adjustment to the resulting overall sound – be it in the search for pure thirds, for a uniform unisono, or for cacophony. When relating to musical instruments, intonation may also signify the setting of a pre-set tuning of pitches and pitch-tables – as the pre-set tones of organs, pianos and synthesizers. The two other words *Sensory* and *Digital* aim at grounding the overall term in the realms of interactivity and in the digital arena. The combination of these three words into one signifies that Sensory Digital Intonation is a procedure for fine-tuning digital artifacts in a sensory setting in relation to musical knowledge.

Accordingly, Sensory Digital Intonation highlights how the fine-tuning of technologies and real-time interactivity relate to artistic concerns and creativity, thereby the similarities with what musicians call intonation, where musical components are fine-tuned in relation to the desired overall gestalt. In fact, when combining evolving technologies with artistic ideas, the artistic and technological outcome can be developed in unimagined ways. In our experience, it is during the procedure that we call Sensory Digital Intonation that the artistic

vision and the emerging technology amalgamate in an artistically viable artifact.

How then did Sensory Digital Intonation have a role in the development of the exemplars, as described in Chapter 4? As mentioned above, it was not until after years of artistic work and research that we denominated this procedure "Sensory Digital Intonation". However, we could never by-pass the procedure as such in the search for meaningful artistic expression in relation to novel interactive interfaces.

One early example of Sensory Digital Intonation is to be found in the development work of what was to be called The Virtual Viola da Gamba, back in 2002 (See also Chapter 4.2). Here, the affordances of the technologies in the sensor system, in the synthesizer and in the software in combination with the urge for creating an artistic expression led to the emergence of a new instrument. However, as the end-goal was not pre-conceived, it was only through a lengthy and explorative development process that this artifact emerged, a process that was later to be called Sensory Digital Intonation. This can be exemplified by the complex and time consuming procedure of changing the placement of sensors in order to find the best way of forwarding chords in relation to the artistic urge to allow for music and dance. In its turn, this work related to the simultaneous process of calibrating the software and the sensors in relation the plethora of choices within the synthesizer, the wireless system and the software — all of these options came together in the procedure of Sensory Digital Intonation with its metaphorical likelihood to *intonation* in music.

A more recent example of Sensory Digital Intonation is found in the development work related to The Throat III (See chapter 4.5) that started out in search of interactively enhanced artistic expression for The Elephant Man opera. Here, drawing on earlier work from Throat I and II, novel functions were developed to let the performer manipulate changes in the singing by bodily engagement through the hand. As the work involved in Throat III incorporated seven singers (myself, Håkan Starkenberg, Gong Yinjia, Henriikka Gröndahl, Maria San-

ner, Annika Hudak and Emilia Feldt), it had many different phases, some of which were more influenced by a traditional master-apprentice approach, and others which had more of Sensory Digital Intonation to it. The singers with more of an interest in the development phase as such opted for more work with a Sensory Digital Intonation-component.

For example, the soprano Henriikka Gröndahl, on working with The Throat III in the Reactor Hall during spring 2012, reported that:
"My task was to befriend the interactive glove 'Throat III'. Carl together with Ludvig Elblaus had prepared the chords to Handel's "Piangerò" from *Giulio Cesare*, and I was to learn that by bending the wrist and by pressing the fingers forward the chords (all in all 55), while I sang the aria. It sounded like a simple enough task for me to achieve, but as the days passed, I felt more and more like an angry child. I was to memorize the chord progression, and it was not entirely straightforward. Also the sound [software] needed adjustment, as originally Carl had performed the aria with his voice in order to program the chords, and my frequencies gave [the software] another sounding result. Then there was the issue of making friends with the glove. We finally had to take the flex-sensor out of operation. Originally, I would change chords by first bringing together the thumb and middle finger, then bend (the sensor that sat along with) the wrist, then straighten my hand back and finally let the finger grip go. But after hassle with (me) and with worn-out sensors and unclear signals, we put the flex-sensor aside, skipped the rough garden glove and taped the sensor box to my forearm instead. The chord changes were much more straight-forward using the thumb, as the pressure sensor now was sitting on the thumb, and life suddenly became a bit easier. The computer had a strange bug that slowed down the program and delayed the effect of the chord change, and this created some frustration in the small cavern. I sometimes had to shut down the window three times to get through my 55 chords. Eventually Ludvig fixed even that."
Here, working together on concerns that relate to both technology and artistry, new functions surfaced — as well as the finding and correction of bugs.

This also relates to what Susanne Bødker has called a "breakdown", in the sense that a negatively colored turning point may very well be the door to new findings. (Bodker 1989)

Another singer, the alto Maria Sanner, reports one year later – on working with The Throat III as well: "When I found a way to fill the silences between phrases with presence and meaning, a magic dimension entered the performance. I had found a pulse in the overall picture, which also helped my breathing. Actually, I felt that the seeds of this new approach in the performance were sown when the filter on the left hand arose in the work process." Here, Maria refers to an instance in which the process of Sensory Digital Intonation is apparent, employing musical awareness in the creating of artifacts. She continues:
"We had tried a noise filter in the beginning, but Carl was not happy with it and created a new sound (or actually a combination of sounds) which in a more tangible way was possible to 'play on', as it had more shades in itself. The more I bent my wrist, the more it changed the sound. With this I was able to 'play on' the voice with an additional means besides my own voice, which brought a special kind of listening to me."

The re-iteration of artistic/technological choices and how these changes in technology related to changes in Maria's artistic rendering – as well as requiring changes back in the technology – is another example of how Sensory Digital Intonation is at work in the development phase.

Furthermore, the thorough work involved in developing The Throat for iPhone during spring 2012 in close collaboration with mezzo-soprano Kristin Gornstein was later related by her: "Working with Ludvig and Carl as Ludvig created an instrument out of an iPhone was incredible. During the process it all seemed very normal and mundane, but looking back on the months, it is hard to believe that the app came together so smoothly and without issue. I felt very included in the process, and my voice – literally and figuratively – was taken into account during the creative process." (Kristin Gornstein, participant in Extended Opera, spring 2012). Here, it is noticeable how musical knowledge, and even a

particular vocal performance was incorporated into the process, rather than being prescribed in advance or added after the technical development. During recurring rehearsals that were intimately linked to technical work, the Throat for iPhone came together, applying "the impact of artistic intuition and experience when fine-tuning digital artifacts", namely Sensory Digital Intonation.
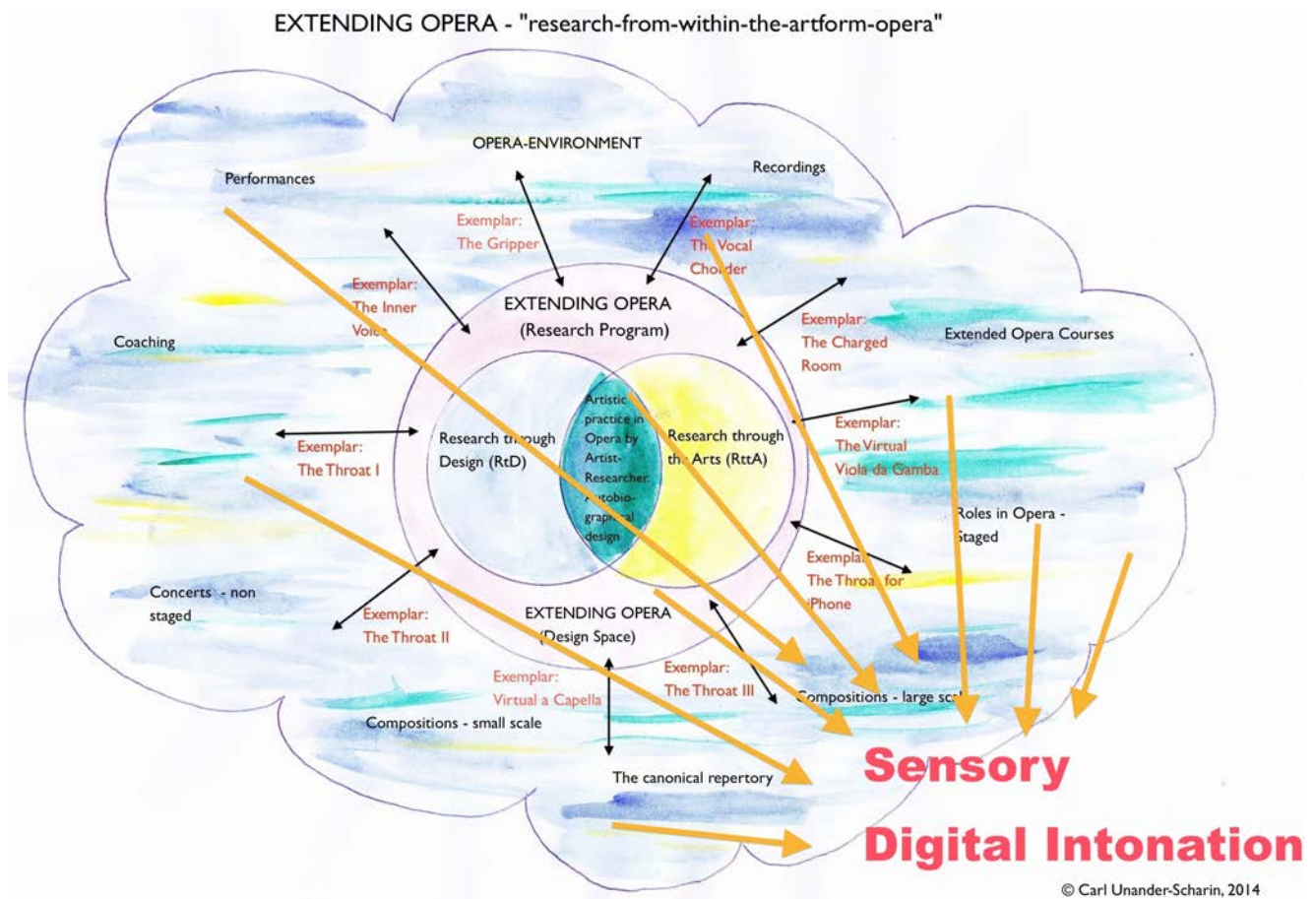
Figure 63: Extending Opera in relation to Sensory Digital Intonation

Performative Stamina and the alternative title "The Premiere Factor" in relation to traditional procedures leading up to a premiere in opera

In developing the interactive, artist-operated instruments, a requirement surfaced, called *Performative Stamina ("The Premiere-Factor")*. I have chosen to baptize this requirement in this somewhat clumsy manner in order to let the term be self-explanatory.

Of course there are many ways of presenting artistic works in front of an audience that don't necessarily mean that the presentation is a *Premiere.* However, in opera there is an ingoing, almost fundamental, component that relates to the challenges in live vocal performance. As outlined in the narrative "A Night at the Opera", the rehearsals leading up to a premiere of an opera — that are sometimes hundreds of years old — require a lot of time. Why is this so? According to my own experiences, the allocated time is needed for establishing stamina in the overall presentation, and — from a singer's point of view — most notably in building reliability in the vocal performance. Arguably, one reason for the audience to attend another version of *Carmen, Tosca* or *La Bohème* is of course partly to experience the recurring new productions of the canonical operas (the common running period for a new production of an old opera in an institution is approximately five to ten years, after which a new production is launched). However, arguably, the audiences that return to their favorite operas in the canonical repertory, presented in large opera houses, do precisely this in order to hear new renderings of the famous parts for the soloist as the music and the fundamental drama remain the same. This implies that the performance of the soloists is the main focal point for parts of the audience. And from this assumption follows that the singers need to prepare themselves thoroughly as they will be compared with former performers (or even themselves) of the very same roles. What then can go wrong after so long a rehearsal period?

The human voice is not a motor that either works or breaks down. Rather, the human voice and the capacity for performing with it rely on a very fine and complex system within the organism. In order for singers to sing and act well as well as to remember their parts, factors such as humidity, varying acoustics, overall physical and mental status, sleeping patterns, allergies, and haphazard things such as how recently someone took a sip of water are crucial for the end-result. These many ingoing components — and even more so in relation to everything else that circulates around the singers in the production — needs to be carefully chiseled out. According to established and commonly accepted procedures, the closer one gets to the premiere, the more of a premiere-factor is entered into the working processes. One example of this phenomenon is the care-

ful portioning of increasingly larger audiences. First only the collaborators themselves are allowed into the rehearsal venue. Later, try-out audiences are allowed, and even later the various *dress-rehearsals* occur. During these, often three in number, more and more visitors are allowed – whereby the singers can gradually probe the circumstances surrounding their personal rendering in relation to the approaching premiere. During such a procedure, which lasts about two weeks (of the five weeks in total), the approaching premiere is a factor that becomes increasingly apparent. In relation to our work with novel interfaces for opera, precisely this rather stressful factor turned out to be a powerful tool, as the requirement that I now call Performative Stamina ("The Premiere-Factor") surfaced. The approaching premiere in the form of a slowly increasing component of the premiere factor requires thorough probing of the stamina in the artifacts.

One example of how Performative Stamina ("The Premiere Factor") influenced our work is evident in the need for a completely new ScenOchSinneSensor, as voiced by the specification seen on page 78. The wobbly reliability in the radio-communication was never as apparent as when the audience was approaching. Even though we devoted hours and hours in developing The Throat III, tiny dropouts and seemingly minor problems of all sorts were sometimes dismissed during earlier development. However, as the premieres of The Elephant Man or of the performances of the Extended Opera Course at the Royal Swedish Opera were approaching, the flaws could no longer be neglected. Often we needed to find momentary work-arounds in order to get through the performances, but at the same time we started to articulate the specifications needed in new iterations of the sensory systems.

Another, more overarching example of Performative Stamina ("The Premiere Factor") is the overall development of the Throat series of hand-held, real-time systems for artist-operated interactivity. From 2005 to 2014 the four versions of Throat (I, II, III and iPhone) came about in relation to quite a few premieres and public performances. The fact that a premiere is approaching has constantly informed crucial choices in the development work. Functions that are availa-

ble in the systems of today could only be wished for in the early systems. However, the affordances of the then-available technology had to be acknowledged and used in the then-current performances. This is somehow quite the opposite of the idea of 'a demo', in which the technology may or may not work in a less stressful situation. Once the Premiere Factor and the positive stress that the approaching audience provokes are taken into account, the development work calls for choices that are fundamental in order for the artistic work to be performed with as much stamina and reliability as possible. This correlates to the traditional way of working towards a premiere in opera, in which the vocal performance of the singer is probed over time in a similar manner, and choices are informed by how close in time the premiere is.

Performative Stamina ("The Premiere-Factor") in Summary

In summary, singers of opera constantly train their vocal technique so that it will acquire the stamina needed for live-performance. Similarly, the demands on robustness in performance technologies used in opera are high, as the singers need to be sure that novel artifacts and all their ingoing components are designed to endure the physical demands on stage and will not let them down while performing. These demands have guided the Extending Opera program itself as procedures common to operatic rehearsals colored the development phase. As opera is normally rehearsed meticulously before the audience sees it, a rehearsal is in fact an inquiry into the endurance of the materials. The repetitions of rehearsals call for stamina in the performers as well as in the instruments, orchestra, scenography and scaffolding.

In addition, when a performer faces an audience, the robustness of the design is tested under somewhat extreme conditions — in terms not only of physical durability but also of delivering an artistic experience, shaped in the moment between singer and instrument.

Thus, the circumstances that are typical of operatic stage work — where reliability is tried through the repetitions in the rehearsal phase leading up to a premiere — offer an environment for thorough testing of artifacts. Performative Stam-

ina ("The Premiere-Factor") relates to the probing of these demands on robustness and reliability within the components and the overall design of the artifacts — influenced by the traditional procedures leading up to a premiere in opera.
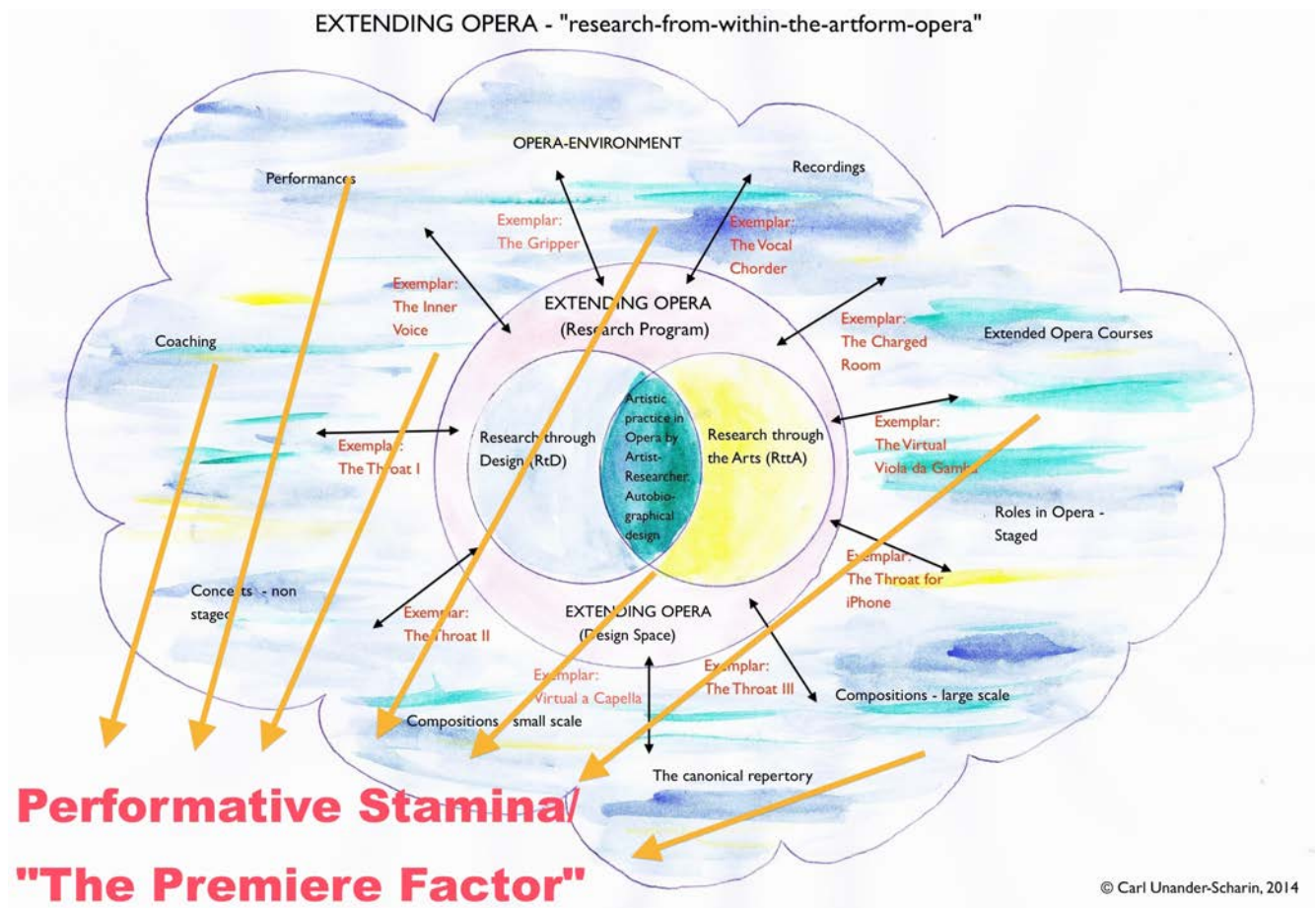

Figure 64: Extending Opera in relation to Performative Stamina ("The Premiere Factor")

5.2.   Experiential Quality: Vocal Embodiment

Having thus explored how a procedure and a requirement have guided and influenced the development of the interactive, artist-operated artifacts within Extending Opera, we can now ask ourselves if and how the singing itself was changed by the interactions with them. As put in the third guiding research question: "What impact can interactive, artist-operated instruments have on the opera singers themselves and on their vocal technique?"

Paul Dourish, in *Where the Action is* (Dourish 2004), suggests the term of *embodied interaction*, as a further development of the tangible and social computing of the 1990s: "Embodiment is the common way in which we encounter physical and social reality in the everyday world". Here, building on phenomenological thinking by philosophers such as Franz Brentano, Edmund Husserl, Martin Heidegger, Don Ihde, and Donna Haraway, he arrives at Merleau-Ponty's aim of "focusing on the role of the body in perception", thereby exploring "the idea of physical embodiment as an aspect of understanding the world." Dourish's accomplishment in turning the focus towards bodily awareness — or as put in a more recent publication "the bodily ways of knowing" (Höök 2010) — supplies us with a backdrop for situating the notion of Vocal Embodiment.

The alto Maria Sanner, on relating her work with Throat III, tells about how interacting with the artifact offered new insights on her singing technique. As described in Chapter 4.5, there is no sound output from The Throat III unless the singer is singing through it. To Maria, this responsiveness in the artifact led her to reassess her own breathing technique with regard to the legato and the appoggio, and she writes "In my working sessions with this instrument, which included rehearsing the aria in parallel with the development and adjustments of the instrument, I came to experience — in a straight-forward way — these factors in my own singing technique." She continues, in comparing The Virtual Viola da Gamba with The Throat III — both of which she had been performing with: "It was precisely this new factor in the instrument that was to offer interesting challenges for my vocal technique". Here she refers to the fact that The Throat III — as opposed to The Virtual Viola da Gamba — produces no sound unless the singer does.

In the design literature, such experiences are often called use qualities, or the more contemporary *experiential qualities* (Löwgren & Stolterman 2004). Examples of experiential qualities are: pliability, fluency, immersion, autonomy, personal connectedness (Ibid.), and evocative balance (Ståhl, Löwgren & Höök 2014). When singers interact with these embodied instruments and thus expe-

rience a sensation – in particular a connection with their own voices – a specific experiential quality arose – what I choose to call Vocal Embodiment. In the latter publication, a detailed description of an experiential quality can be found: "experiential qualities are relational concepts in the sense that they reside in the interaction, neither being properties of the artefact itself nor of the user. This means that a designer can never know for sure what an artefact will render" (Ibid.)

On working with The Charged Room, Annastina Malm experienced how she, whilst performing, found herself listening intensely to the recording of her own voice – as played back by the position and movements in space by herself: "In this case, we had recorded a short loop from a Handel Aria. With Åsa's help we developed a pattern of movement, which we then used to orient ourselves in the soundscape created by the scratching of the pre-recorded voice. The idea of deconstructing and 'scratch' with a pre-recorded melody was highly rewarding and evoked a very concentrated listening. It was exciting to interact with your own voice. Working with this instrument produced a very focused awareness of what was going on around, in the room, in the fragmented sound loop and in the meeting between pre-recorded voice and the 'live'-performed voice. Working with the new technologies in the Reactor Hall has helped me to develop my own listening and raised many questions as well, and above all a desire to continue to search and to find new, current expressivity and approaches to our art form."

The alto Annika Hudak, on working with an arrangement of Erda's aria "Wie alles War" from *Das Rheingold* by Richard Wagner, details how working with The Throat III called for a new methodology for her vocal rendering:

"My challenges were:
1. To memorize, to one hundred percent, Carl's arrangement
2. To learn to understand and manage the hand-held sensor technically
3. To get used to the relationship between my voice and the choir sound extracted from it without compromising my vocal technique

4. To relate to Erda's mythical character and authority

5. To find an approach to the arm movements in relation to Erda's character

6. To relate to the Reactor Hall's rough, natural scenography".

She then continues by considering how this work made her listen to her own voice in a new way: "The sound from Throat III was something I had to get used to. Its volume was directly related to my voice intensity. It became apparent to me which sounds in my voice projected more than others. I was dependent on the fact that the monitoring in the pit had the correct volume in order to be able to analyze that the feed [of the chords] functioned as they should."
Hereby the bodily interaction with the artifact both called for a new awareness in Annika's musical rendering of the aria that she has performed several times before, at the same time as the technology offered insights in how certain vocal sounds project more than others through the bodily engagement.

Let us now, finally, have a look at the work with the Vocal Chorder (Chapter 4.7) and at what some of the singers reported in their reflections after having experienced it as related to Vocal Embodiment.

In the Vocal Chorder we wanted to let the performers accompany themselves through the forwarding of chords by full body interaction. These chords were recorded by the singers themselves, and implemented into the software. We allocated the strings to one pre-recorded chord each, adding up to seven chords. One of the strings was now used as a *disturber*, a string that did not have a sound of its own but that would disturb the sounds of the other strings, allowing for more variation in the accompaniment. As pointed out earlier, the chords were allocated along the wires and thereby 'scratched' by precise inter-action by the user carefully pushing and stretching the wires of the artifact. This gave the performer a sense of *connecting* with the vocal sounds by careful-ly listening to the response of the artifact, whilst performing the aria along with the accompaniment created by themselves by leaning, stretching and pulling the wires from within the large bodily interface.

One of the singers, the soprano Randi Røssakk, later reports on this experience: "I was asked to improvise with The Vocal Chorder in *A Silver Swan* by Gibbons, and noticed that this was a task I had to consider carefully. Not because others judged my performance, or me, but because I noticed that I did that myself, and therefore felt unfree even if the intention was the opposite. Beforehand, I did not think it would be problematic; I'd been doing some improvisation before but it was many years ago and I had perhaps forgotten how one gets into it, and I noticed more prestige in that I did not want to do something that might sound silly, or was not good enough. [...] I do not mean that we should go on making the mistake of not singing properly, but music is a living art form and the music needs to breathe. No appearance is exactly like the next; it is not natural for us humans. It was interesting that this notion appeared to me while working with The Vocal Chorder."

Here she is relating to a holistic and relational experience of her voice that arose from performing with the artifact. In The Technology as Experience framework, McCarthy and Wright (McCarthy & Wright 2004) refer to this kind of experience as *sense making*. They propose six different strands of sense making. One of them is *interpreting*. According to them, interpreting is characterized as "an unfolding experience [that] involves discerning the narrative structure". Here the solo-singer was uncovering the hidden narrative structures in her own professional practice — the narrative that says that an opera singer cannot improvise, cannot become part of the 'living art form'.

Furthermore, McCarthy and Wright discuss sense-making as a process of *reflection*: "[making] judgments about the experience as it unfolds". By making the performance a real-time synchronization between voice and accompaniment, we are allowing the singers to make their own judgments come into play: not sounding silly, choosing the tempo that expresses the sentiments they want to express, and so on. One year later, another soprano, Matilda Wahlund, was introduced to the same setup. In her reflections both *connecting* and *interpreting* experiences are discerned: "I pretty quickly got a feeling for the instrument. One of the major challenges consisted of getting a flow in the style and voice in

combination. An additional challenge was that things happened with the technology at times and it was challenging to try to stay in the moment and to find a flow in the performance and not be disturbed by technological hassle."

In order to comply with the unforeseen obstacles that interacting with the device offers, the performer realizes that connecting with it, and staying in the moment helps to overcome the challenges. Matilda then relates to the bodily experience with the artifact: "There was also a strong and nice experience to see how it became like dance and choreography of the various arias we did together with technical instruments, how the instruments, in combination with us, gave the music form and life in unexpected ways." This may be seen as evidence of how the instrument opened up for different forms of sense making through performing interactively with it.

The first singer, Randi, continues: "We got to play in a way opera singers rarely get the chance to do: exploring movement and playing with sounds; everything did not necessarily have to be beautiful or perfect [...]. It was much more like a theater monologue than a regular song. As I got to know the Vocal Chorder and felt confident in improvisation, I got a completely different relationship to it, and when we came to the last concert I felt really totally free."

Both these singers relate to processes of becoming more and more embodied with and through the instrument. It is not a one-step process, but something that requires some work before arriving at the experience of being 'totally free'. The use of the artifact offered new perspectives on experiencing their own voices and performances, as expressed by Randi: "I had no other accompaniment than myself and did thus not need to be clearly and correctly relating to another human being in order for the music to work; I was in charge of time and could take breaks, too." Interacting with the instrument had a noticeable positive impact on her vocal performance, offering a new freedom and adding new flavors to her voice. And she continues: "As regards to singing technique, I tried to keep it much more naked than I otherwise would have sung in school; it felt like the right thing in the face of this piece. How good it was, it is still difficult for

me to judge, but I'm at least less afraid of being in this situation again, and I stretched a little on the old boundaries."

Matilda concludes, referring to her colleagues who performed with other interactive instruments during the Extended Opera Course: "Another thing that was so interesting and nice was to follow the development of others with both their arias and their work with the technical instruments they had been assigned. How from the first tentative meeting with the new technology it changed to almost becoming part of the person who performed with it."

Consequently, through experiencing Vocal Embodiment, the singers performing with the interactive artifacts are not just singing and imposing changes in the matter at hand. Rather, they are simultaneously singing and engaging in an onstage performance, thereby changing their vocal practice. When influencing and changing important musical factors through bodily interaction, the vocal production alters and a deepened bodily awareness emerges. Through the use of these novel interactive instruments for opera, singers have experienced how their vocal practice has reached a deeper relation to their bodily practices, expressed as an enriched sense of embodiment between their voices and the overall performance, in short — Vocal Embodiment.
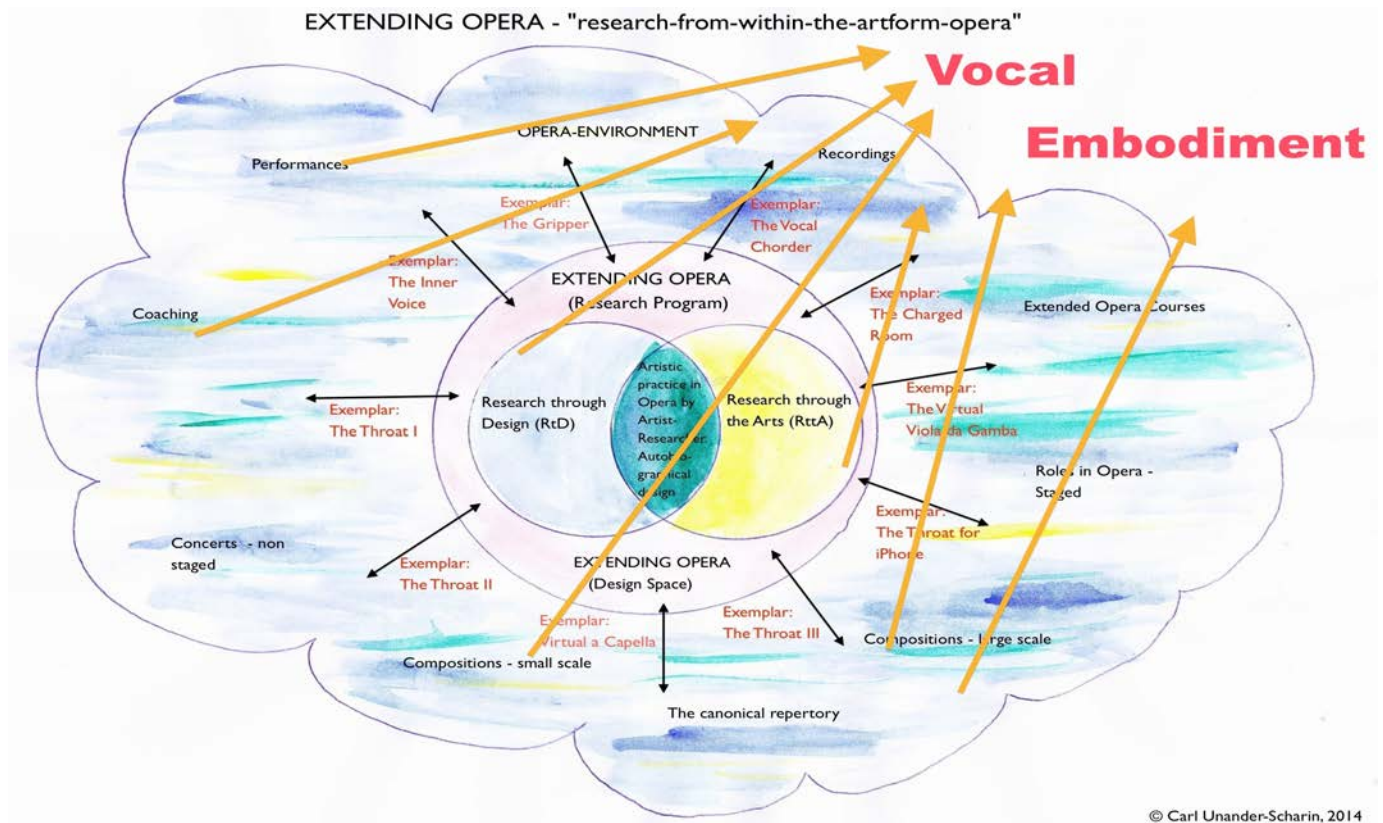
Figure 65: Extending Opera in relation to Vocal Embodiment

6. Conclusion – Artistic Re-Empowerment

How then did the excursions into interactivity affect the awareness of power structures in opera? Did they transfer influence over important musical and vocal components back to the singers themselves?

As discussed above, singers reported on how the work with interactive technologies made them more aware of their own participation in the opera-environment, and of how their practice relates to overarching hierarchies. Interacting with the novel artifacts gave some of our singers a sense of empowerment. However, after working with the Throat III over three weeks, one of our singers reported very earnestly that, in comparison with accompanying herself on the piano: "I have to admit that I did not feel empowered at the current stage." I see this as a healthy and welcome criticism, inviting more work to be done in offering tools that are musically meaningful and at the same time as offering functionality that – even for the professional instrumentalist – is rewarding enough for them to try to master through rehearsals.

In a recent article, aspirations with the aim of empowering users have been called *Interactional Empowerment*, defined as: "a key in designing for affective interaction that aims to empower users in and through the interaction" (Ståhl, Löwgren & Höök 2014). The same authors suggest an "Interactional Empowerment program and the idea of experiential qualities as a form of design knowledge", a quest that agrees well with the aims within The Extending Opera program.

As posited above, designing for opera has not only offered a set of prolific and inspiring tools, but it has also helped in stirring a milieu where the building blocks in opera themselves have been made accessible in order to spur discussion.

Throughout this work, opera singers have performed in ways that are, in some respects, quite the opposite of what they typically do. Opera singers are commonly not expected to engage in the musical pace nor to take responsibility for the musical structure, but rather to concentrate on the singing and acting within the musical drama. When developing tools for singers to appropriate and take control over the rhythmical pace and overall artistic outcome of their performances, the innate power structures in opera have become more evident. Using a designerly process in order to uncover hidden assumptions in an established and in some ways stagnated practice has allowed for questioning the practice itself, thereby offering a tool for *Artistic Re-Empowerment.*

When singers became responsible for the decisions over crucial elements in their performances, while interacting with the novel devices, it not only changed their performances, but it also led to reflections on their profession. Through the creation of these new interactive instruments, hidden assumptions were uncovered while actually re-activating traditions in an overly hierarchical practice, opera.

Interestingly, the participating singers conveyed personal experiences that connected to my own reasoning regarding how the contemporary opera singer has little influence over the essential creative processes and the incongruity between the aura around famous opera singers, the 'divas', supposedly mastering the end-result of their performances. It also connects to the claim put forth by the critic David Littlejohn (Littlejohn 1992), regarding how the opera world of today resides in "the age of the producer ".

Therefore, a main defining property of the exemplars in this design space is the emancipation of singers and the exploration of the impact on their artistic practice through the use of an interactive instrument. In the procedure of designing for empowerment through putting the control of the accompaniment in the hands of singers, this research connects to early operatic practices and the findings add to a historical context of searching for new expressions through ex-

ploring the art form opera with new works and technologies. In particular, the process of *Sensory Digital Intonation* and the requirement *Performative Stamina ("The Premiere-Factor")* have been of great help during the creation of the artifacts. Furthermore, we have seen traces of the experiential quality *Vocal Embodiment* throughout the work with the interactive instruments.

As most operas in the common repertory have been staged many times before, the artistic framework and possible ways of interpreting a particular opera are in many ways predetermined even before rehearsals start. Moreover, as the music in most cases was composed a long time ago, there is little room for the singers to partake in the overall compositional decisions. The singers that took part in our work all expressed a wish of greater participation in the artistic shaping of their art form. Acknowledging opera singers through designing interactive instruments for them challenges century-old power structures in opera by letting singers actively take part in shaping their performance in ways that reconnect opera to its roots, thereby re-empowering the singers themselves.
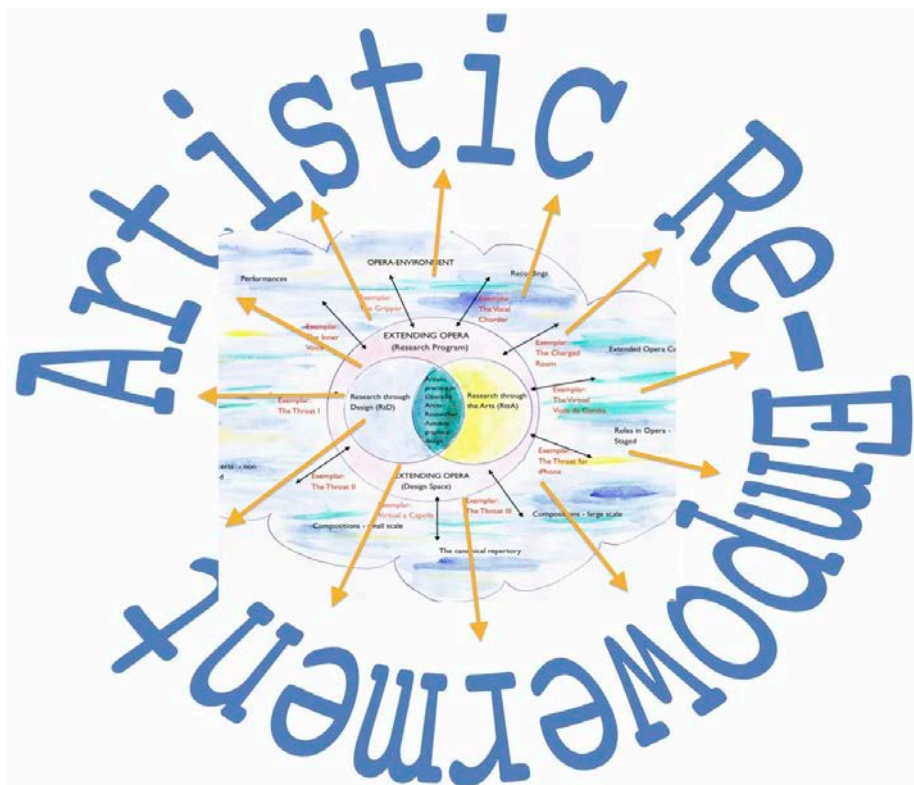

Figure 66: The overarching notion of Artistic Re-Empowerment in relation to Extending Opera

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The work presented in this thesis is collaborative in most aspects, as neither the artworks, the artifacts, nor the academic contributions would have come about without the labor of many.

The idea of inviting me to do a doctorate at The University College of Opera in Stockholm – in collaboration with The Royal Institute of Technology KTH – was originally devised by rector Lise-Lotte Axelsson in 2004 and further advanced by her successor Birgitta Svendén during 2006-2009. Through their common successor Magnus Aspegren, the idea became a reality in 2010. I am deeply thankful to all three of them for their initiative and for the ever supportive 'infrastructure' at the University College of Opera, consisting of Marit Wixell, Liselott Mökjas, Mats Lindberg (who also provided a lot of help with singers' costumes), Christofer Fredriksson and Jan-Erik Sahlberg. Another person instrumental in making this all happen and to whom I am much obliged is Professor Emeritus Nils Enlund, who allowed research carried out by an artist into his academic realm at KTH.

KTH has provided an excellent research education for me, and the most important contributor in doing so is Professor Kristina Höök, my superb supervisor, to whom I am thoroughly and profoundly grateful. Through her friendly tenacity, my long-standing artistic practice could be formulated and propelled out into the field of Interaction Design and Human-Computer Interaction. A very special thanks goes to my co-supervisor Yngve Sundblad, who introduced me to Kristina in the first place and whose senior comments have been of great value to my work, as well as to Professors Ann Lantz, Henrik Artman, Roberto Bresin and Jan Gulliksen for providing a great atmosphere at MID/ KTH. My thanks also go to my earlier tutors Leif Dahlberg, Juvas Marianne Liljas and Mark Tatlow as well as to Björn Hedin at KTH – for his practical help with issues around the formatting of the thesis. Furthermore, I am grateful for the photos by all the contributing photographers (see complete list on p. 124) and

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I am grateful to the many commissioners of artistic works and operas – as well as for invitations to perform them – that constitute the opera-environment in which this research has been carried out. In trusting me with commissions and opportunities to perform, these institutions have also provided me with the confidence of raising a discussion around the very building blocks that they rely on – a confidence that I hope I have lived up to. Thank you! – The Royal Swedish Opera, NorrlandsOperan, Vadstena-Akademien, GöteborgsOperan, Operadagen Rotterdam, Cape Town Opera, the Liszt Academy in Budapest, Scenkonstbiennalen, Piteå Kammaropera and Den Anden Opera, Copenhagen.

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development of the art-form as well as its vocal technique. Also, Professor Jonas Löwgren at Malmö Högskola contributed greatly with supportive and friendly criticism at my final seminar during the running up towards the dissertation, as did Professor Bo Westerlund a year before during my 50%-seminar.

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Stockholm, December 2014.

Carl Unander-Scharin

List of photographs and illustrations

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APPENDIX

The matrix found at the end of this thesis contains works and technologies created and designed respectively between 1991 and 2014. The Matrix lists technologies on the X-axis and works into which these technologies have been incorporated on the Y-axis

WORKS (Y-axis)

1. The Man on the Hill-Side/ Mannen på Sluttningen, (Radio opera, 1991)
[Webpage](): www.electronic-opera.com/node/77
Music: Carl Unander-Scharin
Text: Katarina Frostenson

2. The King of Fools/ Tokfursten (Opera, 1996)
[Webpage](): www.electronic-opera.com/kingoffools
Music: Carl Unander-Scharin
Text: Elgard Jonsson, Carl Unander-Scharin, Nils Spangenberg, Magnus Carlbring.

3. Figures in a Landscape/ Figurer i ett landskap (Song cycle, 1997)
[Webpage](): www.electronic-opera.com/node/70
Music: Carl Unander-Scharin
Text: Ingamaj Beck

4. The Lamentations of Orpheus (Robotic Installation, 1998)
[Webpage]():
www.scenochsinne.com/index.php?option=com_content&view=article&id=60%3Aorfeus-klagan&catid=56%3AKoreografiska+installationer&Itemid=86&lang=en
Choreography & Movement Programming: Åsa Unander-Scharin
Music: Claudio Monteverdi
Programming: Magnus Lundin

Performers: Ensemble Fortezza

      Carl Unander-Scharin, Tenor

      Kerstin Frödin, Recorders

      Keren Bruce Westerlund: Viola da Gamba

      Urban Westerlund: Harpsichord

5. Patterns, Thoughts and Empty Space (Dancework, 2000)

[Webpage](#):

www.scenochsinne.com/index.php?option=com_content&view=article&id=54%3Atanke-moenster-och-tomrum-2000-01&catid=54%3AKoreografiska+verk&Itemid=83&lang=en

Choreography: Åsa Unander-Scharin.

Music & Voice: Carl Unander-Scharin, remixed by Klas B Wahl.

Artistic Cooperation (tech, space, light): Mateusz Herzcka

6. Qivittoq (Dancework, 2002)

[Webpage](#):

www.scenochsinne.com/index.php?option=com_content&view=article&id=51%3Aqivittoq&catid=54%3AKoreografiska+verk&Itemid=83&lang=en

Choreography & Dance: Åsa Unander-Scharin

Music & Voice: Carl Unander-Scharin

Including the aria "Lasciatemi Morire" by Claudio Monteverdi

Text: Ingamaj Beck

7. Corpus Aquarium (Interactive installation 2004)

[Webpage](#):

www.scenochsinne.com/index.php?option=com_content&view=article&id=162%3Acorpus-aquarium&catid=56%3AKoreografiska+installationer&Itemid=86&lang=en

Dance, Concept & Choreography: Åsa Unander-Scharin

Music: Carl Unander-Scharin

Programming: Mateusz Herzcka

8. This is the Nucleus (Interactive opera-aria, 2004, 2013, 2014)

[Webpage](#):

www.youtube.com/watch?v=oxUGb6rmFos&feature=youtu.be&list=UUrCJwo2Rq_5goJ6jd_X
hfEg

Music & Voice: Carl Unander-Scharin

Text: Walt Whitman

Programming: Carl Unander-Scharin

Audience Interactive Mode: Sensory Digital Intonation: Carl and Åsa Unander-Scharin

9. Hybrid, Creatures and Labyrinths (Dancework, 2005)

[Webpage](#):

www.scenochsinne.com/index.php?option=com_content&view=article&id=48%3Ahybrid-
vaesen-och-labyrinter&catid=54%3AKoreografiska+verk&Itemid=83&lang=en

Choreography: Åsa Unander-Scharin

Music: Carl Unander-Scharin, remixed by Klas B Wahl

Text: Various

Programming: Carl Unander-Scharin

Performed: Stockholm – Moderna Dansteatern

10. Ombra Mai Fu - The Interactive Tree (Interactive installation, 2004)

[Webpage](#): www.electronic-opera.com/node/818

Music: G F Handel, remixed by Carl Unander-Scharin

Programming and tech: Carl Unander-Scharin, consultant: Magnus Lundin

Concept and Interaction Design: Carl & Åsa Unander-Scharin

11. From Things to Sounds (Choral Suite, 2007)

[Webpage](#): www.electronic-opera.com/node/492

Music: Carl Unander-Scharin

Text: Gunnar Ekelöf

Programming & Visuals: Carl Unander-Scharin

12. The Crystal Cabinet (Dream play, 2008 – dance/opera/video/interactivity)

: www.electronic-opera.com/thecrystalcabinet

Music: Carl Unander-Scharin

Choreography: Åsa Unander-Scharin

Text: William Blake, Carl Unander-Scharin, Åsa Unander-Scharin, Keith Turnbull

Programming: Mateusz Herzcka, Carl Unander-Scharin, Nenad Popov

13. The Insomnia Clinic/ Sömnkliniken (Opera, 2009)

: www.electronic-opera.com/node/theinsomniaclinic

Music: Carl Unander-Scharin

Text: Alexander Ahndoril

Programming: Carl Unander-Scharin

14. Olimpia (Robotic installation, 2010)

1 : http://vimeo.com/21271430

2: www.operamecatronica.com

Choreography and movement programming: Åsa Unander-Scharin

Tech: Magnus Lundin

Music: Carl Unander-Scharin and Jacques Offenbach

15. Extended Opera Course I: *Extending Opera* (Course, 2011)

: www.electronic-opera.com/extendedopera

16. Artificial Body Voices (Interactive Dancework, 2011)

: http://vimeo.com/52078586

Music: Carl Unander-Scharin, remixed by Klas B Wahl

Choreography: Åsa Unander-Scharin

Video: Lene Juhl and Mark Viktov

Programming: Mateusz Herzcka, Carl Unander-Scharin, Nenad Popov

17. Extended Opera Course II: *Opera Mecatronica Live* (Course, 2012)

: www.electronic-opera.com/extendedopera

18. The Elephant Man (Opera 2012)

Webpage: www.electronic-opera.com/theelephantman

Music: Carl Unander-Scharin

Text: Michael Williams

Hardware and Software development of The Throat III: Ludvig Elblaus and Carl Unander-Scharin

19. The Silver Swan (Interactive Aria, 2010-2013)

Webpage: www.electronic-opera.com/a_2011_SilverSwanInTheThroatIII

Music and text: Orlando Gibbons

Tenor: Carl Unander-Scharin

Software and hardware development: Ludvig Elblaus and Carl Unander-Scharin

20. Extended Opera Course III: *Sing the Body Electric! A Corporatorio*
(Course and Corporatorio, 2013)

Webpage: www.electronic-opera.com/singthebodyelectric

Music: Carl Unander-Scharin

Texts: William Blake, Albert Einstein, Walt Whitman

In collaboration with Åsa Unander-Scharin and Ludvig Elblaus

21. Extended Opera Course IV: *Electric Body Songs* (Course, 2013-14)

Webpage: www.electronic-opera.com/extendedopera

TECHNOLOGIES (X-axis)

A. The inner voice (1991-1996)

A concept used in both *The King of Fools* (Tokfursten) and *The Man on The Hill-Side* (Mannen på Sluttningen), allowing the performer to make fast changes in vocal expression. This is used on stage to make an inner line of thought expressive to the audience, while the performer is in the midst of a scenic action.

Programming: Carl Unander-Scharin: Ensoniq EPS and Yamaha mixers. Cordless microphones

B. Reverbed Harmony (1991-1997)

The use of large electronic spaces, similar to those in a church through which harmony is created by the singer.
Programming and tech: Carl Unander-Scharin; PCM-80, Harmonix Harmonizer

C. Virtual a capella (1996-2014)

A creation of a capella chorales when no choir was de facto assembled — thorough planning of harmony/and or programming was/is used. Programming: Carl Unander-Scharin; Logic, Max/MSP. Novel version from 2010 on: Programming by Ludvig Elblaus

D. Remixed Vox (1997-2013)

A straightforward concept when remixing is done with tools in the music studio. Programming/ Editing/ Composing: Carl Unander-Scharin; Logic, Max/MSP, Metasynth

E. The Gripper (1998-2000)

The functionality of a switch — transformed to a glove. The gripping and remixing of sound is accomplished via a Lexicon PCM-80 with pitch expansion. Programming: Carl Unander-Scharin

F. G. H. The Charged Room: A, B, C (1998-2013)

A long-term development carried out in close cooperation with Åsa Unander-Scharin, Mateusz Herzcka, Nenad Popov and Ludvig Elblaus. The basic technology is the use of a camera that translates movement — to sound and color. Max/MSP, Tarsier.
A: 'The performer as Joystick'
B: 'The performer scratching sound'
C: 'The stage as sample player'

I. DJd VOX (2002-2013)

The use of a DJset with two CDs containg prerecorded vocal sounds. This enables real-time DJing of the pre-recorded voice. Denon DN-2600F. Concept: Carl Unander-Scharin

J. The Virtual Viola da Gamba (2002-2014)

Created in close cooperation with Åsa Unander-Scharin, this instrument gives the performer the capacity to accompany the singer with bodily movements (sometimes accomplished by the same performer) – similar to the movements of a Viola da Gamba player. DIEM Dansedraegten (later ScenOchSinneSensor), Max/MSP, Cordless mic, Clavia Nord Modular gen 1. Programming: Carl Unander-Scharin. Additional programming: Ludvig Elblaus

K. The Vocal Chorder/ Midi-Harp (2004-2014)

A large bodily interface, enabling the performer – or the audience – to interact with sounds and visuals by stretching and leaning on wires. Rolls MP-1288 interface, potentiometers, Max/MSP, Nord Modular v 1. Programming: Carl Unander-Scharin and additional programming by Ludvig Elblaus

L. The Throat I (2005)

The first generation of the carry-on interface that enables the singer to take part in scenic action – and on the same time influence vocal sounds with hand-movements. Nostromo keyboard, Max/MSP, Junxion software by STEIM. Microphone. Programming: Carl Unander-Scharin

M. The Throat II (2009)

A developed version of Throat – now operated by a sound-engineer. Microphone in the scaffolding. Max/MSP. Programming: Carl Unander-Scharin

N. The Throat IIb (2010)

Basically similar to Throat II, this verson had a visual component added, in order to allow for realtime video accompaniment. Max/MSP/Jitter

Programming: Carl Unander-Scharin

O. The Throat III (2010-2014)

The third and thoroughly revised version of The Throat. Programming and hardware: Ludvig Elblaus using SoundCollider and Processing.

P. Throat for iPhone (2012)

Built on ideas from the Throat series, this version is built for handy carry-on use, and incorporates everything needed for vocal performance.
Programming: Ludvig Elblaus. Hardware: Apple iPhone 4s, microphones, loudspeaker in back-pack, Apogee One interface.

Q. The Interactive Tree: (2007)

Created for and in the work "Ombra Mai Fu" — an interactive installation that has encapsulated the voice of a singer within the shadow and stems of the famous Handelian tree. Max/MSP. Ping Ultrasonic sensor and PIR motion sensor. Arduino. Programming: Carl Unander-Scharin, and Magnus Lundin.
Music: G F Handel, remixed by Carl Unander-Scharin
Concept & Interaction Design: Carl & Åsa Unander-Scharin

R. The Gigantic Junk Marionette: (2007-2010)

Choreography and movement programming: Åsa Unander-Scharin
Electronics and programming: Magnus Lundin using the custom-built software Anima.
Music: Carl Unander-Scharin and Jacques Offenbach

S. The Industrial Robot irb 1400 (1998)

A state-of-the-art industrial robot built by ABB.
Movement programming by Åsa Unander-Scharin, software by Magnus Lundin

T. ScenOchSinneSensor: (2013)

An improved system for wireless communication of sensor signals developed from the specifications by Ludvig Elblaus, Carl Unander-Scharin, Åsa Unander-Scharin