An interface to an interface to an interface

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Abstract The paper relates some experiences from a recent production of orchestrating Conlon Nancarrow Piano Studies for performance on Pipe Organ. Reflections that surfaced during this work concerned the layered nature of interfaces, automation (and thus allusions to the different conceptions of artificial intelligence), and leaky abstractons. This also touches on the authenticity and perception of compositions and performances involving machinic elements, as an extension of human aesthetic capabilities.

The two performances in Stavanger konserhus and Nidaros Cathedral was recorded, with excerpts available at http://folk.ntnu.no/oyvinbra/Nancarrow/2019_recording/.

Keywords. Nancarrow, Automation, HID, Ontology of interfaces

Introduction

While working on a performance of Conlon Nancarrow's Piano Studies in a reorchestration for pipe organ, I stumbled on some reflections on interfaces in general and what role automation plays in our interfaces. This paper can be seen as a case study in this respect. In a very general sense, an interface is an abstraction, and ideally one that would abstract away details of the layers we want to interface with. It represents a reduction of available parameters, in order to provide a manageable means of accessing the larger world that is "on the other side" of the interface boundary. In an ideal processing system, each component is a separate entity that can be replaced without changing the overall function of the system. From the field of software development, we can borrow the Law of Leaky Abstractions, coined by Joel Spolsky (2002) stating that "All non-trivial abstractions, to some degree, are leaky." further he states that "Abstractions fail. Sometimes a little, sometimes a lot. There's leakage. Things go wrong." Looking at the relatively simple MIDI protocol for example, it acts as an interface for transmitting information about musical notes to be played on an instrument. It works reasonably well for this purpose, and this article is not a criticism of MIDI per se (although I do reiterate some points from Moore 1988). My concern is more that the abstraction is leaky, that we need to know *something more* than what the interface provides to make effective use of it. I use MIDI as an example here, but I could naturally also have used the musical score as an example of abstract representation of a piece of music. In a usual use case scenario, we also have audible feedback from the sound-producing device or instrument, and this feedback provides the user (composer, musician, ...) with the necessary detail to enable the interface to be used for nuanced aesthetic expression. This feedback is to some extent taken for granted, but is essential in the larger context of producing meaningful statements with the interface. When working with larger and larger systems of interfaces, we come to rely on these abstractions. In automated systems involving artificial intelligence (or not-so-intelligent artifices), forgetting that these abstractions are in fact leaky, can lead to some misconceptions that could put us on the wrong foot towards automation in general and artificial intelligence in particular. Criticisms of AI, from Dreyfus (1972) to more recent critique (Bickhard and Terveen 1995, Pontin 2018), often problematize representation and the abstract treatment of information. We can see a parallell to the leaky abstractions also here.

In addition to these leaky abstractions, the process of working with the Nancarrow compositions opened questions of automation in the creation, reproduction and re-interpretation of musical compositions. In this context of mechanistic reproduction and re-interpretation, also the well known issues of authenticity (Benjamin) resurface. Regarding the modular approach to interfaces, there is also a question of the scope of the interface. Do we include in the interface the whole chain from thought to realization, or

view it merely as a chain of relatively simple black boxes? One could say the main issue concerns the transmission of an idea or an emotion from human to human, via a number of intermediary steps. Each interface (step) providing an abstraction, and each interface also being leaky. I will not plunge deep into the adjoining issues in phenomenology, psychology, information theory, and so on, even if these questions open a whole panorama of further exploration in these fields. Keeping it on a more practical level, I still feel some surface reflections are worthwhile.

Nancarrow for Pipe Organ

The arrangement of the Nancarrow studies for Pipe Organ was first initiated in connection with the centennial for Nancarrow's birth. A number of concerts, events and symposiums were arranged in several locations (Willey 2012), so also in Trondheim. NTNU had recently built a pipe organ at *Olavshallen* concert hall in Trondheim, and it was a rather opportunistic move to see if Nancarrow's music could be played on this instrument. As it was an experiment in using the MIDI capabilities of the new organ, there was a number of unknowns, and the adaption of the compositions to this instrument were done in an ad hoc manner (more on this below). A combination of Organ, Disklavier and electronic transients were used. We were also invited to do the same repertoire at the Ultima festival in Oslo (Grønland Kirke) in 2013. An excerpt form this concert is available online (Brandtsegg 2013). Now, 6 years later, we were invited to do the same repertoire in Stavanger Konserthus. Their organ was built in 2012, but the completion of the MIDI control system was done in 2018, thus the instrument was now ready for the Nancarrow project. I also contacted the Nidaros Cathedral, asking if it would be possible to also do a similar concert there. Their *Steinmeyer organ* was refurbished in 2014, with MIDI integration, although the MIDI input had not been used to control the organ up until this point. When given the chance to do this repertoire again now, I decided I wanted to redo the arrangements from scratch, and avoid some of the ad hoc solutions from the first two concerts. Technically, this regarded both the channelization (orchestrating the single track MIDI file on to the available organ manuals while also keeping some parts on the piano) and the adaption of the material from the keyboard range of the piano (88 keys from A0 to C8) to the keyboard range of the organ (usually 61 keys from C2 to C7, but this varies from instrument to instrument). The organ I used in 2013 (Olavshallen) had slightly smaller keyboard range and also less manuals, with 4 3/4 octaves and 3 manuals, compared with 5 octaves and 4 manuals in Nidarosdomen. The number of manuals was important, as that determined how many different voices were simultaneously available for orchestration. The Nancarrow material was extended with improvisations for the 2019 concerts, where the improvisations were inspired from the Piano Studies. Some relatively simple improvisation algorithms were used, mostly salvaged from the software ImproSculpt4 that I wrote in 2007 (Brandtsegg 2007). A voice-to-midi converter was also written, inspired by the work of Peter Ablinger, e.g. in the piece Deus Cantando (Ablinger 2009). The improvisations were done on a combination of Voice, Marimba Lumina, software modules, Organ and Disklavier. In Trondheim, I also collaborated with the organist in the Nidaros Cathedral, Petra Bjørkhaug. Her improvisations in dialogue with the software opened new perspectives on the meaning of using automated composition and improvisation techniques in this context. Her performance on the Organ was very different from my implementations. Where my orchestration of Nancarrow was quite "angular" in character, with terrace dynamics and timbral changes, her shaping of the organ sound was fluid, transparent and breathing. I had no deep knowledge og pipe organs before this project, and I learned a lot from listening to Bjørkhaug, and also from organist in Stavanger Konserthus, Nils Henrik Aasheim. I discussed the small nuances of different flute stops with Aasheim, as I tried to come to terms with how to differentiate between them. His advice was "you just have to sit with it, listen and try, until you know the difference". Another unknown for me in this project was the traditional musical environment of the cathedral, where there is no culture for automated music making. Against this background it can be seen as a drastic step to introduce the algorithmic and machinic music of this project.

The sources

The midi files I have used as my basis was obtained from Robert Willey, from his work with performance an reorchestration of these pieces (Willey 2014). He had obtained these files partly from Clarence Barlow's sequencing on a Marantz Pianocorder, partly from Trimpin's scanning of the original piano rolls, and partly from his own adaptions of these sources. Even with the formidable skill and effort of Trimpin,

Barlow, Willey and others, there is some scope of deviation from the original work throughout the process these sources have been subject to. Each step in the process of scanning and representation in intermediate format could introduce artifacts. Any human intervention in correcting these artifacts in each step could also have introducted deviations from the original work. Rather than attempting an as authentic as possible interpretation, I found it a valuable asset to include these layered interpretations as the basis of the current realization. In the case where the midi files contained any orchestration or splitting of different voices, I did try these out in the first two concerts in 2013, but I decided to start over from the original single track piano representation for the 2018 production. Taking a step away from the proficient analysis of Willey, Gann (1995) and others, I wanted to explore what was there in the compound representation, close to the format that Nancarrow used for in his workflow. Nancarrow's coding of his music on piano rolls also can be understood as an interface. His compositional interface to realizing his musical ideas. This interface also comes with its own set of affordances, but also its own set of potential for error. In the punching of the piano rolls it was inevitable that punching errors would sometimes occur. Nancarrow corrected such errors by mending the paper roll with tape, and commenced punching. Subsequent scanning of such a corrected roll might be influenced by this method of error correction. Optical scanning might disregard the tape altogether, or a piece of tape might have gone missing due to material or physical reasons. In the orchestration for Organ, I attempted to extract the various motifs and lines of the compositions. In the the original piano roll representation, whese would be superimposed onto each other in a polyphonic manner. Separation of the different musical lines was done with the intention of articulating them more clearly. The instrumentation for organ can also be said to make the overall sound of the compositions more "tonal" than the original piano versions. OF course, the tonality does not change, as the notes are the same. However, the piano is more overtone-rich and more percussive compared to the organ. This difference comes out rather clearly in these compositions.

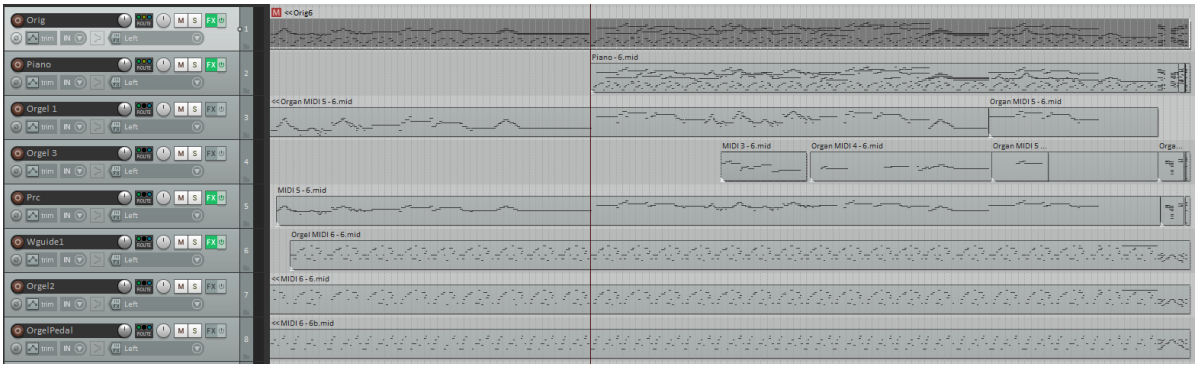

Figure 1: Excerpt from Study 6, splitting the original single track for purposes of instrumentation

The acoustic instrument behind the midi layer

When working with MIDI, we silently accept that the encoding of note information is independent from the instrument timbre used to realize the sounding result. In terms of clean abstractions (interfaces), this is a good thing. Then again, if we use a collection of drum set sounds to play back a piano score we would inadvertently change the meaning of the notes to such a degree that it could hardly be considered an equivalent musical statement. This is of course well known, as we are accustomed to changing synthesizer patches, importing new and better sample sets and so on. We could still say it is an issue containing *something more* when it comes to controlling acoustic instruments via MIDI. The instrumentality and affordances of an acoustic piano is so rich, and so laden with references, that an *abstraction* could be seen more as an *amputation*. Even if the action towards the interface, the piano keyboard, here too only consist of selecting which key to press and how hard to press it, any trained pianist would immediately know that there is so much more to it than that. How is the weight of the hand applied? How are the nuances of timbre shaped? How is this transmitted via MIDI? The example is even more rich with the Pipe Organ, since it also has the possibility to change the registration via the organ stops. Comparing this to the program changes on an electronic synthesizer would disregard the physical entity of the instrument.

Figure 2: The Steinmeyer Organ in the Nidaros Cathedral

Physical differences

The registration of the organ stops, selecting which sets of pipes to be used in the production of the acoustic timbre contributes significantly to the character of the resulting music. Not only in the most obvious sense that it controls the timbre, but also in determining what can be played (or heard) at all. The production of sound from an organ pipe is a physical process that takes some time, from the moment the airflow is allowed to enter a pipe until it starts to resonate a tone. This means that very short notes might be played but can not be heard. Similarly, there is an issue with velocity encoding of the parts played on the Disklavier. With velocities below a certain threshold (which varies for each instrument and each key, but usually lies around midi velocity 25 to 35) giving the result that the piano key in fact moves, but does not make a sound (the hammer never reach the string). The colloquial use of the term midi *velocity* (in the meaning of musical dynamics) is not entirely transparent. Velocity, meaning the speed of movement (of the piano key) corresponds to musical dynamics, but this is but a translation. There is a difference between the physical force used to press a piano key and the velocity with which it moves. Still we reckon this to be an integral part of the interface when playing a midi keyboard, most of the time without reflecting too much on the difference. The difference between the physical actions of each key on an acoustic piano can be subtle, and in many cases does not produce any significant obstacle in the reproduction of music. With the dense rhythmic passages resulting from some of Nancarrow's algorithmic compositional ideas, these nuances can significantly alter the reproduction. A minor difference in temporal response could even change the order of notes in the fastest passages of Nancarrow's music. Minor changes in temporal response of a Disklavier can happen at low velocities. The individual differences between organ pipes are even greater, each pipe having an individual physical reaction time due to the physics of sound production. Larger pipes taking longer to excite, and the different types of pipes (flute, reed, trumpet) each responds differently. Adding to this, the physical position of the various pipes affects the response time. With the speed of sound being around 340 m/s, it takes around 3 milliseconds to traverse one meter. The distance between organ pipes can be many meters, and as we know, even small amounts of latency matters in precise articulation. A human performer on the instrument will naturally take all of this into account, when they know the instrument. Making such adjustments on a programmed sequence is a meticulous process of attending to each individual note. For a programmed sequence, we have this expectation (or at least I did) that each note is transmitted equally

well through the interface, easily forgetting that the interface is leaky. We need to know the nuances of what is on the other side of the interface boundary to make expressive use of it. One thing that I did not reflect on before this production was the nuances of articulation with different organs. Each instrument having its own set of registration possibilities, to such a degree that the music must be adapted again for each new organ and each venue. Coming from arranging with MIDI, and seeing the 4 manuals of the organ, I initially thought I could use them freely in the orchestration. Becoming more famiiliar with the different organs, I realized the each manual usual has a very distinct role in the whole orchestra of this instrument. If I needed more individual voices, I could not expect to just move something from manual 1 to manual 4, and redo the registration as a wanted. Manual 1 and 4 would have their own separate set of stops, with their own very specific musical possibilities. Usually manual 4 would have the very powerful reeds and trumpets. On the Stavanger organ these are pointed directly towards the audience, with no swell doors, so the sound is very clear and direct. This means it has its specific role in orchestration, but this manual can not be used interchangeably with another one. Similar specialization of the manuals can be found on most organs. I found it interesting to experience this shift from treating different midi channels as interchangeable, to find them associated with their own characteristics and specialities. A trained organ player might find these insights mundane, but to me it was a discovery.

During playback of very fast passages, I would sometimes have hanging notes on the Stavanger organ. This might be related to mechanical issues with the closing of the air flow to the pipes. Perhaps it was related to very short notes, so that the valve would not have time to open completely before starting to close again. The behaviour was not repeateable out of context. It did not occur when slowing down the playback, and also did not occur if the density of notes was reduced. The organ did, however, close the valve properly when the same note was played again later on the same pipe. As long as these hanging notes did not occur too often, I thought it a nice effect showing how the mechanical components of the acoustic instrument could just barely keep up with Nancarrow's music.

The interface for MIDI automation of the organ stops is not standardized, and it seems the design of the midi standard does not naturally allow a perfect solution. Each organ builder has attempted to solve it in their own manner, each solution with its own pros and cons. In this project I encountered three different implementations of MIDI control of the organ stops. The organ in Olavshallen uses midi sysex messages, with the complete status of all stops contained in each sysex message. This means that changing one single stop requires re-sending the status of all stops. This implementation does not seem optimal, for the practical reason that one need to revisit all other settings just to change a single stop. Also, the use of sysex messages does not display easily in most sequencers's piano roll editors. In Stavanger, the organ stops are controlled by midi note messages on a separate channel. This means that it is relatively easy to "play" the stops, and the display of registration is easily visible in its own piano roll. It also means that the stops will only stay activated as long as the midi note is on. A standard action of a midi sequencer is to send note off for all active notes when stopping playback. This would then also deactivate all stops, making it somewhat cumbersome to inspect and fine tune the registration. In Nidarosdomen, yet another implementation can be found. Here, midi program change messages is used to control the stops. Program changes on an electronic synthesizer is used to activate a specific combination of synthesizer parameters, like a preset. The program change protocol does not have a message to de-activate a program, as the program would implicitly be deactivated when the next program is activated. When used to control organ stops, however, the organ builder utilized the program change messages so that each stop could be activated and deactivated independently. To enable this, the activation and deactivation messages each have their separate program numbers. For example, activating the first stop with program change 0, deactivating it with program change 1. Activating the second stop with program change 2 and deactivating it with program change 3. All of these three methods of midi implementation for organ stops does the job of automation truthfully, and all of them are quite impractical to work with during the design phase (while composing, and/or trying out various timbre nuances for instrumentation). It seems perhaps a midi NRPN (Non Registered Parameter Number) could have been a better choice, as it would allow selection of a specific stop combined with a separate value turning it on or off as desired. The different implementations of stop automation each have their affordances, and very much change the way it is possible and practical to work with registration during a composition. In Nidarosdomen one will need to play the whole composition from start to end to achieve correct registration automation, while in Stavanger one can not stop playback in the middle of the piece and then listen to individual voices. When the organ is played by a human, of course these issues do not surface, so it is a problem arising only with automated playback from a DAW.

Preparations and transients

Nancarrow was known for the rhythmic articulation of his pieces. To obtain the necessary articulation of transients, he would modify the piano hammers for a more percussive sound. Different methods of modifications were used, sometimes soaking the felt of the hammer in shellac, sometimes adding a leather strip with a nail to the hammer, and sometimes removing the felt altogether and covering the core wood with a metal strip (Willey 2014). Regarding the reorchestration of Nancarrow's music for pipe organ one could reasonably argue that this is a step in the opposite direction for articulation. Much of the effort spent in the reorchestration has been focused on articulation within the possibilities offered by the instrument, and the timing and durations of individual notes adjusted to maximise clarity. Some realizations of Nancarrow's music have also used electronic transients to enhance the articulation, and this was also utilized here. It can be a challenge to make the electronic transients fuse with the sound of the acoustic instrument. For my realization, I have implemented some custom transient synthesizers for this purpose, based on a selection of methods (physical models of strings and percussion, physically informed resonator instruments etc.). Moreover, the playback of the synthesized tones are done via transducers rather than conventional speakers. The transducers would be mounted on parts of the acoustic instruments (the body of the piano, the cabinet of the organ pipes) to create a physical connection. This works both for spatial merging of the timbres, and also for enabling a physical resonance in the material of the acoustic instrument. Once a fused sound was achieved, I could also experiment with dynamics and balance to allow the transient instrument to constitute its own individual voice in some phrases where desired.

Authenticity

In any performance with automated playback of compositions it is reasonable to ask to what degree this is "live". Even though Auslander says "...the playback of a recorded performance should be regarded as a performance in itself" (Auslander 2009), the perception of "liveness" (Emmerson 2007) could be different in each case, depending on the manner in which it is performed. With automated playback on acoustic instruments, we have a physical manifestation of the instrument in the room (and in case of the Disklavier, also the moving keys). The performance would usually be perceived as more "live" that if it was played exclusively over speakers (as with regular fixed media performances). Even though the machine reproduce the programmed sequence faithfully from performance to performance, some phenomenological aspects of performance also come into play. For me the dress rehearsal in Stavanger felt much more successful than the actual concert. So here it must (perhaps) come down to music appreciation rather than the actual content and phrasing of the performance? Some parts were improvised but 6 out of 8 pieces were playback of Nancarrow pieces in arrangements that will not change from performance to performance. This experience also sheds some light on the evaluation musicians do of their own performances. We could think it strange that an some of us might judge a performance poorly, while others, in the same band, on the same stage would judge it as successful. Difference of appreciation from audience members also included, but it is just all the more surprising when two people sharing the same stage might judge their common result so differently. After having this similar experience with a machine, it is all the more easy to accept having it with another human being. After all, I could not blame the machine for being affected by the mood in the room could I?

Layered interfaces, interfaces to interfaces

An interface is often thought to be neutral and transparent. Its purpose is to provide a means of translation from one domain to another, without changing the nature of the message in a substantial manner. In practice, we see that what we think of as an interface usually consist of several layers of interfaes, and that each layer provides its own ontological characteristics. Like the lineage of Nancarrow's compositions represented as piano rolls and scores, via scans of these rolls represented as midi files, the transmission of (DAW) midi piano rolls, via the midi interface, to the keyboard of the acoustic instrument (the organ and the Disklavier), via the mechanics of the instrument, to the physical sound producing elements (valves opening for the air flow to organ pipes, hammers producing vibrations in piano strings), and further on to the acoustics of the room where the pieces are performed. Concerning this view, with

layered interfaces, it can be hard to distinguish where our interface starts and where it ends. Does it start with the midi keyboard, or with the movement of our fingertips, or even earlier with the conception of a mental image of what we wish to do? What is the end point? Is it the numeric representation in the computer, the activation of the acoustic instrument, the resulting changes of air pressure, or the perception of music in the listener's ear and mind? The signal goes on, and the interfaces are layered.

Nancarrow's compositions often use algorithmic elements, like exotic tempo ratios, serial techniques of pitch and rhythm, canons, graphical shapes and more. Reinterpreting these compositions and also combining them with improvisations opened for me some perspectives on machine aesthetics, in the sense that an algorithm or program essentially provides a form of automation. It does something for us, prescribed by us, but something we would not be able to do manually (or by "hand"). We find similar uses of automation also in other algorithmic works, from Lejaren Hiller via George Lewis to David Cope, to name but a few. Compositions made by members of the Google Magenta team (Donahue et al. 2018) represent a more sophisticated technology based on A.I. and machine learning, but in essence they are still automations of layered interfaces. Similar statements could be made about modern tools for production incorporating A.I, like Wekinator (Fiebrink et al. 2009), the mastering tools of Landr, and the whole field of Intelligent Music Production (Reiss and Brandtsegg 2018). Usually, the design of these systems are informed by practice. In early A.I, systems that would emulate the decision making of a human expert would be called "expert systems". Even though one would not use the term "expert systems" to describe these more modern tools, each such automation relies on an understanding of the job it should do in expanding human capabilities. This is not to say we should limit ourselves to recreating human performance and aesthetics, but that there is considerable scope for developing interesting works and of learning more about ourselves in the direct interaction with the algorithms. But as with any musical instrument, we need to practice, spend time with it and stay long enough to internalize its working and become intuitive performers:

> Interaction with these systems in musical performance produce a kind of virtual sociality that both draws from and challenges traditional notions of human interactivity and sociality, making common cause with a more general production of a hybrid, cyborg sociality that has forever altered both everyday sonic life and notions of subjectivity in high tecnological cultures. (George Lewis 2018)

In the context of this production, we used some interactive software modules as an improvisation partner. The modules were quite simple in their musical abilities, using serial techniques for pitch and rhythm but implemented in such a way that the expressive changes (e.g. in tempo, phrasing and articulation) of the human performer would cause corresponding changes in the software output. The aim of this was not to reproduce any given style of improvisation or composition (even though in successful moments it might have similarities to the aesthetic of the Nancarrow studies). Rather than producing replication, it was intended as an incentive to the human performer to challenge habitual responses and thus attain a slightly new way of improvising. By any modern definition, these algorithms are not A.I, but the algorithms in the software have the ability to adapt to a context. Why would it even be relevant to align these tools for music performance with any definition of A.I? In my view it allows a perspective on how we use automated decision making procedures in all contexts where A.I. has been introduced. With the tremendeous opportunities this has to offer, it also shows the role of the human intervention at key points in the automated process, to keep an eye on the values we want to preserve in the dialogue with machines.

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