

MUSICAL CYBERNETICS: THE HUMAN AND THE COMPUTATIONAL

PHD QUALIFYING EXAMINATION/CRITIQUE WRITTEN FIELDS

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ABSTRACT

This two-part paper covers the written portion of the Qualifying examination for the DXARTS PhD Program at the University of Washington. It is a brief presentation about 1) the history and theory of my medium of engagement, and 2) the importance of my particular arts practice providing a brief comparative perspective between personal arts philosophy and a broader reflection of current invention, innovation, and experimentation in my area of engagement.

Due to its brevity, this paper by no means aspires to be a complete presentation of my work, nor an objective, thorough survey of the historical lineages that inform it or to which it relates, but rather an introduction of some key concepts and practices from a personal viewpoint.

INTRODUCTION

My research and work output at DXARTS has largely revolved around designing complex dynamical systems through iterative processes and exploring their artistic potential. I have taken both algorithmic and anthropocentric approaches. The works with which this paper is concerned are three open music compositions that explore different aspects of this idea.

In Part A, I will briefly talk about open composing as the design of complex systems that incorporate 'now' into the creation of a work, as well as about the core function of *listening* in such works. I will also shortly present some early live electronic compositions and approaches that relate to aspects and other lineages of my work. My focus will be on the

1950s and 1960s, as the period when open strategies and live electronics came into prominence.

In Part B, I will introduce three compositions together with some fundamental artistic ideas, goals and methodologies.

PART A: CONTEXT

IMPROVISATION: HARNESSING THE MOMENT

Improvisation forms an integral part of the music idioms of a great variety of cultures. Improvisatory systems and their functional importance may differ greatly, both between cultures¹ and within the same culture at different times. However, regardless of their differences, the fundamental role of such systems can be said to be that of bringing ephemeral expression and the experience of 'being there and then' into the musical process.

The art of improvisation has been an important component of Western art music for a long time, having undergone many mutations. It can be traced back to vocal music manuscripts of the 9th century, and Medieval and Renaissance treatises incorporating folk techniques and developing

¹ For example, some folk systems are based in modes, others in improvised variation, call-response or dynamic pattern selection. Within jazz, almost all styles consist of varying degrees of composed and improvised elements based on the harmonic, melodic or formal structure of a piece.

new ones². In fact, a formal distinction between ‘sung’ and ‘written’ counterpoint only emerged after the establishment of notation in the 14th century. Later, the advent of ‘perfect instruments’ - polyphonic instruments like the organ, the lute and later the harpsichord and piano - created new instrumental styles of improvisation. Many famous keyboard composers, like Sweelinck, Frescobaldi, Buxtehude, Bach and Händel, would often dance the line between composing and improvising, a tradition carried on until the second half of the 19th century by virtuoso-composers such as Mozart, Clementi, Beethoven, Liszt and Chopin³.

OPENING THE COMPOSITION: 1950s-60s

After the Second World War, several composers attempted to redefine ‘composing’, deconstructing the compositional process and opening its different components to actions of the fleeting moment. Structure, timing, content, materials, all became fields to compose not necessarily through a strict description, but by defining probabilities, probable outcomes, rule-sets and modes of conduct that dynamically shape *a* - instead of *the* - musical outcome. Composers employed different strategies, incorporating randomness (Xenakis) and chance (Cage), or improvisation and intuition (Stockhausen).

For Umberto Eco, the poetics of such open works, where “[e]very performance **explains** the composition, but does not **exhaust** it” [2], come as a result of, and therefore a reference and a response to, modern scientific thought as exemplified by quantum and Einsteinian physics. Iannis Xenakis, while taking an algorithmic instead of an open-work approach, shares a similar pivot point: “*Since antiquity the concepts of chance (tyche), disorder (ataxia) and disorganization were considered the opposite and negation of reason (logos), order (taxis) and organization (systasis). It is only recently that*

² Such as, *Musica enchiriadis* and *Scolica enchiriadis* (Anonymous) in the 9th century, *Micrologous* by Guido d’Arezzo in the 11th century, and in Lusitano, Nicola Vicentino and Zarlino in the 16th century.

³ According to Grove Music Online [1], among the reasons for the decline of improvisation during that period was the rise of the performer-interpreter, but also socio-economical conditions that rendered most improvised music into ‘easy-listening’ music of the time.

knowledge has been able to penetrate chance and has discovered how to separate its degrees - in other words to rationalize it progressively”. And later: “*It is the central importance of probability which principally differentiates the science of the twentieth century from that of the past*” [3].

Listening

*Play a sound
Play it for so long
until you feel
that you should stop*

(...)

and so on

(...)

*But whether you play or stop:
keep listening to the others⁴*

Regardless of how different the approaches, a common thread between composers pushing forward around that period seems to be their regard for *listening* as one of the most important responsibilities of the composer. This idea was lurking in the outskirts of Western Art music since the beginning of the 20th century, when the Futurists, attentive and conscious listeners of the new sound world that emerged ‘with the advent of machinery’ [4], brazenly embraced its noises. Carried through by composers like Edgar Varèse and Henry Cowell, this seed blossomed after WWII into many different, sometimes seemingly irreconcilable philosophies, strategies and aesthetics.

The importance of listening is most clearly stated in the artistic and theoretical output of Musique concrète composers. In his *Études de Bruits* (1948), Pierre Schaeffer was deliberately challenging modes of listening and perception through the use and manipulation of recorded material. In John Cage’s case this is also very obvious. Several of his pieces, like *Imaginary Landscape No. 4*, for 12 radios (1951) and the infamous *4’33”* (1952), were precisely about opening one’s ears to the everyday and the social. Karlheinz Stockhausen’s open pieces of the 1960s were also greatly concerned with listening. *Microphonie I* and *II* (1964-65) use the microphone as a sonic microscope to observe

⁴ Excerpt from Karlheinz Stockhausen’s score for *Richtige Dauern* (‘Right Durations’) from *Aus Den Sieben Tagen* (‘From the Seven Days’, 1968), a cycle of 15 verbal-score compositions.

and discover sounds. On the other hand, in pieces like his *Plus-Minus* (1963), *Solo* (1965-66) and the radio pieces *Spiral* (1968) and *Kurzwellen* (1968), involved listening is required from the performers to create the piece in real-time through a recursive process of listening and acting upon what is heard. Lastly, in 1954 Xenakis proclaims the need for a stochastic method of composition that can successfully function on a perceptual level, while criticizing serialist composers for not acknowledging what everyone hears, that their carefully thought-of methods only produce white noise [5].

LIVE ELECTRONICS

In 1939, Cage composed *Imaginary Landscape No.1* for piano, Chinese cymbal and two turntables. The performers play back test-tone records while manipulating the turntable's speed, manually spinning the platter and dropping and lifting the needle⁵ [6]. Many years later he composed *Cartridge Music* (1960), this time only using the turntable's pickup and contact mics, where "all events, ordinarily thought to be undesirable, such as feed-back, humming, howling, etc. are to be accepted" [7].

Electro-instrumental: Stockhausen

Also in 1960, Stockhausen was trying to find ways to incorporate live electronic manipulation of instruments to his pieces [8]. In *Mikrophonie I & II* (1964-65), *Mixtur* (1964) and *Solo*, microphones, filters and/or tape-delays are used to process the instruments. In *Kurzwellen* and *Spiral* the process is somewhat reversed: performers play radios as instruments and 'process' musically their output with their acoustic instruments.

Besides the orchestral *Mixtur*, Stockhausen composed these works for the ensemble and players with which he was touring as the live-electronics performer and sound projectionist. It is probably not a coincidence that these were also pieces where he incorporated and explored improvisation: he knew and trusted the players,

⁵ Behind this ground breaking experiment lies the very practical reason that Cage could not afford a Theremin. The year before, Cage had encountered - and also ingeniously solved - a similar problem: He wanted to use a percussion ensemble in a theater piece, but due to lack of space he decided to create a one-man percussion orchestra by preparing a piano instead.

and developed these pieces with and for them.



Image 1: Karlheinz Stockhausen, rehearsing 'Kurzwellen' in 1968 [9].

More or less similarly inspired approaches can be found sprouting all around the globe at that time, with several ensembles of composer-performers either developing and performing open works or dedicating themselves to free improvisation, with a few of these groups being actively involved with electronics as well⁶.

The voice of the speaker and the voice of the circuit: Feedback

Around the same time, David Tudor, a pianist gradually turning to live-electronics, close collaborator of Cage and performer of many of his and others' experimental pieces, was trying to burrow to the essence of the circuit and the speaker and discover their voices. John Bischoff recalls working with Tudor: "He treated each collection of components as though it had a distinct personality and he was discovering its authentic nature. He accomplished this through feedback oscillation—the machines' spontaneous response to given conditions. For Tudor feedback was not noise, but rather the expression of the machine's persona (...). He'd set the knobs in such a way that when he increased the gain a very

⁶ Such ensembles include *Gruppo (Internazionale) di Improvvisazione Nuova Consonanza* (with Franco Evangelisti, Roland Kayn and Ennio Morricone notable members), *Musica Elettronica Viva* (Alvin Curran, Frederic Rzewski, Steve Lacy et al), *AMM*, the *Scratch Orchestra* (Cornelius Cardew et al), *New Phonic Art* (Vinko Globocar et al), all focusing on free improvisation. The *Sonic Arts Union*, *Gentle Fire* and *Intermodulation* were more interested in performing open compositions (the last two performing several of Stockhausen's pieces) and concentrated on performances involving electronics.

unpredictable thing would occur, that he'd react to" [10].



Image 2: John Cage, David Tudor Gordon Mumma, Merce Cunningham and his dance company, rehearsing Cage's 'Variations VII' in 1966.

In recording his piece *Microphone* (1966), Tudor run speaker and microphone lines to a remote stairwell, generating a complex, reverberant feedback loop which he manipulated live in studio with a series of custom-built processors. Tudor continued developing this quasi-cybernetic approach, with more sophisticated, matrixed feedback networks appearing in *Untitled* (1972) and *Pulsers* (1976) among other pieces.

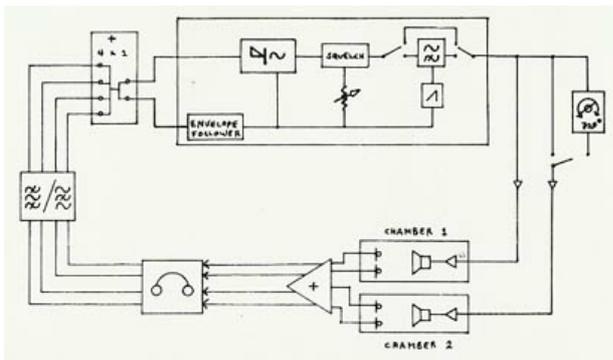


Image 3: Performance patch for David Tudor's 'Pulsers'.

The composer-performer group Sonic Arts Union, consisting of Robert Ashley, David Behrman, Alvin Lucier and Gordon Mumma - who built several of Tudor's devices - also embraced feedback. For Ashley it was 'the only sound that is intrinsic to electronic music' [11]. Pieces like his *Wolfman* (1964), Behrman's *Wave Train* (1966) and Mumma's *Hornpipe* (1967) - a very early interactive piece - all explore the

emergent properties of feedback through performance. Alvin Lucier's *I am sitting in a room* (1969), and Steve Reich's *Pendulum Music* (1968), also study feedback, but taking an observing stance instead of an intervening one.



Image 4: Gordon Mumma performing 'Hornpipe', for French Horn and Cybersonic Console, in 1967.

These explorations of analog feedback, resonate with the early digital explorations in the 1970s by Xenakis, Koenig and other composers by means of non-standard sound synthesis techniques⁷, where sound was composed directly as the movements of speaker cones to mathematically create 'music ex nihilo' [13].

CYBERNETIC LUTHIERS

Evidently, such explorations could not be pushed into extremes with off-the shelf technology. This is obvious in the case of Xenakis, Koenig and other digital pioneers, but already from the analog era several composers were building their own physical devices and systems. According to Behrman's words, they "were aligning ourselves into the tinkerer-inventor tradition handed down from earlier artists who built things, questioned the establishment, and found new sounds or tuning

⁷ For a brief presentation of the different non-standard digital sound synthesis techniques see [12]

systems: artists like the Futurists, like Henry Cowell, Conlon Nancarrow, and Harry Partch” [14].

Earlier yet, Louis and Bebe Barron⁸ had been constructing their own instruments according to formulas from Norbert Wiener’s *Cybernetics* to “function electronically in a manner remarkably similar to the way that lower life-forms function psychologically” [15]. In later years, Roland Kayn followed a similar cybernetic approach, creating networks of electronic devices and taking advantage of the system’s emerging properties through improvisation. Later yet, this also was the strategy of “The League of Automatic Music Composers”⁹, the first microcomputer band (1977-1983), who “created networks of interacting computers and other electronic circuits with an eye to eliciting surprising and new ‘musical artificial intelligences’” [16]. Similar ideals and their creative potential and poetic connotations are expressed in Xenakis’ *Formalized Music*: “With the aid of electronic computers the composer becomes a sort of pilot: he presses the buttons, introduces coordinates, and supervises the controls of a cosmic vessel sailing in the space of sound, across sonic constellations and galaxies that he could formerly glimpse only as a distant dream” [17].

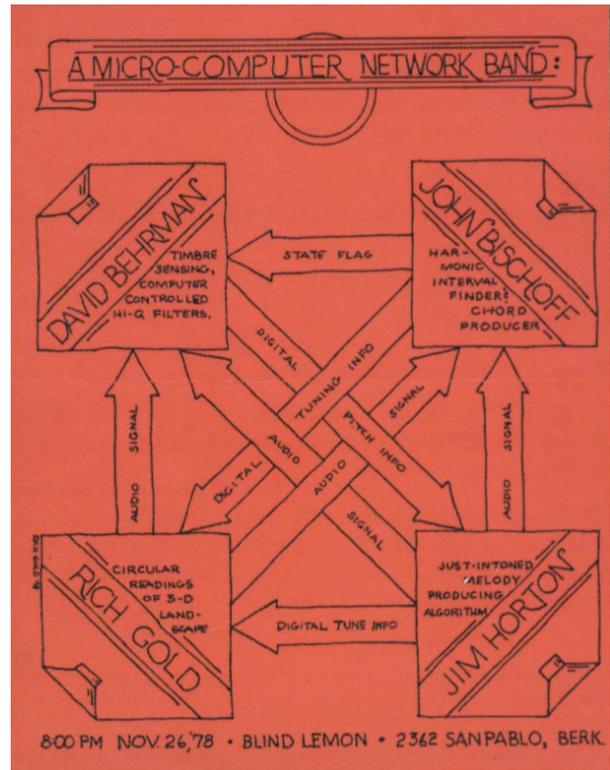


Image 5: Flyer featuring The League of Automatic Music Composers’ system topology from a concert in 1978

⁸ With this methods, Louis and Bebe Barron, who had collaborated with Cage in his *Williams Mix* (1952), composed the first all-electronic soundtrack for *Forbidden Planet* (1956).

⁹ John Bischoff, Jim Horton, Tim Perkis, Paul DeMarinis, Rich Gold, David Behrman.

PART B: (OWN WORK)

COMPLEX SYSTEMS: THE MATHEMATICAL AND THE HUMAN

I am primarily interested in creating a musical language that is both visceral and cerebral; that communicates in a purely cognitive and experiential level while being complex and multilayered. At the same time, I find most intriguing and pertinent to operate in the convergence zone between different areas: Art and science. Composition and performance. Algorithmic design and improvisation. Western art music and - with a broad definition of the terms - folk or 'digital folk' idioms.

I am also very interested in acts of discovery. Most of my work is deeply concerned with the unearthing of rich, complex and organic worlds that can emerge through iterative processes. To rephrase G. M. Koenig [18]: *Given the rules, find the music* – and if it doesn't sound good yet, change the rules.

As a result, before joining DXARTS, I began working extensively with mathematical models for musical structure generation and non-standard sound-synthesis¹⁰. Later on, following the opposite path to a neighboring destination, I co-founded three ensembles exploring various degrees of free group improvisation¹¹.

In DXARTS, I have attempted to combine these two approaches more deliberately, composing three open pieces that explore the continuum between composition and improvisation: a trio, *Navigation* (2008-9), a duo, *Facts To Suit Theories* (2009) and a solo, *Fantasia On A Single Number* (2010). Though present everywhere, computationally complex algorithmic processes are only central in the last piece. Nevertheless, all three pieces are composed as frameworks for exploring complex dynamics that arise through iterative processes, and are guided by defined modes of action and interaction and by real-time listening. Stockhausen's broad definition of feedback is very relevant: *"I mean, for example, any kind of feedback between musicians who play*

¹⁰ I created (and will continue developing) such a model using Lindenmayer Systems, an algorithm originally designed for modeling biological growth (see [12]).

¹¹ Computer Aided Breathing (organ, voice and live electronics), SelectInput (double bass, percussion and live electronics) and Breakcore Tapdance Collective (tapdancer, computer, and live electronics).

in a group, where one musician inserts something, bringing something into context and then listening to what the next musician's doing with it when he's following certain instructions, transforming what he hears" [19].

COMPOSING AN OPEN WORK

My compositional process starts with an abstract concept or idea about the piece that acts as a compass, and which may revolve around form, structure, duration, content, etc. From the beginning, these ideas are directly tied to a piece's 'orchestra': the instruments with their sonic and musical capabilities, but also the specific players and their abilities.

A rough sketch of the overall form is commonly the first step towards realization, followed by rudimentary meso-form sketches and more specific ideas, sonic, textural, etc. Structures and their content are developed in workshops with the players, becoming gradually more detailed and refined, through a distillation process, in which the best ideas, processes or approaches are kept. This continues with each successive performance of a piece: I consider such compositions to not be static, but more resembling evolutionary canvases (*Image 6*). Again, this idea can be found in Stockhausen: *"From this point, retain what you have experienced in the extension of your limits, and use it in this and all future performances of 'Spiral'"* [20].

Digital instrumentation

I consider the design of a digital musical instrument/system to be a fundamental part of the compositional process involved in a piece with or for live-electronics. For me, such an instrument needs to be almost as involved and real-time as an acoustic instrument, to allow interaction in equal terms with other instruments in group settings, and the development of virtuosity, especially in solo settings.

The approaches I have taken differ, reflecting specific necessities of a piece, but also modulated by the technological tools I use and by the extent of my experience with them. As such, my previous, Max/MSP/Jitter system, which I used for live sampling and processing in the first two, electro-instrumental pieces, is a large-scale modular composition and

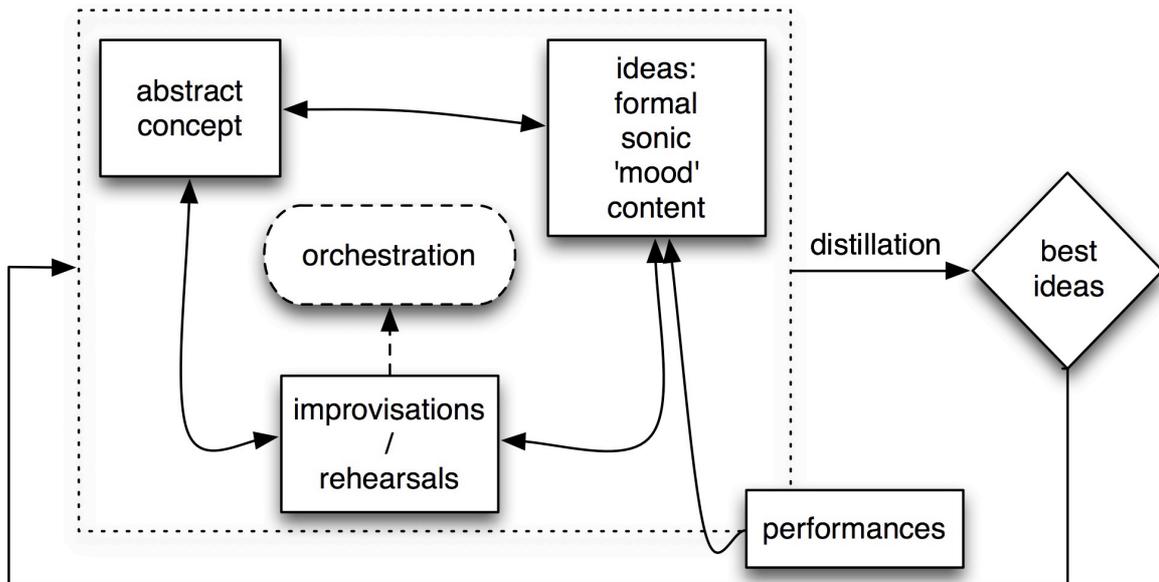


Image 6: A personal approach to composing an open work

performance environment. During the Digital Sound series in DXARTS, I began transferring algorithmic thinking more immediately into the audio signal domain in SuperCollider, and exchanged a universal for a specific approach, developing a self-contained electronic instrument based on digital feedback.

THE COMPOSITIONS

The structural backbone and overall dramatic arc of these pieces are pre-defined, but in a manner that allows - and at many points requires - the inclusion of spontaneous ideas and their development according to the compositional and aesthetical framework of a piece or a section. As such, particular qualities freely emerge and develop with each performance, while the pieces always remain recognizable, retaining their formal outline, and key sonic, gestural and motivic characteristics.

Navigation

Navigation is a 40-minute, 6-part, open composition for pipe organs, celesta, harmonium, voice, wine-glass, loopstation and live electronics, written for the Computer Aided Breathing trio¹². It is a site-specific piece,

created in and for the Orgelpark (Organ-park, Amsterdam) and its instruments. The title is derived from the compositional and improvisatory methods employed in the piece, but also from the manner in which it was developed. The form is constructed as a multi-layered navigation between specific and predefined points - structural, sonic, spatial, and instrumental; it is pre-composed, while at the same time granting the players the freedom to adjust their course, diverge, and explore the areas within these points through improvisation. The rehearsal process, which lasted several months, can itself be described as the act of navigating within an unknown territory, charting it and creating a map/score as a guideline for the performance. The concept of navigation is underlined visually through a spatial exploration. The players occupy different spaces and instruments through the piece, moving from a tight cluster to an obtuse-angled triangle, with lights used to illuminate these spaces.

¹² Kirstin Gramlich: Organs, keyboards;
Stelios Manousakis: Live electronics, programming;

Stephani Pan: Voice, loopstation, keyboards and other instruments.

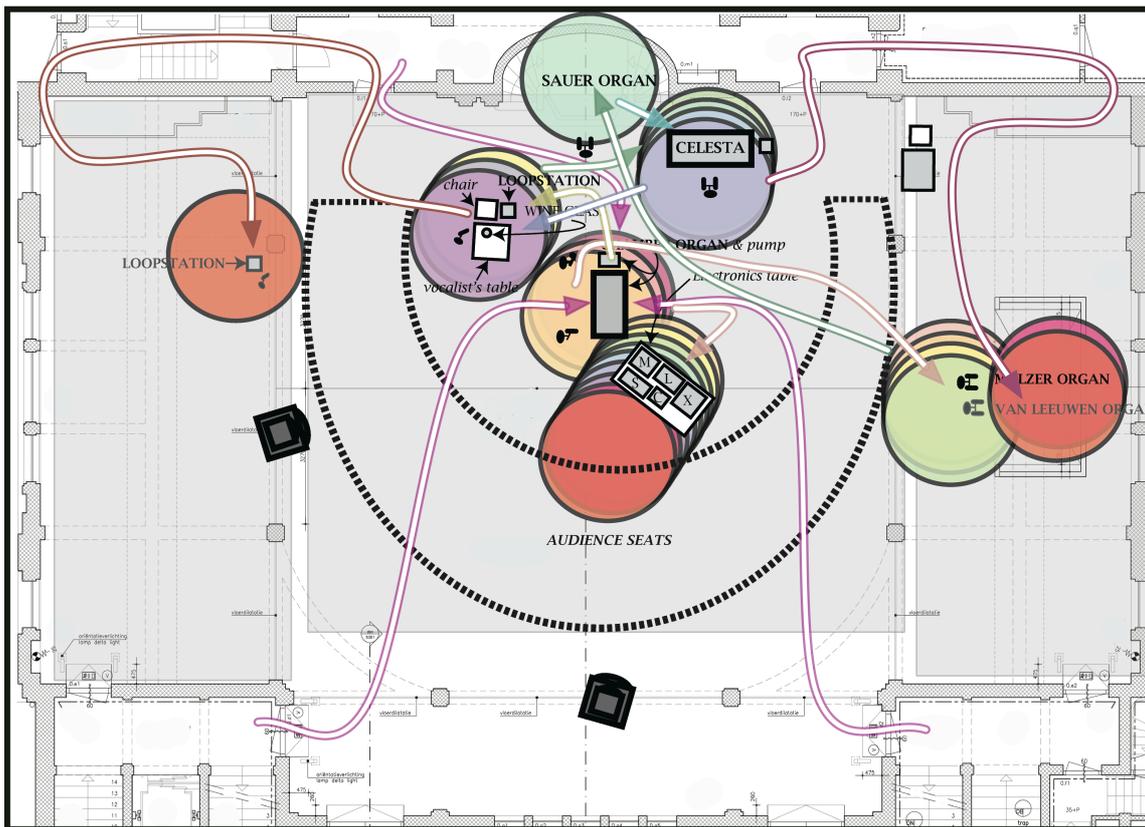


Image 7: Navigation: Color-marked positions and approximate trajectories of the players throughout the piece.



Image 8: Navigation: Images from the premiere: Parts A and B of Navigation (Orgelpark, Amsterdam, November 2008).

Facts to Suit Theories

This is a 30-minute, 5-part open composition for voice, toy harp, wine glasses, loop-station and live electronics, written for Stephanie Pan and myself. The compositional approach is similar to *Navigation*, but the two pieces are overall quite different. *Facts to Suit Theories* is conceived both as a piece and a 'live-set', merging approaches and vocabularies from the worlds of concert and 'underground' music. It unfolds slowly with adjacent parts merging together within a continuous flow, gradually shifting back and forth between drones, feedback, no-input noise, lyric passages and modal song.

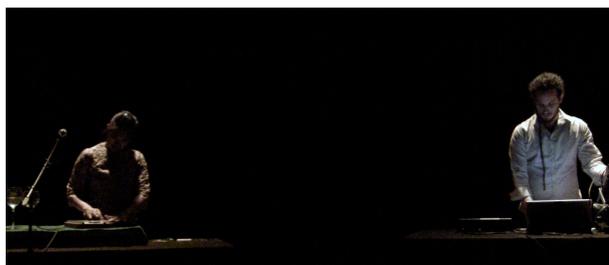


Image 9: Facts to Suit Theories: Image from the premiere (Chapel Performance Space, Seattle, April 2009).

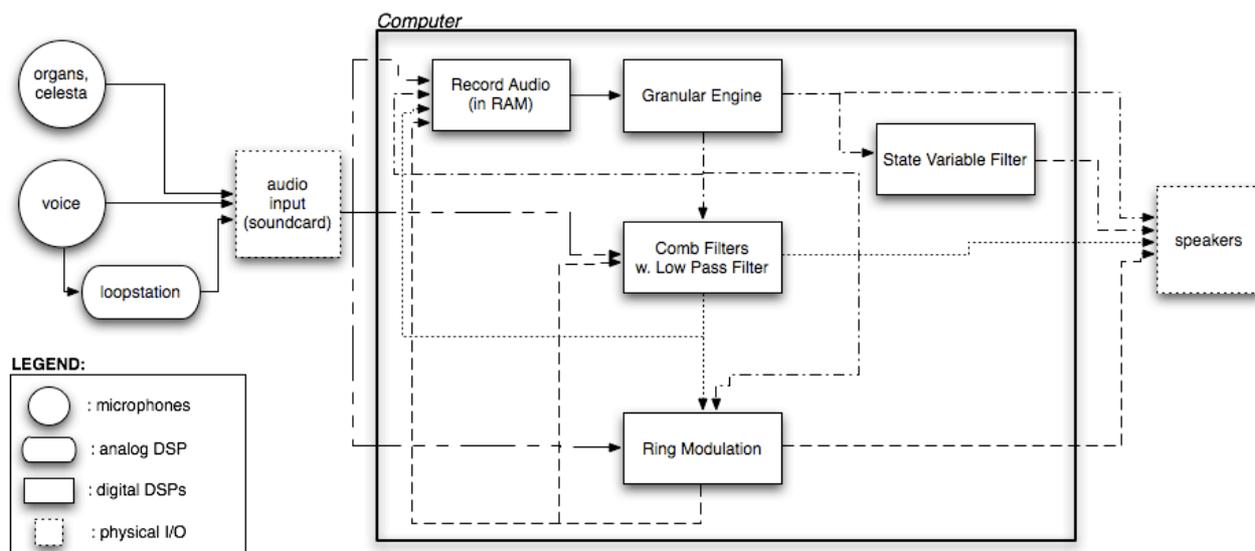


Image 10: The routing system used in 'Navigation' and 'Facts to Suit Theories', incorporating feedback between different signal processes.

Fantasia On A Single Number

This 25-minute solo piece for digital feedback with live electronics, is the culmination of my effort to merge the algorithmic approach of my tape pieces with the openness of my live works. The piece grows from and expands on the tradition of virtuosic, 'composed improvisation'. The live electronics instrument is designed as an open cybernetic system, consisting of a feedback network of non-linear equations/processes; a single number iterates through the system's components at a rate of tens of thousands of times per second exciting them. The role of the performer is to manipulate the number's path as well as the system's structure and configuration in real time, guiding the system into states of equilibrium, oscillation, chaotic behavior, noise and silence - with the score and the sonic output being the ultimate guides.

The piece is organized in several hierarchical layers: On the largest scale, there are 10 different 'Scenes', from 45 seconds to about 3 minutes. Each Scene has a particular structural function within the piece and a specific sonic character. Scenes consist of one or more functional units: 'Cues'. These last from only a few seconds to more than a minute; they portray a certain degree of structural integrity and are relatively simple forms; they may require development of a sonic element or idea, lead from one place to another or back, or be relatively static structural units.



Image 11: Fantasia On A Single Number (Chapel Performance Space, Seattle, December 2009).

OTHER CYBERNETIC AND ITERATIVE SYSTEM EXPERIMENTS

Besides these works - my only output in DXARTS behind which I can truly stand, despite any shortcomings - I have pursued similar ideas in several areas, undertaking experiments in most classes I took: in the Mechatronic Art series, in Haptic-Enabled Control Systems, Special Topics and Independent studies, Sound in Space, and now in Telematic Art. Even though most of these efforts still remain experiments, tools and ideas I have developed are making their way into my work, or await future use.

CONCLUSION

Music is more than an object of study: it is a way of perceiving the world.

Jacques Attali,
Noise: The political economy of music [21].

It is my belief that to create a successful and enduring artwork an artist must become and remain extremely sensitive and attentive to his/her spatiotemporal surroundings. At the same time, he/she must continuously digest and reinterpret, consciously and through osmosis, past and current art, science and philosophy, to develop and maintain a dynamic understanding of the world in the past, the moment and the future, steering away as much as possible from blinding static doctrines and rigid pre-conceptions. It is the artist's duty and responsibility to simultaneously be a *demiourgos* (creator), an *epistimon* (scientist) and a *philosophos* (philosopher) – or, at least, to genuinely try.

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