

The Embodied Hybrid Instrument

**Incorporating Digital Processing
into an Improvised Electro-Instrumental Practice**

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Abstract

This thesis describes my practice-based research process of implementing computer-based sound processing into my existing performance practice, resulting in the development of the Hybrid Instrument. Implementing a new layering- and transformation engine brought the challenge to directly and intuitively manipulate the DSP parameters, in order to allow me to make use of my embodied performance knowledge and musical intuitions. Focussing on the demands of free improvisation for development and performing, this thesis examines the paradoxical role of constraints in this context. The transformed functioning of body and mind in performance mode has had effects on the interface development; this is addressed through the notion of embodiment and cyborg. Along the way I discuss issues concerning the laptop on stage and my double role as both developer and performer.

Keywords: Instrument, Interface, Embodiment, Free Improvisation, Electro-Instrumental, Experimental, Constraints

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Introduction

Preface

This thesis describes my practice-based research process of implementing computer-based sound processing into my performance practice. This transformation has been the main subject of my master 'Instruments & Interfaces' work.

My existing performance practice until then consisted of transformed, layered and looped sounds originating from wind- and other monophonic instruments by means of stomp boxes and pedals. Through the years I had built up a strong embodied connection with the hardware devices in my setup and I was finding that this connection was broken when trying to include more advanced sound processing through Max/MSP and generic midi controllers.

The focus of my research has been to develop a system that encompasses four layers of devices: the traditional instruments, the core existing transformation devices of my existing setup (pedals etc), with the addition of a new DSP and a new multi-layered interface. Throughout this process the overarching objective has been to make use of my embodied performance knowledge and musical intuitions and find a way to directly and intuitively manipulate the new parameters in a live performative setting.

This new configuration of hardware- and software-based objects manifests in the form of a new **hybrid instrument**, where the individual elements of the instrument, gel and become inseparably involved through the act of playing.

In the first chapter, I will explain the elements of the existing setup before the transformation, their musical functions and limitations. I will then describe my research goals for the Hybrid Instrument. I discuss my own double role as both developer and performer of the instrument, and the problematics of the appearance of a laptop on stage.

The second chapter focusses on free improvisation and its demands and challenges for development and performing, as well as the paradoxical role of constraints in this

context. The chapter ends with a technical look at the layering- and transformation system that forms the new core of the Hybrid Instrument.

The third chapter considers the transformed functioning of body and mind in performance mode, and how this have influenced the interface development. Challenges that arise out of the demands for fast intuitive reaction in the free improvisation setting, combined with the transformed perception of the performance moment are addressed through the notion of embodiment, summarized in the concept of the 'Natural Born Cyborg'.

The search for an embodied experience of playing a complex and multifaceted instrument has been the underlying premise for the entire research process. Embodiment does not only play a role in the connecting of body and hardware:

Embodiment [...] denotes a form of participative status. Embodiment is about the fact that things are embedded in the world, and the ways in which their reality depends on being embedded. So it applies to spoken conversations just as much as to apples or bookshelves; but it's also the dividing line between an apple and the idea of an apple. (Dourish, 2004, p. 18)

Both my development and research process is conducted through fully embodied experiences, as it s fully embedded in an ongoing live performative practice.

Scope

My development process was not aimed at the construction of a generally applicable instrument or system which could be distributed to and used by other musicians. The design decisions were made with my personal performance practice in mind. The research and development took place in a practice-based, bottom-up approach; experiences and experiments in the studio and on stage were at the source of the development of the hybrid instrument.

I have however tried to anchor my process in concepts and methods from related fields. My research has been influenced substantially by numerous talks, presentations,

discussions, books and papers. The main difference with my previous, more intuitive development process has been the addition of **language**: terms from different scientific areas; metaphors, philosophical approaches not only to the more music related topics of the field of **Sonology**, but also touching on cognitive processes, perception, psychology, mathematics etc. became part of my thinking and research. This has allowed for more dimensions in reflection and influenced all aspects of my work.

In the writing of this thesis I have taken an approach that mirrors my work on the diverse concrete and virtual objects that make up the Hybrid Instrument. Based on and inspired by my practical research and performance practice, I have taken a broad selection of concerns and topics into consideration. All of these are full-fledged research fields that could keep one busy for more than a lifetime, and in this thesis I merely scratch the surface of each of them. Nevertheless, through the process I have been able to assemble a language that allows me to think and talk about my own research concerns in a way that extends the possibilities of my previous unarticulated feelings and intuitive knowledge. As a consequence of this I take some artistic license in my use of terms and to avoid confusion I have added my definitions in the appendix.

Chapter 1: The Emerging Hybrid Instrument

You know, I never went to Italy, so I had to write a song about it to know it.

(Boris Vian)

Shaping Hybrid Instrument and Performance Practice

Most of the performance practice and the combination of instruments, electronic devices and hardware that I call my hybrid instrument has been shaped and combined in a bottom-up approach over a long period, as a product of experimenting, intuitive decisions and practical concerns; influenced by specific collaborations, almost coincidentally agglomerated instruments, and ‘sound wishes’ that inspired the modification and transformation of this source material. All ‘traditional’ instruments that I use as sound sources (saxophones, bass clarinet, theremin, and the self-developed *Pataphone*) have one thing in common: they are monophonic, meaning: when played in the ‘official way’, the output consists of one tone with a perceivable pitch. This limitation, and the wish to overcome it (without nullifying it by for example switching to guitar or piano) has been an inspiring and driving force for the development of the hybrid instrument, resulting in two general approaches:

1. Layering

Using layering of sounds through temporal manipulation in different degrees of diffusion, ranging from reverb via delay to live looping. These approaches have in common that they make use of the synergy that springs from juxtaposing one sound with another (harmonic tension etc), but differ in how they impose other characteristics (rhythm, repetition, sense of room) on the result.

2. Timbral transformation

Using extended technique, filtering and resonating to emphasize overtones next to the fundamental note, for example in employing ‘false fingering’ / multiphonics on the saxophone, harmonic singing or using wah-wah or similar filtering effects. These may produce perceivable additional pitches, or transform the timbre in a way that parts of the harmonic spectrum are more pronounced. Also overdrive, distortion.

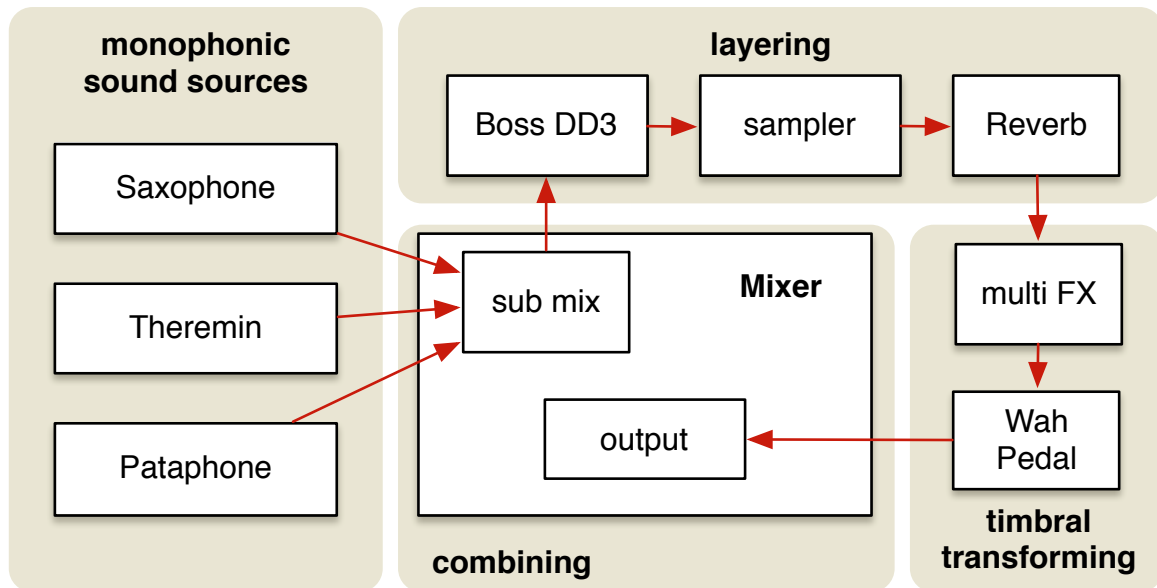


Figure 1: My pre-Sonology performance setup, in the period from ca. 1995 to 2012

In the previous performance setup, the source sounds were transformed with hardware effects – a modified delay stomp box, a reverb and a multi effects pedal – into soundscapes, based on layering of loops. This specific constellation was shaped by certain ‘sound wishes’; sonic results that I attempted to reach led to this constellation of equipment, together with influences and inspiration from a scene of experimental ambient artists who heavily used reverb, delay effects and experimental four-track recording for drone creation. At the same time however, another process was initiated: The equipment that now was part of the objects that I *played* with - its affordances, but even more importantly its limitations - shaped the further development of my performance practice far beyond the possible fulfillment of the ‘sound wish’. Self-imposed constraints, inspiring equipment limitations and rules thus play an important role in my musicianship and instrument development; I will focus on these in a wider sense in the next chapter. In the current chapter, I will first describe the function of my general sound shaping approaches in my performance practice, their inherent limitations and the reasons and methods for breaking out of some of them; then I will outline some issues that stem from being developer of and performer on the Hybrid Instrument at the same time. From this I will continue with some observations that are concerned with the laptop as object on stage.

1.1 Personal Sound Transformation Strategies

When I lecture about the work we have done at STEIM in this field I'm regularly confronted with responses like: 'but that is all very personal'. Fortunately in music a lot is 'personal', but 'the personal' is not an analytically impenetrable romantic chaos of emotions, feelings and ghosts. One can analyse and create distinct relationships between the character changes of a gesture, and the change of musical content - and context - in a way that ones musical intentions are clearly grasped by listeners. (Waisvisz, M., "Gestural Round Table", 1999)

The sound layering and transforming practice came to the foreground when I started performing with the 'Poets from Epibreren' - a group of initially four, later two poets that expressively performed their poetry, which I accompanied instrumentally. As soon as I started playing sounds of saxophone, didgeridoo, flute and Casio VL-Tone keyboard to their poetry, I felt the need to 'broaden' the sound. The wind instruments, especially the saxophone, in my opinion have the characteristics of 'pushing into the foreground' with the attitude of a solo instrument (in the sense of taking the lead) even in cases when that is not the objective. I however wanted my sounds to be a background layer for the words, not distracting, but instead working as a kind of 'carrier wave', on which meaning and sound of the poem could drift. In my opinion, certain characteristics of the saxophone sound are contributing in varying degrees to the effect of distracting from speech: If one strives for variation, the 'natural monophony' (as opposed to extended technique) encourages an emphasis on melody, which easily attracts attention. Another issue is the phrasing that is imposed by the length of human breath (if one is not applying circular breathing, which also has a tendency to arouse attention). And finally, I feel that a timbral similarity to the human voice, if unmodified (and depending on saxophone choice), clashes with speech.

Layering Strategies

Using a modified Boss DD3 (Digital Delay) allowed me to '**stack**' sounds by playing them sequentially, using a delay with a noticeable amount of feedback. To facilitate knob

manipulation while playing saxophone, I put the pedal at waist height, extending the on/off switch with an extra foot pedal for the *Hold* functionality, which allows for freezing the *sound stack*. In one version of this setup, I could additionally sample a maximum of two cycles of the DD3, which freed this device for the building of a new stack.



Figure 2: My modified Boss DD3

The repetitive character, imposed on the sound outcome by the cyclic playback from the DD3's memory, contributed to an *entrancing* effect:

Surprisingly repetition either puts our minds asleep, or heightens our awareness. Cyclism makes us assume we do not need to anticipate change. Put our scanning of the data stream to rest. This is sometimes perceived as a nice state of mind; that has room for 'other' thoughts and observations. (Waisvisz, 2003)

And indeed the characteristic and functionality of this approach in my previous setup was not only the stacking / layering of sounds, but also the cyclic, rhythm- or trance-imposing quality.

A more diffuse type of sound-agglomeration came from a device, which (at least) added a small amount of *room* to the sound (to make up for the small *actual* room acoustics picked up by close miking), but which could also provide a diffuse, sound-preserving ‘endless’ reverb (and the obvious feedback issues).¹ Christensen (2012) writes

Two kinds of auditory perception are simultaneously active in the brain. One provides the basis for spatial discrimination, the other provides the basis for object discrimination. (Christensen, 2012, p. 69)

The effect of a long, pronounced reverb paradoxically exceeds the suggestion of acoustic space. Instead, it ‘de-localizes’ sound object discrimination, ‘melting’ distinct objects together by a shared diffused background layer and allowing for sound layering. This diffused layering is reminiscent of an atmosphere charged with energy; the kind of sounds that constitute this charging are determining the nature (pressing, threatening, enlightening, uplifting) of this transformation.

The resulting structure of looping and reverb in my original setup had an ambient feel to it, which I found matching its purpose - providing a broad, diffuse sound which could act as a ‘carrier wave’ for the stream of words from the poets. This way of working came with obvious limitations:

- erroneous additions to the feedback signal could not be undone
- the sampled material in itself was static; its cyclic nature made it easy to ‘forget’ about this layer, bringing the risk of boredom
- the sampling / delay time was limited
- syncing with existing rhythms (and between the DD3 and the extra sampling stage) was guesswork

¹ One important encounter with sound layering through reverb happened when I played saxophone in the huge concrete structure of a former *bunker*. My reverb addiction might stem from the desire to recreate the acoustic characteristics of that space and the connected experience.

But in a way, these limits were useful for my purposes in that period, as the process was transparent to the listener - the sound provenience was clear, the interface actions were visible and connectable to the sound outcome, and the resulting soundscape didn't attract too much attention from vocal components of the performance. This arrangement also asked for creative solutions to deal with the limitations when the outcome was *not* supposed to be a background layer (for example in solo performances). I will look closer at the useful aspects of constraints in the next chapter.

Unwanted / Static Repetition

Although looping is a permanent element in my setup, I often have tried to avoid the overly apparent machine-like static quality that easily is invoked by simple looping and sampling - for example by limiting the rhythmic qualities of the layered sound material, or by manually morphing the sound. Especially in solo performance situations, I wished for a developing and morphing background texture, which could easily be added to or taken from.

Timbral Transformation

The other general approach to add timbral variation to played or stacked sound meant re-contextualizing sound material by emphasizing / diminishing parts of the spectrum, by distorting and filtering it. This was mostly achieved by using a wah-wah pedal, combined with distortion (part of the multi-effect pedal). The slow morphing of the filtering characteristic that I had in mind had to be done by slow movement of the foot; a balancing act that didn't combine too well with the static theremin playing position.

1.2 Developing While Playing

Developing the Expansion

The impulse to extend my performance setup with DSP and gestural controllers came from the wish to implement a less static looping system for a specific concert / collaboration, where I planned to play theremin (and thus keep the hands close to the

antennae) but still wanted to control sound layering and transformation. I had already worked extensively with Max/MSP - mainly in the field of live visuals - and experimented with and developed DSP patches. Although this method promised solutions for my wishes and issues concerning background layers and sound transformation, attempts to implement computer-based processing into my live performance practice were never structurally successful, as intuitive control of the salient (intangible) parameters was frustrated by the lack of an embodied connection to the general-purpose midi controllers that I used for this purpose. I will extend on these issues in the chapter *Embodiment and the Now*. During a workshop at Steim I created a first prototype of gestural controllers that allowed for wireless parameter change; I combined this with a non-static looping patch that I had developed for a previous experiment. The result of this experiment was twofold: 1) I saw that in principle this setup could work for me, and 2) that it would require much more work to develop a performance practice around it. This was the beginning point and research proposal for the Instruments & Interface study.

Design premises

I had a number of wishes and demands which the computer-based processing system of my performance setup should address; also there were a couple of things that I intuitively knew I *didn't* want (without necessarily knowing why).

- It should be a system suitable for free improvisation
- Both solo and group setting should be facilitated
- It should allow for the construction of layers of sound, but in a less static way than previously
- It should not involve prerecorded sounds; instead using live input
- The system should contain flexible, intuitive control possibilities, including wireless hand controllers

Playable Core

As the objective was to extend my existing setup, and it also had been clear to me that any development I'd do would benefit from early testing in practice (which means on stage and in performance), I decided to develop the extension around a 'playable core' - a bare-bone version of the previous version of the setup, which provided a known base (and thus security and confidence) to operate from in performance, while still allowing me to experiment with the extensions. This facilitated a gradual transformation of my performance practice: implementing and testing elements of the Hybrid Instrument separately, getting to know the new '*phase space*', and developing new transformation- and structure strategies. The new technology that entered the setup - hardware, but especially the endless software possibilities - brought inspiration and opened up new directions to explore and extend my 'sound world' into. But this also brought up the tricky balance-issue of not getting drawn into directions that were incompatible with certain *axioms* that constitute my performance practice (which was not made easier by the fact that I was often just vaguely aware of their exact shape, let alone their purpose).

At the same time, performers and creators using new technologies are not able to escape the force of the object. That is, the instrument itself in many ways acts as a co-active force in the development of a new performance practice by either restraining certain behaviors or urging and encouraging others. (Kaiser, 2013, p. 93)

I will examine the *axioms* and other kinds of self-imposed rules closer in the next chapter.

Different Modes

Being the one who not only *plays* the Hybrid Instrument but also the one who *develops* it makes that there are different tasks to be done at different moments; in a way it could almost be described as developing a split personality. To give it a less dramatic name: I discerned roughly three different *modes*, which partially overlap and inform each other, but which also have to be separated to a certain degree in order to make them work. Two of these modes I encountered in my previous performance practice and musical life: the

performance mode during performances, and the **experimental mode** during tinkering with objects¹ or technology, or experimentation with extended saxophone technique.

There is no question that we try everything in music. It is the nature of music to embrace the from new materials to new rational systems. Musicians are sluts for tech and crazy ideas - almost everything that comes along seems to be incorporated in a musical experiment. (Ryan, 2012b)

In the accelerated and more focussed current development process, a **development mode** also manifested itself, which encompasses a tight feedback loop between imagining a certain function of the software or hardware, implementing / programming / building it, testing and evaluating it. These modes overlap; elements of each can be found to varying degrees in the 'home domain' of the other.

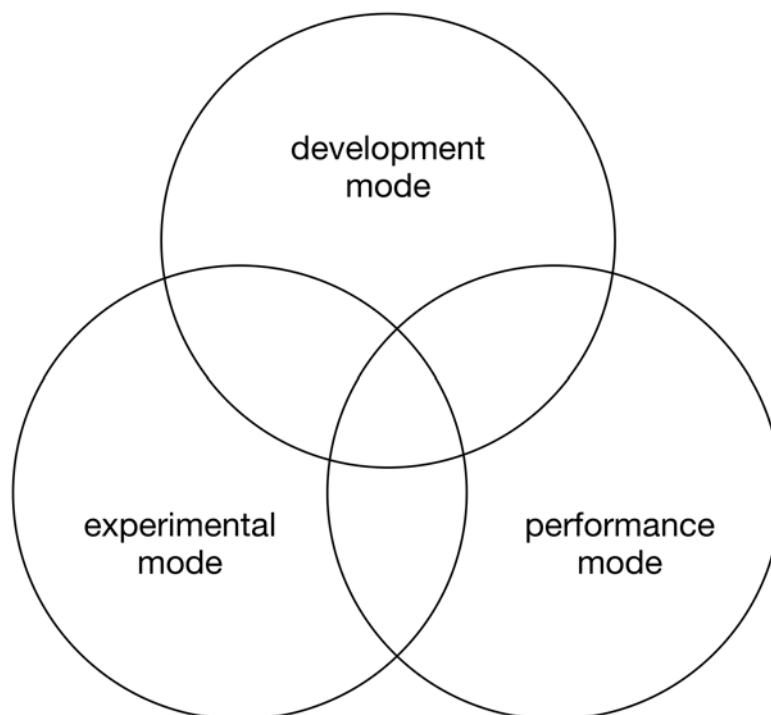


Figure 3: The different modes of the development cycle

1 This is the way the *pataphone* came into existence: Experimenting with plastic tubes of different diameters I originally intended to build a didgeridoo; discovering that they fit into each other, I was happy about the 'sliding didgeridoo' for a brief moment, but then discovered that also the mouthpiece of my baritone saxophone fit to these.

How much these overlapping parts are useful and when they become problematic depends on the setting and the individual situation.

One characteristic that illustrates this switch of modes is the view of ‘concrete’ objects (like instruments, sensors / controllers) and DSP objects (like a sampling- or transformation module):

In **development mode**, objects *represent* something else; it is a question of fixing the mapping, to make them work together in the Hybrid Instrument in the desired way. It is here that the *imagination* of connections between mind/body and the interface/sound engine plays an important role; the possible representation of a value in actual 2D or 3D space, the combinability of parameters into this representation, the interface implementation. It is important to note and keep in mind that these representations are *tools*, not to be confused with the desired *result*:

[...]in computer music you are constantly faced with strong but simplistic representations. You have no other choice than to work with these representations, or devote your time to making instruments, which turn those representations back into something you can play with. (Ryan, 2012b)

One striking realization that appeared in *development mode* is that *the rules by which the world functions do not have to be accepted as given*.¹ In *performance mode*, constraints are a useful and inspiring element (more on that in the next chapter); in *development mode*, each limit is subject to evaluation and reconsideration, which is easily inhibited by habituation and ‘object persistence’². For a grounded evaluation however the experiences of affordances and limitations made in *performance mode* are needed. While performance mode per definition involves full attention, some kind of information-passing is needed. This is an ability that, as I learned, has to be *trained*: a mechanism of

1 In how far this is only limited to the world of a Hybrid Instrument is left to the consideration of the reader.

2 which I define here as ‘things that do the job more or less, so that other things that might do the job better are not considered’.

making a mental note to the developer-part of the split personality, indicating what is wrong and needs to be fixed, or which function would be helpful. The difficulty lies in letting this note-taking not interrupt *performance mode*.¹

In **performance mode** on the other hand objects *are* what they afford; if the real processing takes place somewhere else, through other objects and/or representations, is not important. This process will work only well if in the developer-mode the mapping and other features have been engineered accordingly. One could say that when controller objects are mapped well and thus enable embodied control (more of that in the last chapter), the abstraction collapses at the moment they are used for musical playing, and indeed one is manipulating the sound directly.

All these modes are influenced and driven by playfulness and have elements of the concept of play, as elaborated upon by Huizinga (1938) and Caillois (2001). I will deal more with these in the next chapter.

In the process of the development as it was embedded (or embodied?) in the Institute of Sonology, something like a fourth mode of **theoretical reflection** entered. It became an underlying element which started to connect to the other modes. I don't see it as a full-fledged mode though; it is more a like an additional information channel that establishes bi-directional reflecting and informing between all elements and a growing *database* of theoretical knowledge, enabling more precise reflection due to additional *language*.

Development Stability

Developing the Hybrid instrument means living with an evolving system, which features multiple layers of technology that I have to map into my *musician body knowledge* in order to use it. This makes the process of developing-while-playing an interesting, however not unambiguous process. The activated *development mode* does not mean that the Hybrid Instrument is subject to *constant* evolution and extension. It is indeed an ongoing process, but not regulating this stream of change would put the *developer*-aspect of my triple-split personality into the foreground. I however see the *performer* in

1 Although, as I will mention in a later chapter, also dealing with interruption can be trained.

this position, and the performer profits from relative stability, to support the emerging of an embodiment connection, and develop something like virtuosity.¹ Not seldom do musicians at a certain moment completely stall the further development of their instruments for years, or even permanently:

For my improv performance rig—the setup I use to play in ensembles with acoustic instruments—I have changed neither the software nor the hardware for over ten years. This of course is an eternity in the world of computer technology, and I’ve certainly had ideas about extensions and changes I could make to my instrument. But as time has gone on, I’ve gotten a little stubborn about the idea of keeping it the same, and by now I’ve come to think of it as a long-term experiment: How long can this instrument stay interesting to myself and others? When will I stop finding new things I can do with it? Is it rich enough to be responsive to the development of my own skill and performance practice, without technical tinkering? (Perkis, 2009, p. 161)

Others implement this stability by admitting a gradual evolution, especially *under the hood*, but keeping the main mechanics of performing with it in tact:

The trajectory of “finishing” your Max patch is something you approach on an asymptotic curve - you approach being “done,” but never quite reach it. [...] There’s always something new or something more you can add. It seems as though the difference between patches in this regard is how long you work with something before you decide to make the change. I’ve used the same basic approach to performing and improvising for a number of years now in the patch that I use, but the actual insides of the patch itself are very different with what I started with when I thought my performance patch was “done.” It changed in tiny increments very slowly over a long period of time – I’d make a change, go do a few gigs or some recordings with it, and slowly decide whether my great improvement really was great or really was an improvement. (Taylor, 2011)

1 An interesting and controversial term, which I will examine closer (but not in depth) in chapter 3.2

Another approach of regulating the change / stability equilibrium is to establish periods of *instrument stability* between major *tech development* moments, as stressed by Michel Waisvisz:

About my own experiences with gestural controllers I can only say that I fight with them most of the time. That's something that almost every instrumentalist will tell. But if you are in the position to be able to design and build your own instruments, and so many interesting technologies pop up almost weekly, you are tempted to change/improve your instrument all the time. This adds another conflict: you never get to master your instrument perfectly even though the instrument gets better (?) all the time. The only solution that worked for me is to freeze tech development for a period of sometimes nearly two years, and then exclusively compose, perform and explore/exploit its limits. (Waisvisz, M., "Gestural Round Table", 1999)

I can't report about the experience of freezing development for two years, but clustering bigger changes in the setup together, with larger periods of only minor tweaks and focus on performing (a blend of Gregory Taylor's and Michel Waisvisz's approach, so to say) helps to keep the emerging Hybrid Instrument playable (as described in the *playable core*), and to build up the embodied knowledge of how to perform with it.

Exploring and exploiting limits as part of mastering the instrument, as mentioned by Michel Waisvisz, will be handled in chapter two.

1.3 Performer and Computer on Stage

In this sub-chapter I will describe some observations that I made regarding the transformations that occurred by bringing in a laptop on stage as part of the Hybrid Instrument. Two distinctive features of such a machine are that it's a multi-purpose device, which could be doing (almost) anything without showing the processes that are being executed on the outside, and that it has a screen, which *might* show some indication about these processes to the performer, but often this information is not visible to the audience.

Laptop, Focus

The computer (in the shape of my laptop) fulfills an important role in the Hybrid Instrument; it houses the new *core*, the layering- and sampling engine (described in more detail at the end of the next chapter). But next to this, the laptop is also an *object*- and not a 'neutral' one, but one that brings along many associations, expectations and (pre-)classifications: Terms like 'laptop musician' come to mind. The question might come up how important it is to have this object visibly on stage; how its visible presence might support the performance. I'm generally in favor of transparency of the applied technology, but I'm tempted to say: not at all, as long as the employed interface objects work as intuitive and tangible objects that can also function as 'personification' or *representation* of the connected internal processes for both me and the audience.

Even though I might in the future phase the laptop gradually out of the 'image', for example by using a 'headless' setup¹, for the moment it is there. Including the screen, which I initially needed to understand and control the processes, until I transferred most of the control- and state checking elements to the Mira interface on the iPad. Here's an example on how the visible presence of the laptop influences audience *reading* of the performance actions: In the feedback of a concert, I received comments about a perceivable mode change when I focussed on the screen of the laptop for a moment. Questions like '*was there something wrong with the patch?*' indicated that apparently I had performed an action that rose questions about their purpose. At that particular moment, nothing was wrong with the patch; I had just checked the state of the engine, checked if a certain sample was indeed recorded, and at what position in the buffer. My previous action, playing the saxophone or theremin, was easily understood by the audience - the object was, in case of the saxophone, in my hands, or in case of the theremin, another kind of relationship between hands and theremin existed, but was understandable for the audience. I had to look into a different direction than before, as I had positioned the laptop on my right hand side, out of the line between me and the audience. But the aim of my look on the computer screen was not evident to the audience; the interface not visible for them. I will research this sub-mode perception of

1 a computer without a screen, or a not prominently placed laptop with an almost closed screen

the audience in chapter three.

Richard Barrett noted (Barrett, Personal communication, January 17, 2014) that he doesn't like the idea that the performer sees things that the audience can't see, as that forms a visual barrier between them. Also, the fact that audience members try to get a peek of the computer screen after the show indicates that they have been wondering about what's on there during the performance, instead of focussing on what they're hearing and seeing. This altered, (normally) undesired focus is described by Denis Smalley as 'technological listening':

Technological listening occurs when a listener 'perceives' the technology or technique behind the music rather than the music itself, perhaps to such an extent that true musical meaning is blocked. Many methods and devices easily impose their own spectromorphological character and cliché's on the music. Ideally the technology should be transparent [...]

(Smalley, 1997, p. 109)

Also technology transparency will be treated more in chapter three.

From my personal experience as an audience member, witnessing a performance where the actions of the musician takes primarily place on a computer whose screen is not visible to the audience, but on which the performer intently focusses, I sometimes experience a feeling of unfairness - reminiscent of experiences as a child where somebody would not allow me to participate in a game he or she was playing. Not knowing what the performer does, what the 'rules of the game' are, the ingredients and manipulations. It might be related to a certain empathy that I associate with attending a performance, and which in this case is impeded: feeling the risks of free improvisation, enjoying the production of powerful sound etc. from an imagined viewpoint within the performer is something that (possibly unconsciously) adds to the appreciation of a live performance. But for this to happen, one must have an impression of what is actually going on - otherwise, that *game* is not understood.

Likewise, there is nothing of real interest on my computer screen. It's not necessary. Does a piano have a display? Another gripe I have with much laptop music is that the musicians are off in their own world, mesmerized by a sophisticated environment of GUI [...] plus mouse and taken out of the shared acoustic space the rest of us in the room are inhabiting. That's fine for certain styles of preplanned and slowly changing music, but when trying to keep up with acoustic players, I want to live in the same aural-plus-kinesthetic world that they are in and not be off in the textual/visual world of the current standard GUI interface. (Perkis, 2009, p. 162)

Poetic Control Gestures

When a system enables gestural control or other interface-empowered influence of the transformation processes, the degree of this influence can't always be clear to the audience. They can only make educated guesses about the connection between the control gestures / actions of the improviser on the one side and the sound outcome on the other. There is a big range of possible transparency of this connection, from totally unrelated to totally obvious. Some examples:

Action	Sound result	Relation
no perceivable action	active, varied	unrelated
transformation-like movement	sound transformation	connected
gong-hitting gesture	gong sound	obvious

The full transparency of an obvious relation is mostly neither possible nor necessary; it can easily impose the character of a demonstration or an educational atmosphere on the performance, which might impede musical listening and instead provoke a technical listening mode. A totally unrelated connection also raises question about the control gesture. So a discernible connection between action and change is supportive to the appreciation of the actual processes that the performer undertakes, but might not have to be easily *decipherable*. Different strategies exist to allow the audience to relate to a

non-trivial relation; for example, a connection between control interface and effect can be introduced in a relatively obvious way, and then be used in more complex constellations. The audience will have at least an entry into the context. A sense of meaningfulness is established; functional control metaphors can free the audience from the (perceived) need of fully understanding the technical backend. In that sense, I believe a control interface can be *poetic*.

Theatrical Element

Performative interaction however also can *imply* transformative power without actually *being* empowered, or only within narrow limits. This could be due to theatrical gestures, or performers that are ‘carried away’ in the moment of (limited) embodied control. This discrepancy becomes most striking when the gestural action (maybe through its expressive or rich nature) suggests total improvisational power over the system, controlling all its essential parameters in one giant fusion of the performers mind, the transformative system and the musical content, while in reality, the influence of the gestural input is limited to a single element of a preset (and thus determined independently from the gestural control). A variant of this situation is where the gestural influence is similarly limited, but has at least the power to change the preset, so the implications of the gestural actions have changing meaning, depending on the current state.

This type of performative element (which does not have its *raison d’être* in required musical actions) might help the audience to connect to the performance; I myself however strive for a presence on stage which I allow be expressive, but which should be guided and driven by musical necessity.

Unified Instrument?

During the first phases of development, the agglomerated technology (hand controllers, XBee receiver, iPad, Leap Motion, foot pedals etc) seemed to me an absurd collection of objects to haul around, and even stranger to set it up for a performance. The new elements clearly didn’t feel as natural parts of the system. Only at the moment of performance, (most of) the objects suddenly made sense, their function ‘fell into place’.

After a couple of iterations of this process, most things lost their alienness and had proven their place in the setup (and others phased out); the *unified-system*-perception was restored. As I interact with these components, I don't think of them as separate objects. And, more noteworthy, when performing with the system and in performance mode, I don't think of *them* and *me* as structurally separate entities; when everything is working correctly and mapped well, it feels just like an additional, but natural capability of my hand to change the volume of a sound by a certain orientation change.¹ The ability to affect the performance system just by mental power, by imagining a certain change is tempting. A similar wish had initially driven me to join the STEIM *Instrument Lab* workshop: to manipulate effect parameters without lifting the hands off the theremin antenna. This *combined identity* of the Hybrid Instrument is not permanent. At the moment that I stop performing, that I disconnect the first cable, the parts fall back into their separate object identity again, and I might engage with them in different ways. The laptop is something that I should use to reply to my email, the hand controllers are again the prototypes that I should charge the battery of, the saxophone I could use to practice some scales. I will extend on this idea of unified system in the sub-chapter 'Cartesian Split Symmetry' of chapter three.

1 Almost like a super power; mental control of the outside world. Maybe less impressive than telekinesis, but much more practical than that during musical performance.

1.4 The Transformed Hybrid Instrument

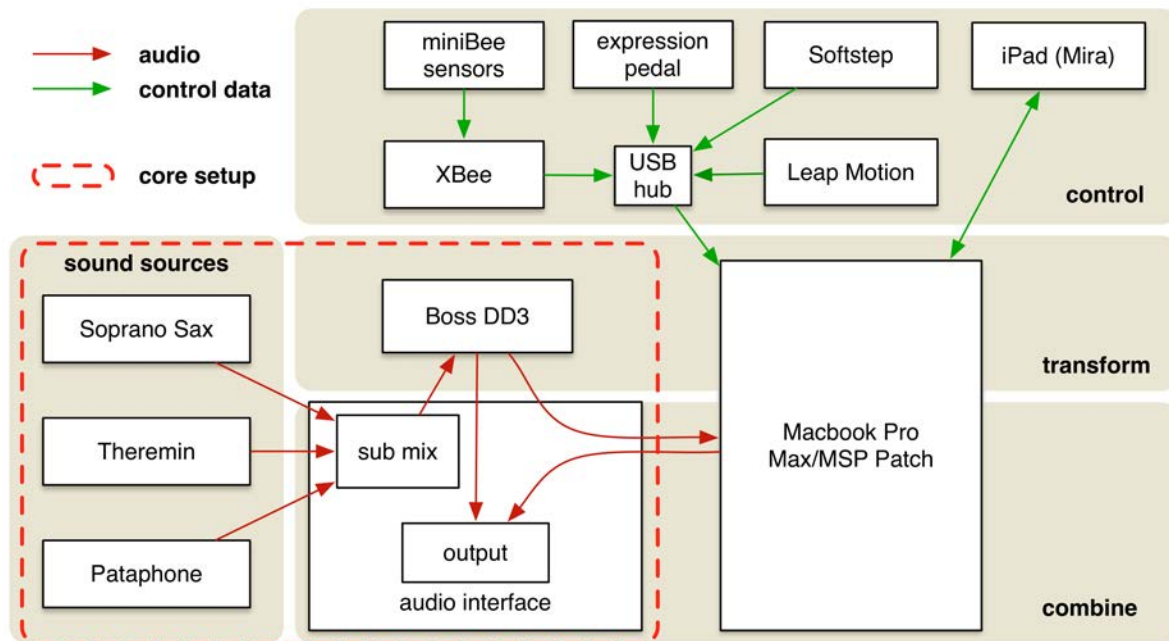


Figure 4: Schematic of the new, extended Hybrid Instrument

The ‘reptilian brain’ of my performance system, the DD3 stomp box, is still present in the current Hybrid Instrument, enabling me to rely on my experience and practice built around it. Maintaining this ‘playable core’ during development allowed for gradual and natural emergence of the changes while exposing the experiments to practice, and at the same time provided a ‘safety net’ that let me continue sound and tension in the case of a mid-performance computer problem.

The big change is of course the addition of the laptop running a Max/MSP patch which contains the **DSP engine** and a **mapping engine** that connects it to a multi-layered interface, which in turn involves the iPad (running Mira, a ‘window’ into the Max patch), wireless hand controllers, foot buttons and an assignable foot controller.



Figure 5: The performance setup at STEIM Studio 3

The layering- and transformation system I will describe at the end of chapter 2, and the multi-layered interface at the end of chapter 3.

Chapter 2: Improvisation, Constraints and Predictability

At the uninterrogated core of common notions of interactivity as it is practiced in the digital domain, we find the primordial human practice of improvisation. (Lewis, 2009, p. 458)

The main application I had in mind for the Hybrid Instrument is free improvisation - both in solo- and group settings. This is partly because in these situations I felt the most pronounced need for the extension of my instrumental possibilities, but also because in improvisation context, any shortcomings in terms of speedy intuitive control, wide expression range and 'coherence' will show clearly. The term 'free' easily invokes a wide array of associations and expectations, especially in the realm of improvisation. Diving deep into the historic context lies outside the scope of this thesis, but it is useful to narrow down my use of the term to what is relevant here. 'Free' is a vague term, because it seems to imply the absence of any constraint, which often can not be the case for practical reasons, but which often also is not *meant* to be implied. Instead it is intended to describe a *relative* freedom, an absence of *certain* constraints or structures - or a sort of *playground* which affords freedom by *defining* certain constraints.

Constraints in the shape of pre-conceived knowledge and structures inhibit our instruments, the hands that use them, and the mind. Be it years of instrumental practice (major scales, embouchure), once studied bebop licks, an internalized melody - all are part of the combined system of performer and instrument, all have influence on our internal source of actions that we might perform in a certain situation - whether we are conscious of them or not. Unconscious muscle memory, trained responses and limitation based on *lack* of training, perception, conscious ideas, strategies, doubts, focus and distraction are influencing the performer, and together with a complex set of affordances and limitations on the side of the instrument, any action is dynamically 'negotiated' between all these forces (later in this chapter I will look closer at this and other

important features of constraints). Musical performance that incorporates improvisation can embed this relative freedom in many ways; depending on conventions, traditions, compositions, strategies that the performers accept and apply as a basis for their actions.

These general approaches to improvisation can be discerned:

1. Improvising within Structure

A pre-conceived structure underlies the improvisation. A chord progression is more or less maintained during the period of the improvisation; also the rhythm mostly remains defined (although it may vary in terms of double time etc). Within this frame, the improviser is free to play any tones in the context of the given harmonic and rhythmical space - material from *inside* this space, embellishing it, or from *outside*, bending or extending it - but not breaking it.

On this background of predictable regularity, the soloist moves freely in melodic phrases of inventive variability. (Christensen, 2012, p. 105)

2. Improvising the Structure

No pre-conceived structure exists, or such a structure has been 'let loose'. Any material that is put within current musical context is improvised, and also the emergent musical structure is subject of improvisation and constant change and renegotiation.

These approaches often are mixed up, and frequently also combined with compositional elements or looser structural agreements. The range that is defined by these approaches could be described as providing varying degrees of certainty about what will come up in the proceedings of the improvisation, and allowing for varyingly confident anticipation: In a well-known chord structure with a defined and clearly indicated tempo, a certain pattern of filling in the possibilities with actual tones applies; in a setting where a number of musicians meet on stage for the first time and play without any pre-discussed structure (except for maybe a rough indication of duration), possibly on instruments which are not conceived with defined pitch and / or tempo in mind, other processes and conventions, actions and reactions will occur, with a different system of certainties and

anticipations. Nevertheless, even in a setting as free as the above described, reactions take place based on musical decisions and personal background, chosen instrument (or instrument building choices) and current performance intentions, bringing the freedom again into context and constraints. It is this kind of free improvisation that I find interesting and challenging as a play-field for my Hybrid Instrument. The challenges arise out of the minimal certainty that is provided; the anticipation span can be extremely short, as any structure that one might rely on to contribute a certain sound might fall away without a warning, asking for a musical reaction that leaves no time for any intricate system configuration.

As a consequence, the functioning of an instrument for ones personal performance practice can be judged by the degree and speed that this instrument allows to create output in satisfaction to ones musical response wishes. Now of course is the question what these 'musical response wishes' are: How does one know the possible range, and how does one decide to attempt to invoke a certain musical output? How does one prepare for this field of possibilities - as practitioner of a certain instrument, and (if one creates ones own instrument) in making the design decisions, in shaping the affordances and limitations? In my opinion, the reaction speed and intuitiveness are key elements in this process, due to the short available anticipation span. In the creation of a Hybrid Instrument, the complex interplay of numerous parameters and interface connections sets out a huge field of affordances.

One way to define instrumental virtuosity would be to say that it is the ability to instantly access any technique, sound, note, fingering, or timbre available on one's instrument. It is the facility to move between loud and soft, high and low, noisy and clear, rich and thin sounds - at will and at any moment.

(Pluta, 2012, p. 3)

Traversing this field in *no time* to an imagined constellation can not happen fast enough if conscious thought has to be invoked for low-level value manipulation; one has to make use of shortcuts. There are many kinds of *shortcuts* available, so it comes down to the fact that one has to decide what kind is appropriate for different situations in ones

personal performance practice. Before the *Instruments and Interfaces* study I had not consciously thought about this problem. Instead, I had made decisions about what is appropriate and what not based on intuition, on self-imposed rules (of which I didn't know the origin and purpose) and on vague assumptions. Which can be a viable methodology. In the current development process of extending the Hybrid Instrument however I attempted to consider and implement these rules more consciously, which gave conceptualization a bigger role:

Where Bailey finds “I just play, man” as the best answer, I find the feedback relationship between conceptualization and practice fascinating. (Kaiser, 2013, p. 14)

To gain insight into my internal set of self-imposed rules or *axioms*, I attempted to reflect on the actions that I normally perform on stage, *why* I do certain things and think of other things as ‘*not done*’ within the rules of my sound world. Generally speaking, I consider the **creation, combination and transformation of sounds** a structural part of my creative process on stage. Generating source sounds and joining them in certain ways, applying transformations to highlight or change certain features and in this process contextualizing and re-contextualizing other musical elements constitutes my performance practice, much more than for example the playing of melodic lines. Therefore I came to the conclusion that using pre-created and pre-transformed sounds would defeat the purpose. The simplicity of the input ingredients, combined with a manually or actively influenced transformation process makes this intriguing to me (more on the creative use of constraints later in this chapter), and poses the fascinating challenge that is essential to the *flow* experience.

Coming back to the before-mentioned shortcuts in the context of free improvisation: I would consider it illicit for my practice to implement a preset into my sound transformation engine which on the switch of a button would produce a guaranteed interesting and rich result, no matter what the sound input or interaction gesture. This would render those actions that I consider essential to the shaping of my sound output unnecessary; I could recline to changing presets every now and then and employing

some expressive, theatrical (but essentially un-influential) gestures in the meantime. But, considering the expectations that I attribute to the context and my actions, I would feel a *cheat* (to use a term borrowed from Huizinga). Of course (and luckily) there are other places in my setup where I allow myself the implementation of presets; even the enabling / disabling of certain transformation process can be seen as employing presets and does not feel like cheating.¹ Generally, it is the lower level functionality (like enabling an *octaver* effect within my playback engine) that I find this acceptable in, and the *combination* of a multitude of these settings that I find problematic - at least, if the preset is a way to provide ease and predictability while it reduces risk.

But to return to the before-mentioned need for speed: The *shortcuts* that I find most helpful to circumvent the too-long processing time of conscious thought are based on built-in functionality of the human. By designing interface objects in a way that enables *intuitive* control over parameters; by *bundling* parameters in meaningful multi-dimensional fields, and connecting these fields to embodied capacities, one can invoke a broad interface connection between the human and the non-human part of this emerging combined system. I will go into more depth of embodiment and the natural *cyborg* within humans, parameter mapping and bundling in the next chapter. In this chapter, I will first focus on some elements of the above mentioned concepts: Improvisation (with computers), constraints, predictability, risk and variety.

2.1 Improvisation plus Computer

I see free improvisation as a moment in space and time where the participating musicians create a kind of *tabula rasa* for the brain; impeding thoughts and processes are (or should be) banned, so that every creative spark (or *improvisational impulse*) gets the chance to be seen and acted upon - by the performer him/her self, and the other participants . If there's too much distracting neural fireworks, the one spark that is relevant for the improvisation situation might not be seen. Reminiscent to a *cloud*

1 Of course this is based strictly on my personal performance practice. Others might focus more on *placing* sounds, where the source of the source sounds is of secondary importance (or, in the case of striking samples, of a different nature).

chamber, where passing energetic particles are made visible by setting up a sealed environment with supersaturated vapor (“Cloud Chamber”, n.d.), the improviser catches and materializes improvisational impulses into actions. In a way many ‘doors of perception’ are opened up; actions and reactions are encouraged to happen and to be sensed, which demands a special kind of attention. Not only auditory content and cues are important, but the whole presence of the performer. Improvisation is embodied creation, engaging multi-dimensional communication.

This can be distorted in varying degrees from slightly to heavily by distractions from outside the tension field that has been set up (the performance space, the audience, the instruments, the silence); I will extend on this in the third chapter.

When improvising, I react on the surrounding sound world by a number of trigger-reaction mechanisms. These are not one-on-one connections, but form an interconnected ‘vector field’ of forces that may support or contradict each other. For example, sonic emptiness may be perceived as void which might ask for being filled; on the other hand, the wish to create tension (or to oppose a previous, more busy period) may nullify or weaken this ‘vector’ (or might be nullified by it). Here I see a similarity to cycling through masses of people; see spaces, estimate speeds, predict openings and obstacles; sense the density.

Falling off a Bicycle

Programming decisions can be seen as constraints that have so much influence on the methods of playing with and the outcome of the instrument that they can be considered compositional decisions (Barrett, Personal communication, January 17, 2014). Also in improvisation decisions are made, but in my opinion it is a different process - one that eliminates the feedback loop of reconsideration regarding decisions that have been made. In free improvisation, any decision made has to be considered a given fact, as the actions following these decisions (mostly should) appear instantaneous. In that sense, it reminds me to the process of falling off a bicycle: Once the cyclist’s center of gravity is shifted over a certain point, there is no action to be undertaken that could reverse this process - acceptance of the fact of falling is the only option, and relying on embodied

reactions like bracing. The same goes for the reaction on events encountered in improvisation. Impulses (sonic events in the case of musical improvisation) from oneself and others have to be accepted and reacted to in a speed that often is out of the range of conscious decisions, and there is no possibility to discuss them or negotiate the outcome. At this low level of action (making / changing sounds, playing a note, shutting up) doubting and consciously considering multiple options (and their consequences) is not at its place. This doesn't mean that the consciousness doesn't have its role - quite to the contrary. It is actively present, observing the stream of actions and reactions, and judges it from a meta position, processing the incoming audio, combining it with higher-level concepts, wishes and concerns, and may reconfigure, disengage or intensify the constant flow of improvised action/reaction. Of course, this separation between conscious and unconscious mind is a vague abstraction and will be examined further (and reconsidered) in the third chapter.

Foreground, Background, Following, Leading

The beginnings of the development of my Hybrid Instrument lay in the wish to create a background layer for content provided by others; initially poets. In solo performances, I myself took this role of the other, playing melodies on top of the background layer that the electronic elements of my setup provided. It is impossible to draw a clear line between which sound is part of the background and what of the foreground; naturally, these two layers combine and form a synergetic third. But still, layers can be discerned: sounds that have been stacked / sampled, and sounds that are played 'on top' of this other layer (without directly contributing to that). So one could call the more static, sampled layer the *background*, and any more pronounced instrumental addition the *foreground*: it attracts more attention because it contains changing elements, whereas the cyclic and diffuse character of the other layer has the tendency to recede out of consciousness of performer and listener. There are two viewpoints from which to investigate this foreground/background issue further. One is to explore the roles of separate elements within my Hybrid Instrument, possibly also including my actions, and the other looking at the position that me playing my instrument might take in a group setting. Culturally seen, it is often the contributor of the musical foreground that receives

most attention (soloist in a big band, lead singer), while the background-providers have a supportive role (which of course can be musically equally or even more important than the lead).

At the same time, the standard goal of most any improviser is the ability to switch roles between leader and follower, guiding the improvisation at points and following a leader at others. Historically, however, the tendency of the laptop performer has always been to play the role of the follower. This is primarily due to the temporal relationship the laptop has with the real world. (Pluta, 2012, p. 25)

In the extended performance practice with the Hybrid Instrument, I discovered that the DSP-part *emancipated* itself from the background layer. It afforded a new richness in layering- and transformation possibilities that allowed me to explore whole new parts of an extended *sound universe*, and were on the other side asking for a musical development (developing strategies to play the electronic layer in the *foreground*) and the limitation of this endlessness, in order not to get lost. Which lets me consider issues of *affordances* and *constraints*.

2.2 Constraints (and Affordances)

In this sub-chapter I will talk about diverse types of limitations and constraints - inherent in object or action, self-imposed or cultural - that are essential for the designing or playing of the hybrid instrument.

Creativity arises out of the tension between spontaneity and limitations, the latter (like the river banks) forcing the spontaneity into the various forms which are essential to the work of art or poem. (May, 1975, p. 137)

Constraints

The development of the hybrid instrument doesn't stop with simply feeding sound input to the computer and enjoying its infinite DSP possibilities. The promises will never be concretized into musically usable processes if the designer of the program doesn't make

decisions - and these limit the (theoretical) endlessness into actual affordances of the processing system. With each new element that is included into the hybrid instrument, it has to be 'domesticated' to be useful.

Employing limits and constraints to develop a system that is supposed to facilitate performance freedom, possibly even be used in free improvisation, might seem counter-intuitive. But next to the above-described concretization - or better, realization of possibilities, they appear in many shapes in the creative process and the development of the hybrid instrument, fulfilling many functions.

Performance Axioms

An example is my 'axiom' of not using pre-produced sounds, of using only input that has been generated in the performance.

Instrument Limitations: General

One limitation in my original setup was the minimal control over the delayed / looped / layered sound content accumulated in the DD3 delay. When a sound is sampled or added to the delay line, it isn't possible to get rid of it without losing the rest of the looped material. For a long period this sufficed as a creativity-supporting limitation; dealing with workarounds and solutions to unexpectedly sampled content provided a variety of improvisational impulses and also shaped the possible 'sound world' by providing technical boundaries.

Instrument Limitations: Physical

The pataphone is an example of a physically quite limited instrument; its (non-overblown) playable range is about half an octave - other tones have to be reached by using harmonics (which the saxophone mouthpiece affords, including multiphonics). But even this half octave can not be played rapidly. As the tone hole of the pataphone rests in front of the microphone, the whole upper body is included in this sliding movement.

Also, the *availability* of the traditional instruments means choice of *input sounds*. Although I consider as beneficial to have a broad selection available (soprano saxophone, tenor saxophone, bass clarinet, theremin, pataphone, flute are my 'main choices'), this

might be problematic. As Richard Barrett remarked (personal communication), visible instruments on stage are like *Chekhov's gun* ("Chekhov's gun", n.d.) and create expectations:

Remove everything that has no relevance to the story. If you say in the first chapter that there is a rifle hanging on the wall, in the second or third chapter it absolutely must go off. If it's not going to be fired, it shouldn't be hanging there. (Anton Chekhov)

Having *less* options creates a challenge and limitations of the possibilities, but these can also be used creatively.

Instrument Limitations: Software

Here, the *compositional decisions* (as mentioned above) come into play: which of the endless possibilities of DSP are essential, which are distracting? What is the *sound wish*, what are the possible methods of implementation? Software objects are easier exchangeable than hardware parts; they can morph and be reconfigured on the fly. In order to create an embodied, intuitive understanding of the sound engine, they have to be *decided upon*. This is part of the (commonly quite limit-inducing) process of *programming* - which, thanks to the architecture of programming environments like Max/MSP, can still allow for flexibility.

Interface Mapping

This is an essential part of developing computer-based (or DSP-including) instruments. Without any connection to the processes of the sound engine, no influence can be taken by the *instrumentalist*, the one that plays the instrument. But as important as the *existence* is the *character* of this mapping. The affordances and constraints of the instrument are *implemented* by this mapping; gestures are translated to parameter change. This can happen on a 'one control element to one parameter' basis, or by bundling parameters and controlling them more indirectly through higher-level gestures, or even (in a higher level of abstraction) by tying them to AI processes which in turn are also mapped to a control layer. The design decisions within this huge field of possibilities defines the instrument and how it can be interacted with; I will have a closer look at this in the sub-chapter 'Building (for) Embodiment' in chapter three.

Trained embodied responses

As will be explained more in chapter three, certain responses of our mind / body can be *trained* - we can even train certain behavior without being conscious about it, by following habits and unconsidered self-limitations. But much training implies a conscious effort. For example, having learned a C-major scale on the saxophone is something that still haunts me. De-programming through counter-training is a way to deal with these limitations (learning *bebop licks*); becoming conscious and focus attention can be another method; especially fruitful in combination of knowing alternatives.

Musical, temporal structure

In free group improvisation, cue systems or a pre-defined playing order might be used as a constraint that enables freedom. This is useful, as an auto-emerging structure¹ is difficult to establish with many active agents.² In small groups, sources of improvisational impulses are easily assessable, and musical development (suggestions, changes of energy input by other musicians etc) are easier recognizable.

Performance Constraints

A social flavor of constraints is that of limitations related to conventions of performance:

Performances are not only shaped by the performer's plans; they must also conform to external constraints, for example, those imposed by the work of which it is a performance. Thus a performer must intentionally play a certain work under certain acknowledged constraints. These work-centred constraints are expressed in conventions adopted by performers. These conventions encapsulate what a given performing tradition holds to be especially important in respecting a work's proper nature (Godlovitch, 1998, p. 32)

This is also true in the context of free improvisation, where there technically is not a pre-set *work* - instead, the work emerges, but nevertheless under the conventions accepted

1 a structure that *emerges* seemingly out of itself, without pre-conditioning

2 those who have agency

by the participating musicians. An example for location-based performance constraints can be found in the Oorsprong Curators Series¹, a regular evening of free improvisation sessions in Amsterdam. The curated sets (3 per evening) consist of performers who (preferably) never played together before, and who have not yet played in the running series - in order to keep the encounters fresh and surprising, and to prevent forming of habits and 'clusters' of musicians. Participating musicians accept these constraints, and don't for example spontaneously jump on stage to participate in the set of their colleagues, which might happen under different performance constraints.

Obstruction: Self-imposed Constraints outside of Logic

Illogical decisions - decisions that can not be explained or understood based on logical reasoning - can be valid methods to create limitations that paradoxically provide freedom. This mechanism is explored in many surrealist and pataphysical techniques, as for example the Oulipo:² *'What characterizes the Oulipian approach is constraint'* (Hugill, 2012, p. 106).

Therein lies their success: the delivery of an elegant, witty, and sophisticated text while behind the scenes, as the reader may or may not perceive, a monumental struggle with the exigencies of a self-imposed set of rules is taking place. In some cases, this tension between aesthetic surface and compositional reality may produce art that is genuinely sublime. (Hugill, 2012, p. 106)

Making musical use of these impulses is not possible to do in a one-on-one translation. According to Boehme (2014), *'music can not be solved in a surrealistic way, as it is already*

1 <http://oorsprong.wordpress.com>

2 French group, founded 1960 by Raymond Queneau, François Lionnais, and others. Oulipo - or, more correctly, OuLiPo - is short for *Ouvroir de la Littérature Potentielle*. (Hugill, 2012, p. 58) Self-definition 1: "Oulipo: group which proposes to examine in what manner and by what means, given a scientific theory ultimately concerning language (therefore anthropology), one can introduce aesthetic pleasure (affectivity and fancy) therein". Self-Definition 2: "Oulipians: rats who must build the labyrinth from which they propose to escape." (Hugill, 2012, p. 107)

a highly abstracted art whose relation with the outer world is indirect'. What is possible however is to take the outcome of a system that produces surrealistic musical suggestions and incorporate it in an embodied way, through musical and esthetic decisions made by the musician. I will explore the musical decision making process between computer and human a bit more in the sub-chapter *Cyborg*.

Affordances

An affordance is '*a property of the environment that affords action to appropriately equipped organisms*' (Dourish, 2004, p. 117) - in the context of the Hybrid Instrument, the affordances spring from the physical objects that are part of it (including their constraints), the performer (and the employed or built-in limitations) - and the context of the performer *playing* the instrument.

In other words, an affordance is a three-way relationship between the environment, the organism, and an activity. This three-way relationship is at the heart of ecological psychology, and the challenge of ecological psychology lies in just how it is centered on the notion of an organism acting in an environment: being in the world. (Dourish, 2004, p. 118)

The affordances thus are the options that are available, that can be experimentally explored or consciously *navigated to* in the above-mentioned *field of affordances* - which in turn depends on the limitations and constraints to be set in order to be defined. Only engaging with limitations in a real-life setting lets one creatively explore and exploit the emerging affordances.

Play

All involved *modes* that I mentioned in chapter 1 have in common that they're driven by the desire to play; they all make use of *playfulness* and should embrace and facilitate it. Next to the benefits like for example discovering new, fresh combinations of known elements, other useful mechanics and concepts can be associated with the notion of *play*. As we have seen, the creative process needs constraints to allow for freedom. This is closely related to the notion of *rules* in the description of play by Huizinga (1938) and Caillois (2001):

The confused and intricate laws of ordinary life are replaced, in this fixed space and for this given time, by precise, arbitrary, unexceptionable rules that must be accepted as such and that govern the correct playing of the game. (Caillois, 2001, p. 7)

Free improvisation has a tolerant attitude towards *bending* rules; it *plays* with them (in the sense of breaking conventions), which might relate to the *cheat*: “If the cheat violates the rules, he at least pretends to respect them.” (Caillois, 2001). This however is different from *cheating* against self-imposed rules for other than musical reasons - for example, as a method to provide security. I will deal with these issues in the next two sub-chapters.

2.3 On Predictability and Structure

Even though it may seem counterintuitive in a culture so focussed on finding new connections as improvisation, predictability in itself is not a bad thing; to a certain degree it inheres the *instrumentness* of the chosen instrument: a trumpet solo will have some predictable trumpet traits. The sound output of the Hybrid Instrument in a number of performances has been described as *recognizable*. Even though it is developed with free improvisation in mind, it can’t produce every possible sound. Does this apparent limitation indicate design flaws, or shortcomings of performance skills? Although the Hybrid Instrument is flexible - consisting of multiple parts that add a huge amount of affordances to the whole - it still is an instrument; design decisions have been made that limit the possible layering and transforming, so to a certain degree the outcome could indeed be considered *predictable*. Another view could be to say it has a *personality* (Ryan, personal communication, May 2014): It is recognizable throughout different phases of development; it has the potential to establish *familiarity* with it; but still the possibility of variation and surprise - of emergent *behavior* - remain.

Re-usable Musical Elements

Musicians develop tricks, strategies that they know will work in certain situations. This is the case for bebop as well as for free improvisation; for acoustic instruments as well as

electronic. In that case, strategies can also be saved or preserved as *preset*, which I discuss at another point. Using such a trick brings a certain amount of predictability to the musician: having used a certain method before allows for educated guess of the effects of repeating it. In my opinion, this is fully compatible with free improvisation as long as it is a decision made for musical reasons (and not for easy effect). For example I have witnessed musician Anne La Berge producing a certain sound in different performances. Using a flute that is transformed by a certain preset of her Kyma system, she produces sharp impulses of air that create the sound with bassdrum-like qualities. Never have I thought ‘ah, it’s that effect again’, as the placing of this effect and the impulses was based purely on musical reasons; it made absolute sense at that point of the improvisation¹. So a ‘trick’ like this might simply have the function of a certain musical instrument, like indeed a bass drum, or any special-use percussion item, and using a preset to quickly call up this configuration totally makes sense.

Another example of a strategy is the setting of an initial *sonic base layer* to let the further performance emerge from. I discovered that often I start a free improvised solo performance with playing long pataphone tones, as an almost ritualistic way to invoke the coming of other sounds, sound-wishes, associations and ideas. It gives also a feeling of reassurance; in the endless possibilities of free improvisation; getting me over the difficulty to choose an initial starting tone. After that has been played, the rest emerges almost by itself..

Complexity

In the design premises of my Hybrid Instrument, I originally included that it *should allow for the creation of complex texture layers*. This was a reaction on the staticity of my previous performance system. Since then, the layering- and transformation engine has ‘emancipated’ itself from merely providing a background layer². I also realized that I see

1 The cue for this action might have come from a semi-automated improvisation-guiding system, the *Shackle system*. But musical - human - decisions govern the automated suggestions of this system, and they are executed through musical interpretation. <http://shackle.eu/the-shackle-system/>

2 as described in sub-chapter 2.1

complexity not as a goal in itself;¹ instead, I focussed on its function within my performance practice. I expected from my system that it should show emergent behavior, which means it should offer a surprise element (unpredictability in varying degrees, as opposed to staticity), which could be musically used as improvisational impulse.

Regarding the *complex texture layers*, I find important that my layering- and transformation system affords what Erik Christensen describes as *micromodulation*:

Complex and irregular forms of micromodulation are fluctuation, shimmering and distortion and the noise-like timbral qualities produced by special ways of playing such as the *collegno* and *sul ponticello* effects of stringed instruments. (Christensen, 2012)

According to Christensen (2012), the essential function of these *micromodulations* is the '*continuous stimulation and maintenance of the listener's attention and awareness*'.

I will examine the technical implementation of this *micro-surprise engine* in sub-chapter 2.4 and at the end of this chapter, and related issues concerning *improvisational impulses* and the division of decision-making between human and machine in the third chapter.

Structure / Undo / Errors

Implementing 'undo' functions into my performance patch raised interesting questions. For each buffer layer, I implemented it in two ways:

- 1) to undo a recording (retrieve the previous content of the buffer, before a recording has taken place);
- 2) to undo (the sequencing of) a control gesture.

The classic function of 'undo' actions is to correct mistakes, to allow for the 'stepping back in time' to a situation where an undesired outcome of a control event is made ineffective and the previous situation is restored. The correcting of errors however was

¹ As opposed to what one might expect when counting the parts of the Hybrid Instrument, I like simplicity.

not the primary reason for building it into my system. Instead, the urge to be able to retrieve a previous state of the system for *musical* reasons prevailed. As the gestural controllers, with their emphasis on variety generation and intuitive control (at the cost of exact manipulation of parameters) afford a great indeterminacy, it is close to impossible to produce the same combination of movement and position to replicate a previous gesture. As the audible result of a *control* gesture can be very characteristic / outspoken, it can be seen as a strong *musical* gesture. When attempting to create structure in a piece, be it improvised or composed, a returning musical gesture / motif is a useful and meaningful method (Barrett: Why structure); it can enclose one or more different sections, provide a recognizable element to serve as a connection point for the musical listening of the audience, a moment of order in otherwise free flow of the improvised performance.

If, in a given performance, the laptop performer inhabits Layer 1 for an extended period, then moves away into other Layers, a return to Layer 1 can, but does not necessarily, indicate a return to a previously explored sonic environment. Depending on how the performers interact with the software when returning to an already explored area, relationships between larger sections in the music may be perceived by the listener, thus facilitating the creation of large formal structures. (Pluta, 2012, p. 16)

But the question might arise if my *undo-implementation* is 'cheating', meaning: breaking self- or socially imposed rules / conventions of free improvisation. And to a certain degree it definitely is - at least, if misused in a certain way. One of the more common 'objectives' of free improvisation (and also one that I happily accept) is the welcoming implementation of coincidence, error, glitch: whatever finds its way into the 'musical field' of the performance can (and sometimes has to be) included as element of the improvisation, inviting / provoking a musical (or performative) reaction.¹ If for example in the course of the performance a sonic texture has been constructed which by mistake / unconscious action unexpectedly disappears, this could be seen as a disaster,

1 With musical field I mean the auditive events that are perceived by performer and audience as the sonic content / material of the performance.

with panic, apologies, shame as reaction. Alternatively, it can be welcomed as an event that has to be dealt with in a welcoming way, with immediate acceptance, as interrupting can't be undone - once interrupted, something remains interrupted. But the way that this interruption is included in the further proceedings of the performance can turn it into a valuable contribution to the improvisation, just like any other musical gesture from within or without ones own system.

2.4 Seeding Risk, Harvesting Variety

Leaving the established paths, the most logical route, the common way to do things is an essential part of many creative fields like literature, fine art and music. Exploring and exploiting the boundaries is especially important in experimental improvised music. This endeavor however often faces the problem that habits form easily and unnoticed, and breaking out of safe or standard ways of doing things (methods that *just work*) can be unexpectedly difficult. Building in methods that *derail* the proceedings from the established path thus has a tradition not only in experimental sound engine design, but also in other fields of art.

Useful Uncertainty

Especially the surrealists and practitioners of 'pataphysics have embraced a big range of these *un-commoning, uncertainty-producing or -embracing* methods and phenomena. Syzygy for example appears in 'pataphysics:

[Syzygy] has its origins in astronomy, where it denotes a moment of alignment of three or more celestial bodies, such as in an eclipse. Unexpectedness or surprise is a feature of syzygy, probably because of its origins in a time before such events became predictable. At any rate, this is not the same as the more typically bourgeois notion of "serendipity" which, while it contains the idea of a chance encounter, lacks the sense of scientific exactitude of syzygy. Here we see a parting of the ways between pataphysics and surrealism, for while both embrace Chance as a productive principle, pataphysical chance is neither irrational nor

subconscious. There are laws that lie behind pataphysical chance, but they are the laws of pataphysics: contradictions, exceptions, and so on. (Hugill, 2012, pp. 13-14)

Next to the above-named terms syzygy, serendipity, unexpectedness, chance, contradictions, exceptions, there are also uncertainty, indeterminacy, chaos, complexity, obstruction and constraints (as mentioned in sub-chapter 2.2), surprise, and many more.

All are welcome ingredients for free improvisation, as they are a rich source of improvisational impulses; they however have to be implemented *musically* in order not to derail the performance itself. In the rest of this sub-chapter I will tell more about the implementation of uncertainty in the Hybrid Instrument.

Risk, Failure

Working with experimental, self-developed hardware and/or software (or depending on a laptop on stage) brings risks, just like depending on free improvisation for a performance. Some of these are important and desired, others are undesired and can influence or even destroy a performance in unpleasant ways. So both human and technology bring in risk, and both have strategies to deal with it.

Overcoming greater risk of failure takes more skill than overcoming less. But this relativizes skill to one's intentions. Skill is surely a more objective phenomenon. (Godlovitch, 1998, p. 21)

When something goes wrong, technology often has the attitude to resign in its brokenness; leaving things for others to handle. Humans often *are* these others, and also have the capability to change their plans to make up for a dysfunctional object.¹

But risk is not only part of the technological components; it is also inherent in the process of improvising; attempting to ban it would be pointless. Each musical action contains chances and risks, some of which small, others huge. Relying on *safe choices* for too long can result in failure, as well as taking a too big risk too soon without giving a

1 As a strategy for any computer-related failure, I have the DD3 ready to maintain soundscape and tension in a performance (while the computer / program / process restarts).

musical passage the time to develop. The cliché of failure in music, playing a '*wrong note*', has a different connotation in free improvisation:

Improvisation is the redemption of accident, a magical process in which the unintended is perceived as part of a design. The improviser justifies a wrong note by following it immediately with another one. The two wrong notes together suddenly form a new world in which the errors of the past are reconciled. (Rzewski, 2007, p. 78)

So failure in the context of free improvisation could be considered the avoidance of invoking risk, or the inability to contextualize improvisational impulses (including '*provoking*' content) and *harvesting* the chances that emerge.

Abandoning User Security

As Kim Cascone (2010) mentions, one interesting aspect of designing one's own performance system is that the affordances are not pre-limited by marketing departments, who have a tendency to instruct engineers to reduce risk or vagueness in order to keep a generalized client group happy and out of trouble. This reduces the chance to meet glitches and artifacts in one of these stability-focussed products, which makes it less inspiring and rewarding for creative (mis)use off-road from the main tracks.

Glitches and Artifacts

In experimental practices, an important part of exploring an instrument is *exploring its limitations*; bending the 'standard' use and see what comes out of that. This is not only true for traditional instruments, where application of extended technique is quite common (at least in free improvisation); also electronic instruments explore the side-effects of their engine when configured in certain ways. Musically harvesting these artifacts and glitches became an important ingredient in my emerging performance practice on the Hybrid Instrument; the richness in these 'side effects' allows me to put the electronic transformation of my source sounds into the *leading position* (see chapter one). Admitting these sounds was a demand that my *performance-mode* personality

made towards the *developer-mode* engineer, who might otherwise have found ways to prevent these from emerging.

Gestures as Variety Source

I make use of the un-precision of control gestures to provide a certain degree of unpredictability, which, through the architecture of the looping engine, translates in an increased variety in the sound outcome, which has the goal to avoid the static and machine-like character that ‘clean’ control signal provides. Another strategy would be to either add variety by introducing randomness, or by creating algorithms that help to create unpredictability out of a basically well-controlled position.

In my work I have always designed instruments that demand a considerable degree of physical effort to be played and at the same time they are able to convey the slightest trembling of the hand. These tremblings are, during a concentrated performance, not just errors, but an integral part of the muscular/mental effort pattern that lays at the base what is perceived as musical expression. Music in a pure conceptual format is only understandable by the ones who know the concepts. Music that contains the physical expression of a performer is recognisable by a larger group through that expressive mediation of the performer. (Waisvisz, 1999)

Taking the approach of the ‘natural born cyborg’ (more on this in the sub-chapter *Cyborg*): the inexactitude is already built into the human body. Even a hand held still is trembling, pumping blood and varying amounts of adrenaline. A holding-still-gesture of a hand is significantly different from that on a laptop trackpad, which again differs from that of a multi-touch device. If motion sensors on the hands have a control function which influences an engine that is able to create a huge variety of outcomes based on slight changes in input, then the complexity (or *micromodulation*; see above) is not artificially generated, but ‘naturally grown’ and (again) *harvested*. I will extend more on the difference between implementing AI or taking the cyborg-approach in the last chapter.

2.5 Technical Details: The Layering- and Transformation System

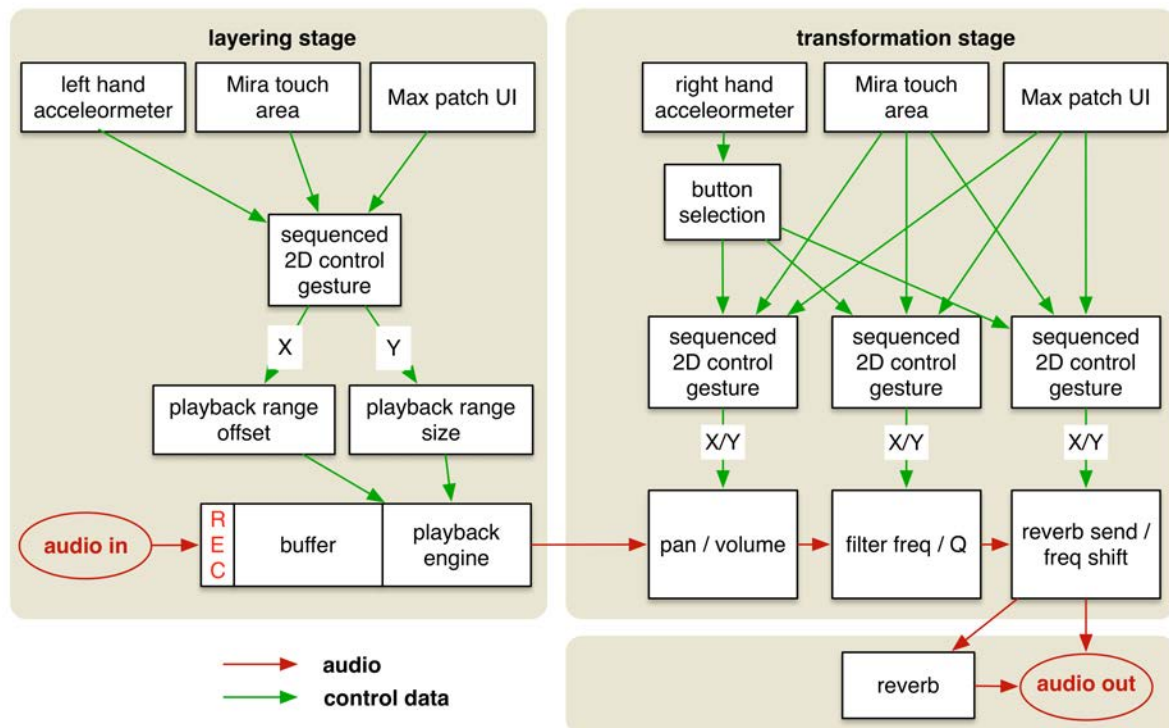


Figure 6: The connection of the control data and audio manipulation in the Max patch

The layering- and transformation system is the core of the DSP engine of the transformed Hybrid Instrument, just like the DD3 was the core of the previous performance setup. The patch is roughly organized in two sampling / playback blocks of the same structure. Each of these blocks works in two stages, the **layering stage** and the **transformation stage**.

Additionally, there is one block dealing with direct transformation of live signal, plus a reverb block that the other blocks feed into. The purpose of the layering stage of the sampling / playback blocks is to first determine *how* input audio will fill the buffer - replacing previous material, or combining it (leaving it up to 100% in tact) - and then, to determine which part of the buffer is played back, and through which method.¹

The resulting audio signal is then piped through a number of transformation modules. In

¹ ...and also in a range of possible speeds from extremely slow to very fast, pitching the sound accordingly.

Also the pitching down of one or two octaves is selectable.

order of appearance: a **panning / volume** module, a **state variable filter**, and a combination of **reverb send** and **frequency shift**. This then forms the output of one block. Each layering- and transformation module (always combining two parameters into a 2D representation) is controllable through a couple of interface methods: the accelerometer of the hand controllers, a XY-touch area in the Mira interface (which is provided by Max as a replication of a selected number of UI objects), and through the GUI objects of the Max patch. These control gestures are automatically sequenced: Whenever a gesture across the 2D-area is stopped, it will be repeated in the same speed as it initially happened.¹ The gestures of the different modules are neither synchronized to each other nor to the audio playback window in the layering stage. A consequence of the latter is that - as playback window position and size may change while the audio is playing, a new pass through the referenced audio material might play a different range; as the range length varies and is not synced to the window morphing, a simple control gesture can already produce quite a variety out of limited audio material. Two different methods through which this playback window reacts to changing control data are examined more closely in the Appendix. The combination of all these more or less unsynchronized transformations produces throughout its iterations an output that has consistency (because it is based on the same source audio material and involves some cyclicity), but at the same time a non-static variety. Staticity can still be reached by canceling the looping of a certain (or all) control gestures, but normally, constant transformation is involved - even minimal, as attempting to hold still the accelerometer does not deliver totally stable data, as already mentioned in the sub-chapter 'Gestures as variety source'. Next to variety stemming from this layering and transforming, the system also allows for the appearance of certain *glitch* sounds; side effects of the processing, these can be found, emphasized and creatively exploited in the more 'extreme' parameter settings. Exploring these is actually as important as navigating the 'safer' ranges of the *phase space*.²

For even more complex and unpredictable sound results, the routing of the blocks and

1 Of course there are modification possibilities, like speed- and direction changes.

2 see definitions

stages can be fed back into the buffer as input signal.

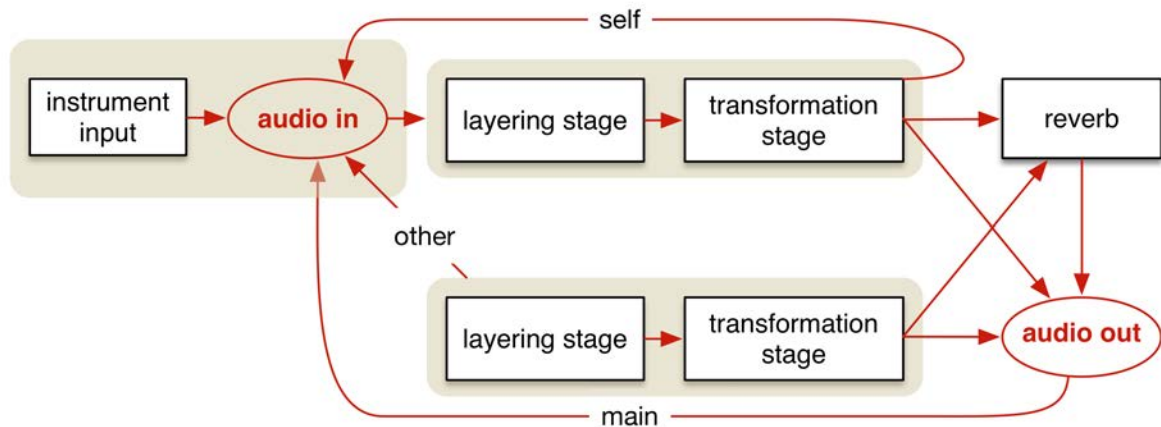


Figure 7: The routing of the audio between the layers (depicted for the first block)

Each buffer's audio input has not only the live instrument available as source, but can also take the output of the own transformation block, that of the other block or the combined main output of the patch. Recording these into the buffer can happen while the layered, looped and transformed material is played back from it; this can produce sounds that are extremely aliased and quite far away from the original input signal, impeding recognition and *source bonding*.

The **reverb block** has a special function. The controls of the reverb are organized in three 2D-sets of parameters, which can be controlled simultaneously through the same options as the sampling / playback blocks. These controls offer instant change possibilities in a huge range, from setting a neutral light room to creating massive sound-layering reverberation; from creating resonant frequencies to creating implementation-based artifacts (which however can be exploited creatively).

The huge range of transformation possibilities through a relatively limited amount of control gestures is what allows for important performance ingredients like slightly varied, non-static textures, but also wild and rough sounds; together, they form the new core of the Hybrid Instrument. How to connect this set of parameters in an intuitive, embodied way to the body and mind of the performer is the subject of the next chapter.

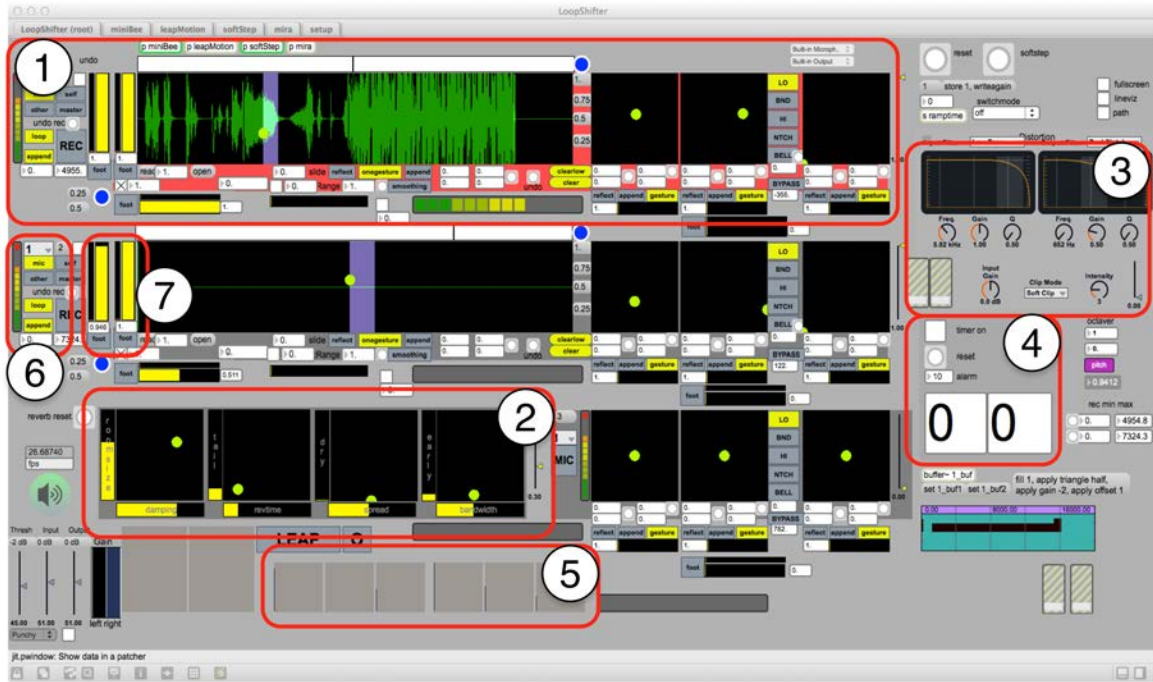


Figure 8: A screenshot of my Layering- and Transformation patch

- 1) A sampling / playback block with the input stage, the buffer / looping window, three transformation panels and associated control elements
- 2) The reverb stage
- 3) An experimental distortion stage
- 4) A timer, to counter time-perception distortion when necessary
- 5) Incoming signal from the MiniBee controllers
- 6) The input stage
- 7) Expression-pedal-controllable parameters (recording feedback, playback speed)

Chapter 3: Embodiment and the Now

The thing is this: When I play, what I try to do is to reach my subconscious level. I don't want to overtly think about anything, because you can't think and play at the same time — believe me, I've tried it (laughs). It goes by too fast. [...] I'm not supposed to be playing, the music is supposed to be playing me. I'm just supposed to be standing there with the horn, moving my fingers. The music is supposed to be coming through me; that's when it's really happening. (Sonny Rollins, 2014)

No matter how interesting the experimentation- and development phase of the Hybrid Instrument is, the situation that it ultimately is intended for and where it has to 'proof' itself is in performance. In this chapter, I will examine different aspects of what performing on stage with the Hybrid Instrument means and encompasses. Looking at the elements separately (mind and body of the performer, interface and sound engine, hardware and software of the instrument) will enlighten some aspects, but will also introduce a couple of paradoxes that can only be solved by looking at the combination of the elements in a holistic way.

First, I will extend on the notion of a special state that I encounter when performing - the *performance mode*. I will describe from a personal perspective what changes to body and mind I encounter in such a situation, and what the consequences for the development of the Hybrid Instrument were. Next, I will examine the paradox of the *now*, the instantaneous reaction to auditory input in a speed that exceeds the possibilities of conscious thought, and consider solutions to these problems and paradoxes by looking at embodied interaction and reconsidering the *Cartesian Split*. I will reflect on the development of interface elements in the light of these processes and concepts, and will conclude with the notion of us being a *Natural Born Cyborg* (Clark, 2004).

3.1 Body and Mind in Performance

Performance mode

As already briefly mentioned in the first chapter, I often find myself in a different state during a performance, a state which I refer to as ‘performance mode’. Getting into this state of mind (and state of body, as we will see) happens more or less automatically, unplanned and unconscious; I mainly notice it when it is interrupted during the performance, or in retrospective afterwards. No special ritual has to be followed, except for setting up the necessary equipment in an appropriate setting, focussing, and beginning to play (the process of preparation can however be seen as a ritual which might be involved in the establishment of performance mode). Elements that have to be present in order to allow for entering performance mode are those that are prerequisite to the kind of performance that is envisioned, like a properly equipped stage / sound system, an attentive audience, appropriate environmental settings etc. In performance mode I behave differently from everyday life; partially because of the heightened public (due to the audience) and private (due to focussing) self-consciousness¹ caused by the performance situation, partially because certain behavioral changes appear unconsciously. For example my eyes are often either fully or half closed, and my facial expression and bodily movement are emotionally linked to the musical content (within the constraints that instrument- and interface demands define).

Altered Perception

Perception is the organization, identification, and interpretation of sensory information in order to represent and understand the environment.
(“Perception”, n.d.)

Apparently, these processes are altered in order to adjust to the needs that arise out of being situated in this special environment. I will focus here on the situation of playing with the Hybrid Instrument in a free improvisation performance, which obviously will differ greatly from the performance experience a member of a string quartet will have,

1 Private self-consciousness is a tendency to introspect and examine one’s inner self and feelings. Public self-consciousness is an awareness of the self as it is viewed by others (“Self-consciousness”, n.d.)

for example.

Thinking about **visual perception**, I find it striking how after exiting performance state, I often find I'm not able to specify what I have been looking at during large parts of the performance. (Of course the partial or full closing of the eyes might be the reason for this - or a consequence.) An altered mode of perception seems to 'take over'; certain streams of sensory information seem to gain priority, others are impeded. The balance might change during performance between different *sub-modes* (explained later in this chapter).

Next to visual perception, also **auditory perception** is altered dramatically (as might be expected). The nature of the transformation depends strongly of the performance context. I noticed that in a free improvisation setting, I'm initially not so much analyzing, identifying and interpreting sounds - prior to that, a fast and unreflective chain of association and possible reaction takes place; only then I am starting interpreting the sounds and to a more conscious degree thinking about possible intentions by other musicians or consequences on (and of) my actions.

I experience a heightened awareness of **Proprioception**.¹ The whole body is situated in a paradox of control, as on the one side an effect of performance mode the body can become subject to unconscious, almost trance-like movement, while on the other side, instrument operation demands high control over the position of the body and its parts, from finger tips and lips to the breathing system. These positions are important in relation to fixed or moving objects, but also relative to each other. An interesting effect that I encountered when playing the Hybrid Instrument is that proprioception includes - or at least seems to include - certain objects that are perceived as extensions of the body, or as part of the hybrid system of body & instrument. This includes heightened attention to the position of the own body, especially relative to the theremin; the position of the saxophone relative to the microphone; the feet relative to control switches / pedals. With

1 Proprioception, from Latin proprius, meaning "one's own", "individual" and perception, is the sense of the relative position of neighbouring parts of the body and strength of effort being employed in movement ("Proprioception", n.d.)

the inclusion of gestural control, also orientation and position of the sensed body parts relative to the sensor (or including the sensor) is part of heightened attention to proprioception.

Another phenomenon I frequently observe is the change of **time perception**, particularly concerning the duration of the performance or subsections. Distortion of the sense of time is one of the components of the *flow* experience that Csíkszentmihályi (1993) defines; I will extend on the notion of Flow later in this chapter.

So, after a show, if you come up to me and say, “Oh! You remember when you did this at that part?” I most likely will say, no, because I’m not conscious when I make the choices, the choices just happen and I just move with them...
(Maria Chavez as cited in Kaiser, 2013, p. 57)

Sub-modes

Switching between different modes of perception might also be perceived as different modes of performance; the immersed, flow-like experience might change into a more self- and situation-conscious mode. This change might also be noticeable by the audience. An example is the state-checking glance at the computer screen¹ in contrast to a previous, more *entranced* performance sub-mode, where the question about possible malfunctioning indicated an interpretation of the sub-mode change. Quick switching of states and modes - including *back* into the previous (flow-like, for example) mode is thus an important capacity; it enables the incorporation of certain (possibly mode-changing) cues and pieces of information,² without breaking the flow of the performance. In my opinion, this ability can be trained by experiencing and practicing it, preferably in a performance setting (or at least in performance mode).³

1 as described in chapter one

2 like the *note to the developer-self* in chapter one

3 Reminiscent to how the ability to remember ones dreams and exiting / returning to dream state can be trained, shortcutting the long process that falling into sleep and reaching the REM phase normally takes.

Development Consequences

This altered perception of the performance state has certain influence on the demands, design & functioning of the Hybrid Instrument and the performance environment.

The experienced **Performance blindness** for example has consequences for the design of visual feedback. When I soldered blinking, colored lights to my hand controllers to provide visual feedback about the state (or state changes) of my sound transformation system, I discovered two things: I didn't notice these during playing, just like a whole battery of flashing LED's on my foot sensor. The other thing took much longer to realize: I didn't need much of this visual feedback. Most of the relevant information I could deduct from the audible changes that control movement caused; the position and orientation of my hand (and the connected parameters) I knew thanks to *proprioception*. The graphical interface of the system on the computer screen is mainly needed for initial configuration and problem solving - mainly in the (semi-permanent) phase of prototyping. But it can also provide an important service in state-checking, when the system 'takes care' of background layers, giving information on what's going on.

A special case is the touch screen interface of my iPad. Providing physical control in the touchable shape of sliders, XY-areas, buttons, switches, it is important to know the boundaries of these control elements. Tactile feedback for these boundaries however is not available; visual attention is required, especially in the initial touching of an element (many control elements in for example Mira, Lemur and TouchOSC maintain the interaction connection even after a touch gesture exceeds its boundaries). So a quick initial glance to hit the correct slider is necessary, followed by a less visually bound manipulation which is supported by physically sensing the shape of the iPad. Having the iPad tilted in a slight angle makes that bringing a slider *up* also means physically *up*, which helps the body to connect, again through proprioception. Also the hand controllers are influenced by the embodiment considerations - both in the sense of being situated on stage with me (being in performance mode), and considering embodied control of the sound engine. The concrete consequences of these aspects will be described in the next sub-chapter, 'Building (for) Embodiment'.

Flow, Trance, Ecstasy, Meditation

Parts of performance mode overlap with what Csíkszentmihályi (1990) describes as **flow** experience¹ :

Flow is the mental state of operation in which a person performing an activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity. In essence, flow is characterized by complete absorption in what one does. (“Flow (psychology)”, n.d.)

Although I encounter this fully immersed state in *performance mode*, it doesn’t cover it completely - and it also occurs elsewhere. In playing music for myself I can experience *flow* just as well; also in programming.²

Trance might be a good candidate to consider as being of influence, as the looping and ambient drone sounds might induce such a state.³ But for me, trance has too much association with *loosing control*, which might work for the audience, but for me as the performer is only partially true - I dislocate some of the conscious control into the realm of the embodied and intuitive action, which is not the same.

Another related notion is that of **ecstasy**:

Ecstasy, a state of perception in which one seems to be outside of oneself, or to be in more than one place at the same time, is a fundamental element of

1 Nakamura and Csíkszentmihályi identify the following six factors as encompassing an experience of flow.

1) intense and focused concentration on the present moment 2) merging of action and awareness 3) a loss of reflective self-consciousness 4) a sense of personal control or agency over the situation or activity 5) a distortion of temporal experience, one’s subjective experience of time is altered 6) experience of the activity as intrinsically rewarding, also referred to as autotelic experience Those aspects can appear independently of each other, but only in combination do they constitute a so-called flow experience. (“Flow (psychology)”, n.d.)

2 In fact I heard first about this concept by Cycling ’74 CEO David Zicarelli, at a Max conference in Leicester (2012)

3 See Waisvisz quote in chapter 1

free improvisation. (In live electronics especially, when the sound that I produce reaches me from a loudspeaker on the other side of the room, I may have the experience of hearing myself in two different places.) (Rzewski, 2007, p. 58)

A publicly shared **meditation** is perhaps the most fitting description for the experience / activity that happens in performance mode, especially in solo performances (which tend to be more introspective, as opposed to a more communicative state in group performances). In a Transcendental Meditation (TM) workshop I experienced the distortion of time perception for the first time consciously (ca. 1992). This guided meditation encompassed a *mental journey*, the invocation of images and a relaxed state of mind. While the state of mind during *performance mode* is quite active, it is still readily and openly accepting improvisational impulses, reminiscent to the acceptance of images and thoughts in TM. As Joel Ryan mentioned in a reflection about a solo performance of mine (private communication, May 14, 2014), he had the notion of me *creating a framework like a broad river, a landscape, and then look for things in it* - and that is an image that I find matching to my own experience. Actually, this brings the word **soundscape** into context, which I often use to describe my musical output with.

I will not go deeper into these *alternate states of mind* that might apply to varying degrees; it is important to not forget that these do not cover the full experience of performance mode - the state of *playing for an audience* is also essential. Also, reaching these state is not the prime objective; the musical performance should be seen as such, and not as a tool. I will consider audience-related issues at the end of this sub-chapter.

Performance Honesty

The Poets from Epibreren¹ - the poets and me - *were* crazy when crawling on the floor while reciting poetry or playing music; it was not acted. It is the expressivity derived from being in a different *state*, the *performance mode* taken to the extreme, in the sense that some limitations are lifted.

¹ A group that I performed in, between 1996 and 2007. More information on www.epibreren.com



Figure 9: The Poets from Epibreten during a performance in Krk (Croatia), 2000

This is something essentially different to a performance that might feature a professional actor, doing the same actions in the same extravagant way. The difference is in the positioning of the theatrical momentum: experiencing something directly and sharing that expressively versus skillful *enacting* something.



Figure 10: Carried away by the Delay - Performance with the Poets from Epibreten (2000)

Performance Mode Interruption

Distortions can come from within and the outside. External distractions - movement, a ringing phone etc) are mostly both perceptible to the audience and to the performer, and might be included into the improvisation.

Distractions from the sound environment are to be avoided at all cost. These push the user out of a flow state, and into a world of technical issues, where performance becomes a side note. (Pluta, 2012, p. 38)

Disturbance within - the inability to set out the creative canvas in the mind and protect it from influences like worries, insecurities, preoccupations - is mostly not visible to the audience, and sometimes even not conscious to the performer. It takes training and practice to set up this field and recognize its violation. Setting up can happen through the preparation routine, a process through which the inner mode for the improvisation is set, almost like a ritual.

The Audience

As Godlovitch (1998) describes, performance is not complete without an audience. And indeed I perceive the audience as an active factor in concerts, especially in free improvisation.

One may be tempted to reify musical sound if one supposes that auditory experience captures all that is musically significant. One may close one's eyes at a concert the better to absorb the music. So some listeners believe. But this says less about sound exhausting the musical significance in a performance than it does about the psychological means through which sound may be appreciated and savoured by certain music consumers.

(Godlovitch, 1998, p. 15)

As described above (sub-modes), in free improvisation performances, the audience reacts to other events than just sound alone; visual cues between performers and in fact the whole embodied experience of witnessing a *embodied creation* exceeds by far the pure auditive element. An example might be the glances that often are exchanged

between musicians improvising together. Often the end of a piece has to be negotiated (if there is no guiding 'system' or time constraint), and I have often observed this as being done through exchanging looks:

Performer 1 looks at performer 2 and waits for a reaction. When looks meet, often accompanied by a smile, it is a clear sign that the end has been reached; otherwise, if improvisational impulses are continued to be given by 2, it might turn into a solo part of performer 2, and performer 1 might reconsider the ending-option.¹

So non-verbal communication has an important function in free improvisation, and looks have a meaning. The heightened attention of the audience towards this element also might be the reason that an overly clear look at the screen is given special meaning and interpreted on a personal basis. This interpretation is of course not limited to technical issues. About the audience's sensitivity to inferring states of mind, Joel Ryan mentions:

I don't think this is just about their ability to recognize mistakes, but of the sensitivity of musical communication in general. It's about how good we are at tuning into a player's consciousness.

Perhaps music is no more than a "situation" rigged so that you can reveal your inner states. The musician is forced to attend to intricate dispositions of sensitive matter using all his bodily skills. Sort of musical instruments as dowsing rods (does the wiggle stick wiggle when it's near water because of its material relations to water or is the stick more an amplifier, a display, of unconscious intuition? (Ryan, Private Communication, May 7, 2014)

The Now

In the collection of texts 'Nonsequiturs' by Frederic Rzewski, he meditates rather poetically on the *now* in improvisation:

Time is not just a linear sequence, in which the past conditions the future. It is also a continuous present, in which each moment is a new beginning.

Each moment is a re-enactment of creation.

¹ this obviously is no general rule, but a personal observation example

The universe of improvisation is constantly being created; or rather, in each moment a new universe is created.

Although events may seem to succeed each other in an orderly way, each one somehow growing out of the one that preceded it, there is no reason why this must necessarily be so.

At any moment an event may occur, for no reason at all, with no relation at all to the preceding event.

In this universe each moment is an *entelechy*, with both its cause and its end contained in itself. (Rzweski, 2007, p. 58)

This self-embeddedness of the now, where each moment possibly contains the grain out of which further musical action grows, is the challenge and the excitement of free improvisation; its importance heavily determined the development of the Hybrid Instrument, as in my opinion an embodied connection provides a method to ‘tap into’ this stream.

3.2 Building (for) Embodiment

Embodied Interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts. (Dourish, 2004, p. 126)

As described in the previous chapters, the speed of reaction required in (free) improvisation poses a challenge to the performer, and also to the designer of the instrument that should facilitate quick musical responses. Considering the time that conscious thought needs to process and be translated into motor action, it might seem an impossible situation.

As opposed to the conscious mind, the body is actually able to multitask; one movement does not need to stop while the other is executed - instead, complex combinations of movement trajectories and orientation changes are possible without having to think about it consciously. These movement combinations can be trained (a process which initially does require conscious attention), and can then be triggered in a quick response, where conscious thought might be involved in the ‘firing’ of this reaction, but does not

need to stay with its continuation. In music, this capability is of course exploited for playing instruments, but doesn't stop at memorizing finger positions for key grips. In the example of the saxophone, the whole chain of breath control, embouchure and fingering can be synchronized and trained to form a combined 'hybrid action'. What is more, *chains* of these actions can be trained and stored for rapid triggering; a method that bebop saxophonists for example are very fond of. 'Licks' of note combinations, usable interval patterns and even whole blocks of melodies with embellishments can be available at breathtaking speed. Joel Ryan speaks in this context of 'colonized neurons' (Ryan, 2012a). A saxophone is an object that is not built into the body, but I often perceive it as part of the same system as myself¹, which means I don't use it as an external tool, but as direct extension of my body. I will return to this notion in more detail in the sub-chapter *Cyborg*.

Musicians have a great curiosity about things, they stick strange pieces of wood and metal in their mouths. This amounts to a strong connection to the non-human part of existence. Musicians respect the materials that make instruments and look there for improvement and inspiration. This embracing of materiality and the agency of things is distinctive to music - perhaps more so than other art forms. The problem for computer music is that because of deep roots in the hyper-formalism of the twentieth-century this physical side of music is very poorly developed. (Ryan, 2012b)

Muscle Memory

Terms like muscle memory, body knowledge etc. are often used to describe the unconscious process of performing an (often repetitive) task fast and accurately ("Muscle Memory", 2010). In music, muscle memory often is associated with learning to play an instrument - memorizing the keys, playing scales fast, shaping the sound of a tone of a wind instrument. When playing the instrument, all this knowledge has to be accessible in 'no time' - meaning there won't be time to consciously think about the

1 One interesting side effect I once experienced was the conclusion that I must be ill, which I drew when feeling weak while playing the saxophone. It turned out that a key of the instrument was not closing properly, so maintaining a tone required more effort than usual.

necessary actions to achieve a certain sound result, as conscious thinking is a process much too slow to be useful in even playing a simple melody. With repeating a certain course of action, starting slow and then increasing speed ("Learn Faster by Playing Slower", 2010), a rapidity of action can be developed that seems to have 'freed' itself from conscious thought processes. The term 'muscle memory' speaks to the imagination; however:

The biggest misconception is that muscle memory is how people actually perform tasks, it is not. They perform tasks with either conscious thought or unconscious memory." ("Muscle Memory", 2010)

Unconscious memory and muscle memory are combined to perform the action. Muscle memory remembers positions; transitions are guided by unconscious memory. The sense that is involved in this process is called *proprioception*, the sense that provides information about the position and orientation of our body parts:

Proprioception allows us to learn new motor skills, it is a key component in muscle memory and hand-eye coordination and training can vastly improve this sense. To ensure movements are fast, precise and co-ordinated the nervous system must constantly receive sensory information to be able to adjust and correct movements. The nervous system achieves this mainly through the cerebellum, which receives sensory information about positions of the joints and body from the proprioceptors. (Lindgren, 2012)

This mechanism (which conveniently comes built-in with the human body) is a key element of connecting to a musical instrument (or, for what it's worth, to any object-as-tool - see (Clark, 2004)); it provides an interface to the object through somatosensory perception.¹

Within this context a proprioceptive relationship is established, that is, a largely unconscious perception of movement and stimuli arising within the body from the relationship between the human body and the instrument

¹ which combines touch, proprioception and haptic perception ("Somatosensory system", n.d.)

during performance; a direct relationship is established between the physical gesture, the nature of the stimuli and the perceived outcome.

(Paine, 2009, p. 215)

Although useful for explaining certain aspects, the downside of using terms like *muscle memory* and *mechanism* is that it easily distracts from the embodied situation in which these processes occur and are employed to actually make music. As Joel Ryan notes (private communication, May 2014), the focussing on these terms as part of musical training springs from an old view, separating intelligence from *reflexes* of the body that can be trained:

The muscle memory trope is a leftover from a much earlier theory of mind that takes much of the performative intelligence of musicians, among others, to be "meat". A version of what was, and still is in music schools, described as training your "reflexes" because of their supposed involuntary knee-jerk action. It becomes a rationalization for doubts about improvisation by composers like Luciano Berio who diminish the accomplishments of jazz musicians to that of mere automatism. This distinction is not productive for creative thinking about performance or the problems of virtualized music.

(Ryan, 2012a)

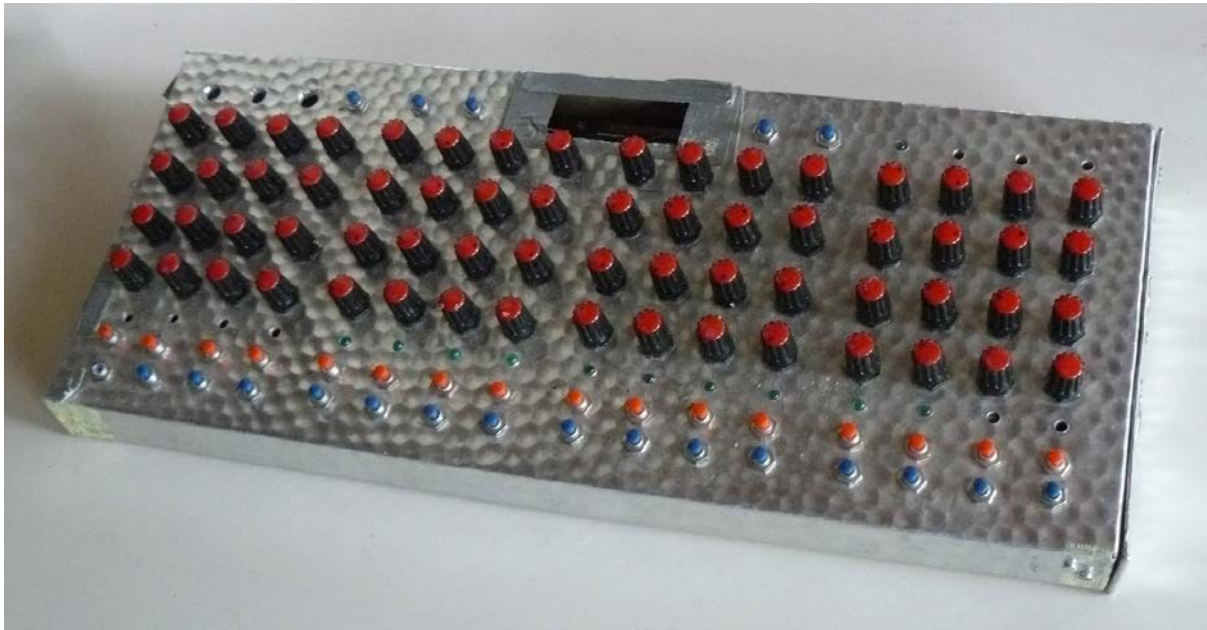
I consider the holistic view of the embodied connection indeed more relevant in the context of the Hybrid Instrument, and will focus on this notion in the rest of this chapter.

Connection Frustration

When I initially encountered computer-based manipulation of sound and image, the wish to physically manipulate the parameters in the patch emerged, born out of frustration with the single parameter, thin connection that the mouse afforded. An array of self-built solutions to this problem (like the DIY-based MIDIbox 64)¹ was followed by then-upcoming commercial products, but they all shared the same problem: I somehow couldn't use them intuitively, which rendered them useless on stage (while in the studio,

1 from <http://www.ucapps.de/midibox64.html>

at least the single-parameter-limitation was lifted).



*Figure 11: The remains of my MIDIbox 64, built with the design objective
‘The more controls, the better’*

Reasons for this were that the parameter-controller-connection was everything but embodied. The controllers were built to be universally assignable; in each patch they had a different meaning, and in none did I know *which* without some extra thinking or looking-up. A controller per parameter quickly ended up in mappings difficult to oversee; intuitive changes rarely ended up in something interesting. To get an idea of the state of a parameter, I had to refer to the representation on screen, while the physical control was on a different location, which had consequences for the *knowing* of the state of the engine.

Connecting Body And Parameter

An embodied connection through body knowledge, combined with ‘natural’ mapping, can provide the perception of ‘direct’ control of computer parameters; rotation of a hand for example can be translated into a sound transformation that is phenomenologically related to the movement, and a link between muscle memory, proprioception and parameter can be established.

The process of learning the technique of ‘aerial fingering’, the method developed by Clara

Rockmore to rapidly (and with a less perceptible portamento) play pitch sequences on the theremin, is a very personal one. As far as I know, no general aerial fingering technique exists, probably due to the fact that the movements of the fingers are difficult to quantize, and each thereminist is built differently, with varying limb measurements (and thus varying influence on the electro-magnetic field)¹. I tried to find ‘my’ method by imagining a natural movement for the pitch change of a fifth, then tuning the theremin in a way that this movement would indeed create the desired effect while positioning the hand in the mid frequency range of the theremin (and in the mid of the natural playing range between me and the pitch antenna), and then trying to repeat this pitch change control movement, to train the muscle memory². Accordingly, I practice the other pitches within an octave, and their relative intervals, without moving the arm towards the antenna (or away from it).

The interesting part of this process in relation to my research is the approach of starting from imagining a naturally-feeling gesture (imagined finger movement for quint pitch jump), and then setting the system accordingly. A saxophone doesn’t offer this luxury, but when developing new gestural controllers, this working direction can make sense. When I prototyped my hand controllers, I imagined the movement to control primary musical parameters of my patch. These were initially the X/Y movement in my buffer player space (defining window position and size), volume, lowpass filter frequency and panning. ‘Overloading’ the sensors’ pitch and roll values with these mappings I implemented with momentary switches in the palm of my hands (doubled by foot controller mapping).

1 in the meantime, I have however discovered the method by Carolina Eyck, “The Art of Playing the Theremin” - <http://www.carolinaeyck.com/pages/en/teaching/method-book.php>

2 which in a real performance situation always is tightly coupled with auditory feedback of the actual resulting pitch

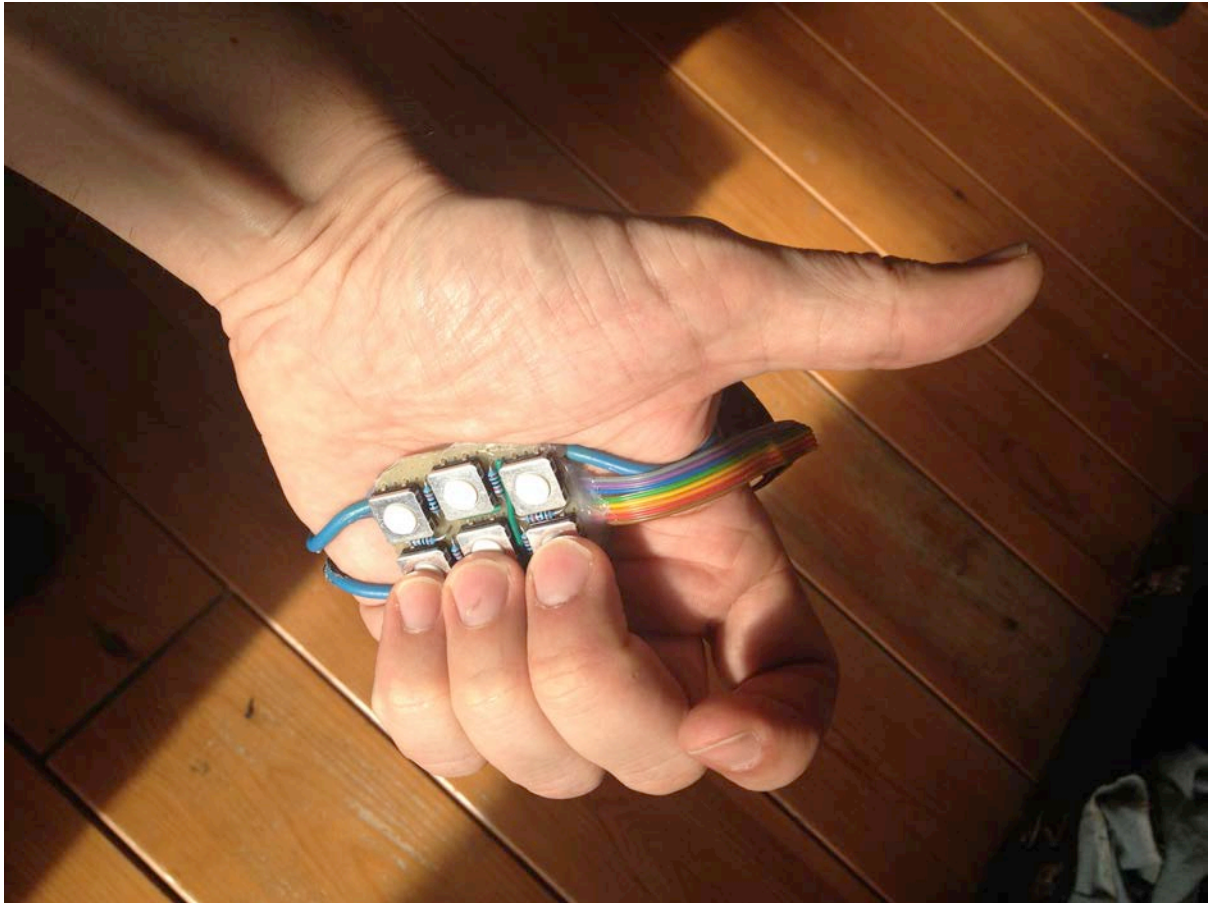


Figure 12: The controller of the left hand

Mapping: Freedom by Focussing

The spatial *encoding* of bundled parameters couples this process with natural capabilities of the sensorimotor system of the body, allowing me to use naturally built-in capabilities of my body (like the orientation in 3D-space, the manipulation of objects), but also the access of embodied representation archetypes (for example, the combination of filter frequency and resonance in a 2D-field). In my development process, I discerned two workflows for parameter-interface-implementation that I applied:

Parameters as Source

1. selection of parameters in sound engine for performance control
2. possibly 2D-bundling / combining: finding pairs of parameters that intuitively belong together

3. implementing control element or gesture in mapping engine

Gestures as Source

1. encountering a *control wish* in performance as an imagined gesture (example: aerial fingering in theremin playing; hand movement for volume / panning)

2. implementing gesture in mapping engine

3. connecting mapped value to parameter

The first approach is based on developer mode; conscious thinking and planning of possibilities from a rational thinking mode, but with performance practice in mind. The second approach emerges in performance mode and makes use of the embodied connection by listening to *embodiment ache* - detecting a missing connection. This approach I will describe further in the *Cyborg* subchapter.

Important for both approaches is the mapping. Implanting the relevant parameter range in the interface elements (soft- and hardware) during development frees me in performance mode from concerns of 'hitting' the correct values; the embodied musical reaction profits from the constraints that the process of mapping, bundling and implementing has built into the interface objects, as these allow for freedom; they make the interface *transparent*, as described further below.

Connection Width

The interface is the connecting point that's supposed to facilitate the "touching of the parameters"; the point where body and object meet and make contact. This contact can happen through a multitude of types of sensory perception, give varying amounts of feedback in either direction, and can happen in different degrees of 'directness' (meaning higher level control vs direct manipulation). Depending on these factors, one could speak about thin and broad connections. These connections form the 'bottleneck' for data exchange. For example, entering a value of a parameter of patch running on a laptop requires quite some sensory-motor activity, but results only in the changed value of a single parameter. Feedback about the completion of the motor activity has to be acquired through the haptic feedback of the mouse (indeed clicked?),

but the success of the parameter change has to be gathered through visual feedback (value indeed entered?).

Besides, you would be hard-pressed to find a more awkward and unmusical controller than a computer mouse. Imagine the rich and complex control panel of an analog synthesizer, with a hundred knobs and sliders and patch cords to play with, and imagine you weren't allowed to touch them and had to poke them one at a time with a stick. That's the mouse. (Perkis, 2009, p. 163)

A saxophone affords a broad connection. Muscles on mouthpiece and fingers, as well as the whole breath apparatus influence the sound directly, but at the same time also give a wealth of feedback (direct haptic, but also more indirect through the sonic outcome).

A broad connection, a good connection to relevant affordances of the sensory-motor system, a well-calibrated mapping contribute to the transparency of the interaction:

What matters is that as far as our conscious awareness is concerned, the tool itself fades into the background, becoming transparent in skilled use. In this respect the technology becomes, to coin a phrase "pseudo-neural."
(Clark, 2004, p. 45)

Feedback

The directness of feedback of control gestures comes in varying gradations. An example of a narrow feedback loop is the embouchure, controlling a wind instrument reed; the lip pressure required to maintain a tone in control is combining the touch senses of the lips with the aural perception, and any required adjustment of lip- or air pressure is executed in relative short time; conscious analyzing of the sensorial input is - during 'normal operation' - not required, as this skill has been trained, and the connection has been 'hard wired' into the sensorimotor system of the body. The width of the feedback loop increases with additional mental or bodily actions that are required to close the action-sensing-analyzing-action process. An example for a wider loop would be the fader of a varying sound signal that controls the output volume. As soon as an exceeding audio level is sensed, the visual system jumps to help to identify the spatial position of the

certain fader; the body takes the necessary steps to get hold of the knob, and together with the tactile information feedback (fader position, smoothness, required force to move it in the required direction), the action is carried out, with conscious analysis of the resulting audio levels. Even wider would the loop be if the fader is not a dedicated hardware element with a fixed position, but for example an endless rotary controller on an multi-purpose midi control device. The additional steps would be to find the rotary controller that the volume has been mapped to (conscious action), and a visual check of the current state of the controller (as feedback is not available by fader position), including visual checks on the possibly reached maximum value (again no tactile feedback of the hardware).

To enable **intuitive control** of a complex system, it helps to keep the feedback loops tight. Embodied control (as with the reed-embouchure-example) allows for much faster response times, and - with proper training - even faster response than conscious thinking would allow for.

In my personal vision for electronic music instrument design I have almost always pragmatically opened as many as possible data channels and their feedback between my body and the instruments. (Waisvisz, M., 2003)

Initially, I thought that knowing the state of the sound engine is essential for using it musically, and that visual and tactile feedback were important elements of true parameter control. Now I'm not so convinced anymore. The embodied knowledge is not so concerned with single parameters, and *knowing* has a different, less exact meaning than in an exact science.

Using **auditory feedback** to gather information about the ongoing processes is an important method, however not without problems. A big challenge comes at the moment of group improvisation. Determining the origin of a sound - the person, instrument, engine or whatever is involved - can be tricky as soon as multiple sources are combined, for example in a stereo mix. The origin of live played saxophone sounds can often easily be discerned, by the saxophone player as well as by the audience. *Sampled* and *transformed* sounds however have the tendency to be disembodied, especially when

playback and transformation is not directly bound to an action, but automated through sequencing or AI. With *one* performer on stage, both audience and performer can still assume safely that this person is the one who is responsible¹. But as soon as multiple electro-instrumentalists share amplification, this can be difficult - not only for the audience, but (more dramatically) for the musician. If there is no good separate monitoring or a dedicated loudspeaker per person, the benefits of auditory feedback vanish (depending on how recognizable the different outputs are). Not seldom have I based my musical actions as a *reaction* on sounds that I assumed were coming from me, but in reality weren't; and also the opposite case - wondering why someone left a certain tone on for so long, and after a while discovering that it came from my sampling engine - happened.

Visual feedback in the shape of a level meter can be a useful instrument to consult in cases of doubt, but good monitoring helps to make the most efficient use of auditory feedback.

Skill

Seeing my instrument as a proper one, that requires skill and practicing, asks for a description of these terms, and a plan or methodology of doing so.

Jeff Kaiser researches the notion of skill and virtuosity in the context of free improvisation in contemporary electro-acoustic music, and mentions:

So we see that not only virtuosity, but the seemingly less loaded term skill was tricky for some of the interviewed artists, as there is implied in the concept of skill an idea of transmittability, that skill can be known and shared. With the idea that skills can be transferred comes the idea of standards and comparisons to those standards, and this can be problematic in a practice that is varied and shifting, changing constantly. (Kaiser, 2013, p. 137)

Especially the association with motoric skill makes the notion of virtuosity problematic

1 ignoring for the moment the possibility that the performer could give an autonomous machine full responsibility

for many of the practitioners interviewed in Kaiser's research.

Motoric skill in the traditional sense is not one of my main focusses. A certain level of fluidity on any (sub)instrument however is needed, a higher level useful, to achieve the power to efficiently explore the phase space of the hybrid instrument; in other words, to become fluent in the specific vocabulary.¹

Practicing

Often, such integration and ease of use require training and practice. We are not born in command of the skills required. Nonetheless, some technologies may demand only skills that already suit our biological profiles, while others may demand skills that require extended training programs designed to bend the biological organism into shape. The processes by which a technology can become transparent thus include both natural fit (it requires only modest training to learn to use a hammer, for example) and the systematic effects of training. The line between opaque and transparent technologies is thus not always clear-cut; the user contributes as much as the tool. (Clark, 2004, p. 38)

Practicing can also take part on each sub-instrument separately. This is self-evident for the saxophone and theremin. The sensor-part on its own (without the DSP which brings meaning into the gestures) is in this sense not very different: I discovered that I can train my *muscle memory* and the internal spatial representation separately. Although it might seem counter-intuitive to *disembody* the controllers out of their context of the Hybrid Instrument, the *mapping* between 3D-movement and the 2D-spatial representation in the mapping engine can be trained (put into *muscle memory*) by exploring the movement and watching the visual representation on screen, which somehow then also strengthens the *internal* representation. It links the somatosensory perception (proprioception and haptic perception) to the internal visual representation of the system by training with real visual feedback. Although this representation is 'forgotten' when in performance

1 Another notion of virtuosity was mentioned in chapter two, as the ability to travel the field of affordances.

mode, the unconscious muscle memory will have an improved connection to the mapping of the DSP. On the other hand, I also consider it important to establish a sense of *knowing without visual feedback* and the confidence to rely on that. Visual feedback can also be seen as an attitude or habit that often is not directly necessary. So I ‘practice’ this by playing the Hybrid Instrument or typing in the computer without looking at the screen, and similar actions.¹

Subjective Control Metaphor

Asked for a metaphor to describe the control experience when performing with the Hybrid instrument (Ryan, private communication, May 2014), I initially thought of riding a bicycle - an activity often brought as example as a consciously guided embodied action, and also appearing in different places within this thesis. But considering the emerging personality of the system, and perceiving within it a tendency of developing and showing some kind of ‘own will’, it reminded me more of my rather recent first experience of riding a horse. While it is possible for the equestrian to guide this combined system of horse and himself towards a desired goal, total control of each movement is neither possible nor necessary. It requires constant communication and negotiation; loosening the reins will have consequences. Me and the horse felt like partners, where it was my job to coach us to our destination, which required respect towards the needs and limitations, and understanding of the perception of the horse.

3.3 Cartesian Split Symmetry

Instrument Unity Revisited

Throughout my research, my focus has changed numerous times from a certain element of the Hybrid Instrument to the whole, and back to a detail. In general, I perceive the separate parts when in *developer mode* - or when consciously practicing an element, and the *unified instrument* when in *performance mode*.

¹ Also by moving in a room or cycling with closed eyes, which relates to the ‘falling off a bicycle’ sub-chapter

Thor Magnusson remarks:

Even if the instrument is presented as a unified object, it will always be characterized by the split between the interface and the sound engine, connected by a mapping engine of diversified complexity. The sound and mapping engines serve as the core of the digital musical instrument; they are its “real body.” This is the location where constraints are defined and the instrument’s functionality constructed. (Magnusson, 2010, p. 65)

In a previous article however (Magnusson, 2006, p. 65), he noted that a holistic view “can be beneficial, as the instrument is easier to understand by a composer or a performer, perhaps helping the instrument to gain historical continuity”. As written above, my personal view of possible splits depend on the mode and situation. In the next sub-chapter, I will look at other possible division lines in the context of the Hybrid Instrument.

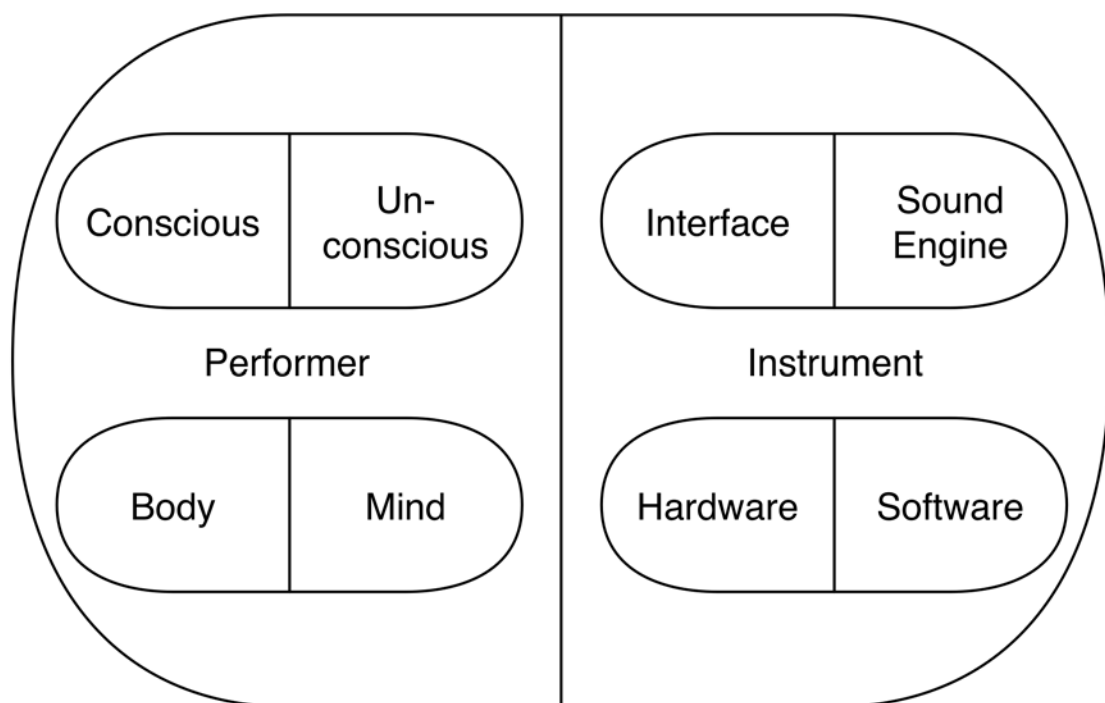


Figure 13: Cartesian Split Symmetry

Body and Mind; Interface and Sound Engine, Performer and Instrument; Conscious and Unconsciousness

It might be clear by now that I perceive the interface and sound engine as parts of a Hybrid Instrument. Although each discrete element can be looked at - and often used - separately, it is in the Hybrid Instrument that their affordances are used in a specific way, and that their limitations are shaped mutually; the whole is greater than the sum of the parts. The same goes for the human performer: Although it can have its merits to look at body and mind, conscious thought and muscle memory separately, it is the complex interconnectedness, the dynamic play between all separate parts of sensing, motor action, conscious and unconscious thought, memory of body *and* mind that creates the essential synergy.

The positivist, Cartesian “naive cognitivism” approach makes a strong separation between, on the one hand, the mind as the seat of consciousness and rational decision making, with an abstract model of the world that can be operated upon to form plans of action; and, on the other, the objective, external world as a largely stable collection of objects and events to be observed and manipulated according to the internal mental states of the individual. (Dourish, 2004, p. 18)

We can think of a third split: the division between performer and instrument. In my perception, me and the hybrid instrument form one dynamic system when performing. When in performance mode, I don't consider the sounds that I produce by using the saxophone as sounds coming from the saxophone; they come from *me*, which in that moment includes the normally external *saxophone object*. At the moment that I could influence the transformations in my sound engine intuitively by moving my hands, I felt that as a new affordance of *myself*.¹ Looking at elements of a system separately helps to conceptualize them and build theories around them, but the practice needs the whole to work and will show only then emergent behavior that creates the synergy; a holistic view completes the story and brings things into context. This leads me to the notion of a cyborg.

1 the system that is me *encloses* parts of the *saxophone system* - and not the other way around

3.4 Cyborg

As our worlds become smarter and get to know us better and better, it becomes harder and harder to say where the world stops and the person begins. (Clark, 2004, p. 7)

Before I encountered the notion of cyborg within the context of improvised electro-acoustic music¹, I considered it as an exotic fascination of other people. But the way that the fusion of the affordances of our body, mind and tools that we might employ to craft a certain effect is described by Andy Clark in his book 'Natural Born Cyborgs', made clear that it is a relevant notion for the Hybrid Instrument:

[...] what is special about human brains, and what best explains the distinctive features of human intelligence, is precisely their ability to enter into deep and complex relationships with nonbiological constructs, props, and aids. (Clark, 2004, p. 5)

In his view, that ability and our use of it make us indeed 'Cyborgs by Nature', even without intrusive technology implants - our ability to treat an object as an extension of our body is enough to be transformed into a hybrid, together with the object. He continues:

Many of our tools are not just external props and aids, but they are deep and integral parts of the problem-solving systems we now identify as human intelligence. Such tools are best conceived as proper parts of the computational apparatus that constitutes our minds. (Clark, 2004, p. 5)

This view and the affirmative resonance it induces into me makes me optimistic about my endeavor to weld the part of my mind that I always considered to be my intuition together with technological extension. No incisions will have to be done, no tissue refusal issues. Me and my instruments, my interfaces are already one (musical) cyborg, giving me an extended array of affordances. It doesn't mean that from now on I will wear

1 (Kaiser, 2013)

glittering costumes on stage and advertise myself as the Musical Cyborg; instead, I found useful the affirmation of the notion of me participating with my tools in one hybrid system. Intuitive control, or *informed* unconscious action with a well-mapped *connection engine* behind it, helps to interface between the object and the 'organic' me. To speak with Clark:

What makes us distinctively human is our capacity to continually restructure and re-build our own mental circuitry, courtesy of an empowering web of culture, education, technology, and artifacts. Minds like ours are complex, messy, contested, permeable, and constantly up for grabs. (Clark, 2004, p. 10)

Decision Making

An interesting question concerning the combined human-machine music making is where the (musical) decisions are made. A common approach to integrate computers into the performance process, for example with the goal to create variety, is to bring AI into the system; elements that employ agency by for example analyzing the sounds produced by others and creating reactions based on that.

In a way, Cyborg and AI can be seen as opposing approaches. While the cyborg-approach attempts to incorporate the technology into the human, making it one hybrid system, AI on the other hand is writing the human out of the system (Andersen, personal communication, March 20, 2014), or attempting to give the computer human(like) intelligence - with the power to make decisions by itself, and act upon them. While employing AI seems like an (or maybe even the most) appropriate approach to implement the self-surprising effect that was one of the objectives of extending my system, I intuitively avoided it. Intuitively in the sense that I was quite sure I didn't want it in my system, without knowing for sure why.

A well working AI algorithm might be able to produce interesting textures out of any input; the action that makes the outcome successful has been taken *before* the performance moment, by means of careful programming and calibrating. This takes some of the essential risk out of the performance moment, which in relationship to my intentions and aims is not desirable. Instead, I'd like to see the computer-based

processing and automation of my Hybrid Instrument as a variety-generating engine that *offers* impulses, which I am free to accept (or ignore) in the improvisation setting - but always based on *musical decisions* that I make myself, as the computer is not able to make esthetical judgement (Boehme, 2014); I like to have the final word. The automation that appears in my patch is neither artificially nor naturally intelligent. Instead, it is based on gestures that I have made for my own reasons, in the (embodied) knowledge that they will be sequenced.

Those who believe that modern digital technology can replace their own phantasy, make themselves slave of that technology which only delivers standards (inherent to the respective programs). The main problem still remains, to mediate between sound-composition and composition itself. It is evident that advanced techniques can be an important tool to achieve that goal, but they are under no circumstance the solution of the problem.
(Boehme, 2014)

Make Use Of What Is There

Another important point is that our bodies are naturally inclined to efficiently make use of what is already there. As an example, Clark explains how our visual perception is not trying to continuously deliver a complete and detailed representation of the world around us to our consciousness or memory, but instead relies on readily available information as a perfect data bank for this purpose: namely, the world around us.

We find ourselves in command of a rich and detailed visual database in which information about the current scene is stored, organized, and poised for use. It is just that much of the database, in the case of vision, is located outside the head and is accessed by outward-looking sensory apparatus, principally the eyes. In each case, however, it is the fact that you can indeed access all this data swiftly and easily as and when required that bears out our judgments about the richness of our own knowledge and understanding.
(Clark, 2004, p. 69)

In the setting of the Hybrid Instrument on stage, an important feedback element that 'already is there' is the audible outcome of the processing; combining (embodied) knowledge of the instrument with the auditory information tells a lot about what is going on in the engine.

3.5 Technical Details: Multi-layered Interface

The user interface objects feature several methods to control the same set of parameters. This redundancy has several functions. It allows me to control the layering- and transformation engine with whatever limb is not engaged in controlling / playing other instruments - pressing some of the buttons of the hand controllers for example is not possible when playing the saxophone; the foot buttons still can activate the accelerometers so that orientation changes of the hands still are of influence. Another function is to enable different kinds of embodied control in different situations. Sometimes I imagine a transformation in its 2D-graphical representation (which asks for the iPad), sometimes bodily movement in 3D space feels more appropriate.

Hand controllers

One of my design objectives was that my hands should be able to operate the 'traditional' instruments, and I discovered that I found the use of gloves too intruding for wind instruments and the theremin. Looking at other available methods of attaching sensors, I found that the backs of my hands offers access to the huge orientational freedom of that part of the body, but as they were not actively used in performance it was possible to place the accelerometers there. The palms (at the opposite side of the hand) were also mostly available, so it was possible to situate buttons there that could easily be reached by the index-, middle- and ring finger in their natural *closed hand* position. To facilitate rotation of the hand, I decided to place the battery for the miniBee on the same metal brace that this is mounted on; this is held in position by the buttons on the other side and does not touch directly the flexible parts there, as to not interfere with finger movement needed for playing saxophone and theremin.

These objects only work in practice if - in my perception during performance - they do

not *represent* a transformation, but actually are *doing* the transformation. If that technically may be implemented differently (processing in the computer CPU) is a concern during development, but not on stage. Objectively seen, this is a misconception; one could also call it a self-deception. Of course, in my consciousness I *know* that the controllers are just a wireless remote control of parameters in a Max patch; even these parameters and the Max objects just representations of processes that involve a representation of sound signal, encoded in zeros and ones. But for my functioning on stage, these objects *are* what they represent. This conception is not consciously constructed; it intuitively jumps into existence, to facilitate the embodied action. Here we can discern a remarkable resemblance to the notion of play, as articulated by Huizinga (Huizinga, 1938) and extended upon by Caillois (Caillois, 2001).

[...] the consciousness of play being “only a pretend” does not by any means prevent it from proceeding with the utmost seriousness, with an absorption, a devotion that passes into rapture and, temporarily at least, completely abolishes that troublesome “only” feeling. (Huizinga, 1938, p. 8)

If we find that play is based on the manipulation of certain images, on a certain “imagination” of reality (i.e. its conversion into images), then our main concern will be to grasp the value and significance of these images and their “imagination”. (Huizinga, 1938, p. 4)

In that sense, not only my perception in the sense of the senses is altered during performance, but also my interpretation of the involved objects changes from a representational to a holistic view.

GUI

There are two graphical user interfaces involved in my setup; one is the max patch running on the laptop, the other one is the Mira app on an iPad which reflects a specially arranged selection of the UI objects of the patch. Their setup and function differ. The Max patch combines sound engine, mapping system and user interface; it is the ‘place’ where development and experimentation with new elements takes place. On stage, its visual

display has more or less a debugging function; incoming data from the motion sensors are displayed visually, the configuration of the audio hardware and signal levels are displayed. Being able to see this is mainly important during setup, and for functions that are not yet built into the Mira interface. As the Hybrid Instrument is not developed for general distribution, the GUI is not aimed to inform the 'universal user'. That means that sliders and buttons don't need to be labeled in an informative way, as long as *I* know (preferably intuitively) what their function is. The establishing of this knowledge is initiated in the conceptualization phase, then manifested in the design phase, and internalized in the practicing phase, so all relevant modes have their contribution to the building of the embodied relationship. As described in the section on mapping, the spatial encoding / distribution of parameters couples this process with natural capabilities of the sensorimotor system of the body.

Add Touch: iPad + Mira - Window into the Patch

The combination of visual representation of certain key elements of the engine, the ability to touch and manipulate them directly and - especially important - in manyfold, makes the iPad a valuable addition to the interface layer. Although technically being a screen, it is placed in the general *playing direction*, which means between me and the audience. A look at this screen distracts neither me nor the audience: for me, it is a 'dashboard glance' - it is in the periphery of my visual field, which makes the jump of my visual attention quick and non-interruptive in relation towards *performance mode*. For the audience, it apparently¹ also is not seen as distracting sub-mode; the perception of musical action outweighs other associations that people may have with this *gadget*.

¹ based on comments

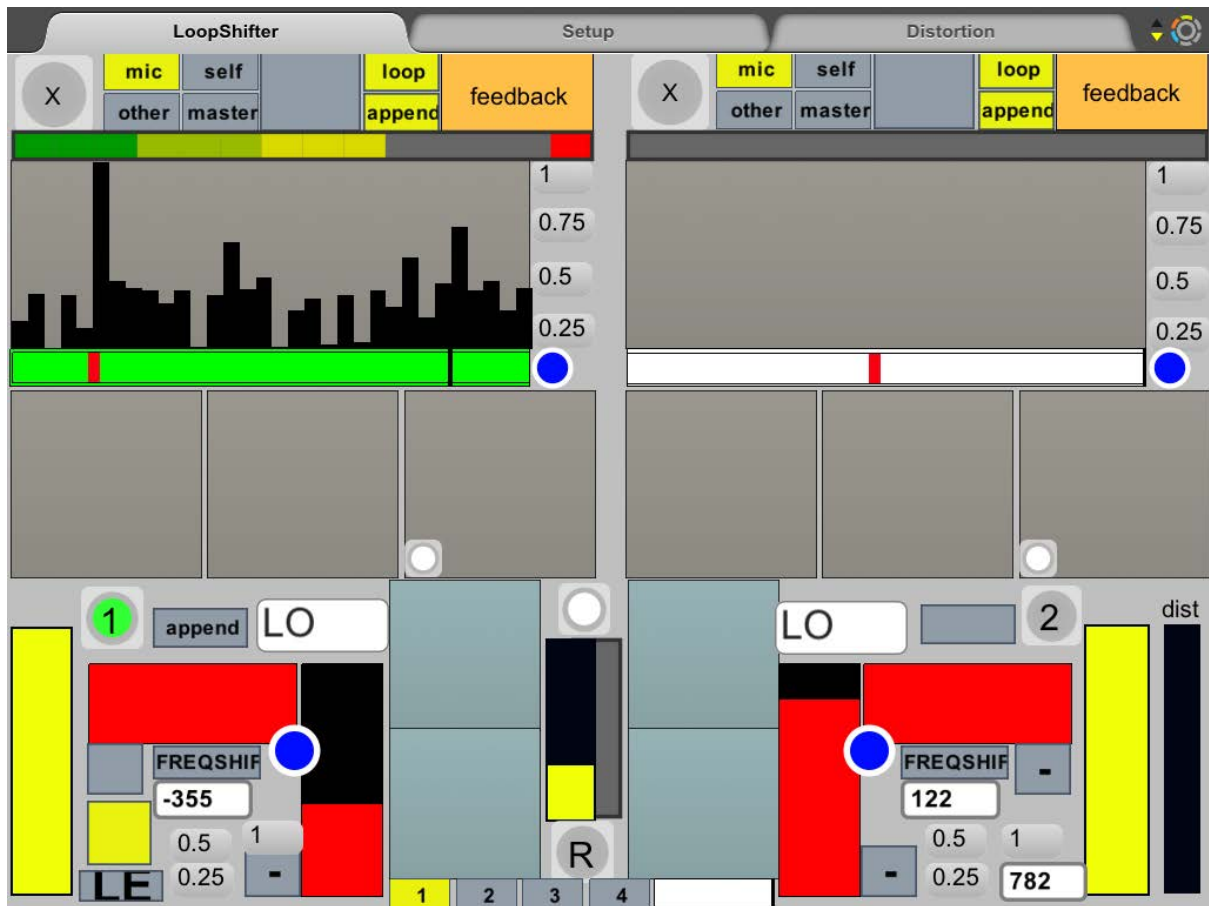


Figure 14: The touchable window into my patch: the Mira iPad app

Foot pedals, switches, buttons

I have a surplus of foot buttons and controllers. Essential in the Hybrid Instrument are the extended foot-switch of the DD3 and the volume-controller of the theremin. Also, there is an Arduino-powered foot pedal that sends OSC-messages to the mapping engine; I can assign the controlled parameter through the Mira or Max interface. This lets my embodied knowledge of using a foot pedal be combined with a diverse selection of parameters. A SoftStep foot switch board lets me switch modes or enable certain mappings of the accelerometers of the hand controllers when the buttons of these are unreachable (when for example holding a saxophone). Lacking tactile feedback and the undecided mapping make this the least-used part of my Hybrid Instrument.

Leap Motion (legacy element)

Although I was excited about the appearance Leap Motion (a device to detect the

position and orientation of fingers and hands within a certain field) and have included it into my setup as soon as it became available, it never really made it permanently into the Hybrid Instrument. Being on a fixed position, it required me to assume an absolute positioning much more rigid than that of the theremin; knowing if I was acting in the active field was not possible without intently looking, which conflicted with habits of the performance mode which I didn't want to change (for now). I *super-charged* the Leap by mapping positioning- and orientation information of a hand to the layering- and transformation engine; maybe a more limited use can be found. I noticed that the *gadget*-character imposed a sense of *magic trick* on my musical actions, which I considered would distract the audience from the content. It would also impose different sub-modes of looking to both me and the audience. These concerns outweighed the benefits (for now), and the Leap faded out of the Hybrid instrument - until I might think of another way of implementing it.

Conclusion

I consider the attempt to implement computer-based sound processing into my performance practice successful. The extended sonic possibilities of the Hybrid Instrument deliver not only non-static, developing textures and impulses for improvisation, but let the electronically transformed part ‘emancipate’ from merely being a background component to something that is also capable of taking the lead role. Intangible processes and objects in the software become *palpable* through the multi-layered interface; this connection feels real, natural and intuitive also in *performance mode*. I find the computer as an object on stage not obtrusive anymore; it is not absorbing my performance energy or blocking my communication with the audience. The Hybrid Instrument offers a solid base to extend and develop further upon, giving me the confidence of a known base to operate from as a new *playable core*; also in its current shape it offers enough depth and inspiring limitations to explore.

It was not the goal to develop a totally new instrument or performance practice. Rather I hoped for opening up my existing one, to find a way to connect it to the domain of digital sound processing. Neither was I attempting to find the ultimate ‘digital extension’ to my sound world immediately; instead, I tried to observe processes, difficulties and opportunities. The intuitive, embodied control gives me confidence that this method will remain in my performance practice, and that this confidence is opening the door to an organic and inspiring extension to the sound world that I can’t wait to explore.

Epilogue

I led the bicycle to the middle of the road, turned her wheel resolutely to the right and swung myself into the centre of her saddle as she moved away eagerly under me in her own time. How can I convey the perfection of my comfort on the bicycle, the completeness of my union with her, the sweet responses she gave me at every particle of her frame? I felt that I had known her for many years and that she had known me and that we understood each other utterly. She moved beneath me with agile sympathy in a swift, airy stride, finding smooth ways among the stony tracks, swaying and bending skilfully to match my changing attitudes, even accommodating her left pedal patiently to the awkward working of my wooden leg.

(Flann O'Brien, *The Third Policeman*)

Appendix A - Definitions

Sound Wish

The desire to produce a certain sound, even with equipment that is objectively seen not designed or even capable of producing that result.

Traditional instruments

The parts of the hybrid instrument that are traditionally known and seen as instruments; instruments in the classical sense. Like saxophone and flute, but also theremin. As opposed to the DSP parts of the setup, the laptop, hand sensors etc.; elements that have not originally been designed and widely been used as an instrument, but can nevertheless be treated like (or included in a hybrid) one.

Phase space

Borgo (2005) uses the term *phase space* in his description of the dynamics of improvisation, borrowing from the language of nonlinear dynamics:

The phase space of a system is a multidimensional "map," sometimes referred to as its "geometry of possibilities," which allows investigators to describe and analyze a system's dynamics. The number of dimensions of a given phase space is based on the degrees of freedom. (Borgo, 2005)

Affordances

I use the term *affordance* as coined by Gibson; here described by Magnusson (2010):

Gibson (1979, p. 127) initially defined an environmental affordance as "what it offers the animal, what it provides or furnishes, either for good or ill." In this definition, affordances are properties of the relationship between the environment and the agent (human or animal). The

relationship consists of a mapping between the properties of the environment to the potential actions of the agent. An instrument such as the violin affords certain actions to the human that it does not afford to a bee. (Magnusson, 2010)

Important difference to the notion of Norman (1988) is that the agent needs not to be conscious about the affordances.

Electro-Acoustic Instrument

In its most minimal form, an acoustic instrument that is electronically amplified, where this amplification has significant influence on the resulting sonic characteristics and is of artistic influence. More commonly used in the context of manipulating / transforming the electronic signal.

Embodied Interaction

Embodied Interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts. (Dourish, 2004)

Appendix B - Inspirational Concepts and Tools

There is no question that elements (objects and methods) in my Hybrid Instrument are heavily influenced and inspired by prominent precessors in the field of electro-instrumental practices. Inspired not in a conscious way, as for example a deliberate starting point or base-concept, but more by having installed a certain concept as a *given*. I got to know the concepts of instruments / interfaces like the *Hands* by Michel Waisvisz and the *Lady Glove* by Laetitia Sonami, as well as the methods found in software like **LiSa**, **Max/MSP** and **Ableton Live**¹ long before I considered my own Hybrid instrument, and when I did, these concepts were established in my subconscious view of the world as *axiomatic* concepts; their existence so logical that their *real* influence easily is forgotten.

¹ all these tools I encountered first in a 2002 Steim research period initiated by italian theatre director Andrea Paciutto

Appendix C - Following the Signal Path

In order to describe the working of my Hybrid Instrument from a different perspective, I follow the virtual path that a sound might take, from source to output.

- In this imagined case, I play a low tone on the pataphone, with a percussive effect at the beginning by means of the slaptongue effect. The tone is picked up by a SM58 type microphone, positioned on the ground in front of the tone hole of the pataphone.
- Entering the audio interface, the sound is pre-mixed with possible other sound inputs (zero-latency-mixing), and sent out into the DD3 Digital delay stomp box. Entering the audio interface again, it is sent to the main stereo out.
- The same signal is also available as a sound source for recording into a buffer in the Max patch, with cyclic recording and variable degrees of feedback with pre-existing content. b) Alternative inputs to the buffer are a) the main output, and b) the other buffer layer / c) the output of the current layer (both after stage 5)
- Depending on gestural control from either iPad or hand controllers, a playback window reads a small part of the buffer, following a number of certain patterns and rules (described below).
- The sound output from this reading operation passes a volume / panning stage, is filtered by a selectable filter (standard: lowpass filter with variable resonance), optionally is transformed by frequency shifting, and then sent to the output stage.
- This signal is also sent to the reverb stage
- The summed dry and reverberated signals are regulated by multiband compression, together with sounds from similar layers (two chains from 3–6 exist, plus optional live input, combined with stage 5 & 6), and sent out the main stereo outs of the audio interface.

Layering Engine details

Here are two methods that are used in the sound engine to play back sounds from the buffer to create interlocking patterns of audio- and control gesture loops.

The main difference is that *Method A* will play a sample defined by the playback window until the end, and only *then* check if the playback window has moved by then, whereas *Method B* will follow control gestures more directly. The details are minor, but determine the surprise level, directness of control and fragmentation of playback.

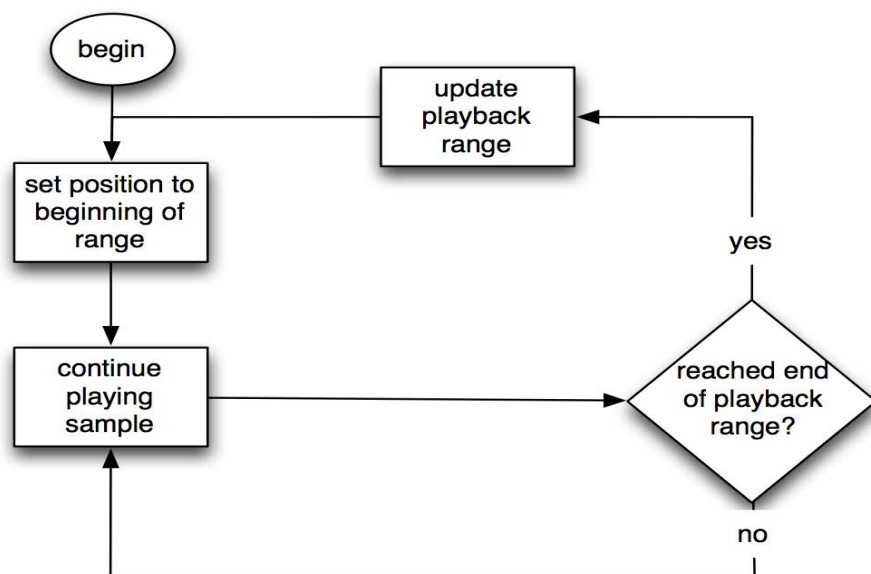


Figure 15: Method A

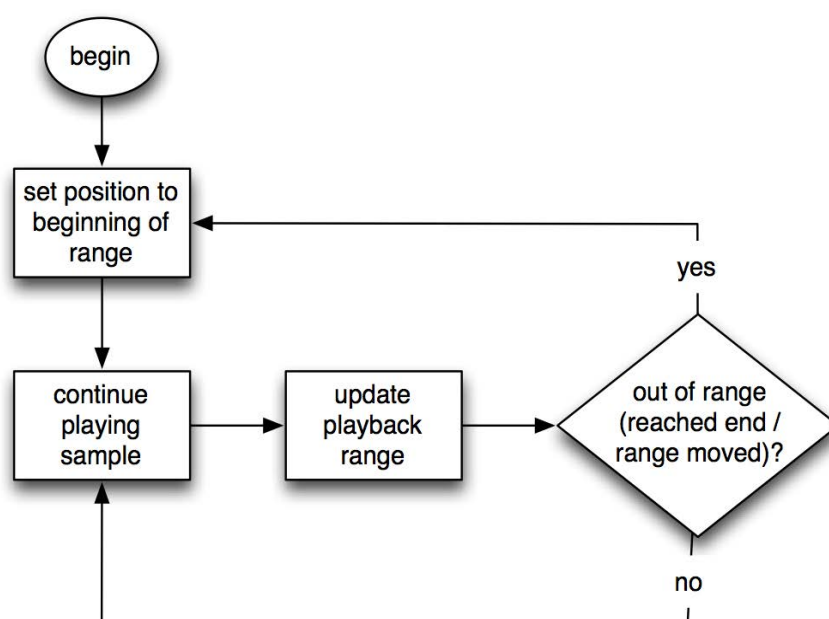


Figure 16: Method B

Appendix D - Further Possibilities

Use as Compositional Tool

Throughout my research I have recorded outcomes of sonic experiments. Although these were often made in the process of technical development in the studio, I realized that the audio material created in this way could form rich base material for a compositional process. The first application of this method took place for a project¹ where I provided the (electronic) musical transition between classical pieces played by a symphony orchestra. Sampling the last violin tone from Wagner's 'Lohengrin' overture, I stretched and *glitched* the sound with my layering- and transformation system to lead it into the distorted, amplified world of Benjamin Yusupov's '*Konzert für Viola und Orchester*'.

Cross Domain Performances

In the '*White Smoke*' project² I have de-coupled and reorganized the elements of my Hybrid Instrument. Combining the pataphone with gyroscope and magnetometer, wireless audio and infrared light allowed me to move freely in the theatre space, drawing light traces on the floor at the position of the tip of my pataphone whenever I played a tone. The playing orientation determined audio spatialization. These tones and spatial gestures were sequenced through a modified layering engine. The result was a combined audio-visual theatrical performance on a dance floor canvas.

Extension with Visuals

The sequenced control gestures of the layering- and transformation engine are a source for numerical data that can easily be applied to other domains. From the first experiments with sequenced control data in Max on I had included the visual domain, but in the process of focussing on the musical core of the Hybrid Instrument, I have set aside these possibilities for later research and application.

1 *Gift for Infinity*, for the 400th anniversary of the RUG (university) Groningen, together with NNO, Club Guy & Roni and Werc Collective. May 2014.

2 March 2013, Grand Theatre Groningen, with Club Guy & Roni

Lifting of Limitations

The limitations and constraints that were essential for the development of the Hybrid Instrument might lead to different *sound worlds* and performance practices when lifted. I intend to leave these in place for the time being, as a new *playable core*. But under influence of the *experimental mode* or a specific collaboration situation, a reconsideration or reconfiguration is always possible. The extended *sound world* of the Hybrid Instrument might also induce new *sound wishes* and performance practices which might contest the axioms and constraints, and new experimentation will have to prove if they can be missed.

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