

Improvising Inside a House of Cards

New performance and music making through a collective networked instrument

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Abstract

This paper presents experiences and reflections related to performing improvised, live processed electroacoustic music within a context of networked music performance. The musical interaction is performed through a new collective networked instrument, and we report how the ensemble “Magnify the Sound”, consisting of two of the authors of this paper, meets the instrument in different networked performance situations, and how this is related to the affordance of the instrument. In our performances the network is inherent to our artistic practice, and we experience a phenomenological and somatic transformation in our roles as musicians, from individual instrumentality to shared instrumentality. The instrument invites to new forms of music making and contributes in fundamental ways to the ensemble’s musical communication and artistic expression. In the present paper we outline our methods of working artistically with the networked instrument, and we point at some artistic results. We then discuss how the collective instrument has facilitated new performance and musical practice within the network.

1. Introduction

1.1 Networked music performance (NMP)

The earliest experiments with networked music performance over the Internet can be traced back to the early 90`s (Sawchuk, Chew, Zimmermann, Papadopoulos and Kyriakakis 2003), at the time sending control data between computers over a public network. In the late 90`s music performance experiments were reported with successful audio transmissions between various locations (ibid.). In the academic institutions there is a long history of networked musical performances, and there are several communities working within this field. Many of these cooperations still use non-commercial protocols for transmission of sound and video. See Rottondi, Chafe, Allocchio and Sarti (2016) for a comprehensive survey. The increased capacity in Internet backbone networks over the last two decades has enabled households to install a fixed

Internet access connection with enough capacity to transmit high quality audio and video. This has again opened the opportunity to transmit and receive multiple high quality audio streams over long distances behind standard home routers. Professional music studios, concert venues, and artists may now interconnect and initiate music collaboration. Assuming the trend of increasing Internet access will continue, it will open for households to receive and broadcast high quality audio and video streams at a level that today is accessible only to larger companies, broadcast stations and academic institutions. Experimenting with NMP has become even more actualized the last years with the emerge of conferences and concerts that specialize within this context. In addition, the focus within this field has had a further boost in research and technological development since 2020, much due to the Covid-19 pandemic where NMPs in many ways have become part of everyday musical practice independent of musical genre. It is worth mentioning that NMP research has until now mainly focused on the technical aspects specifically related to the issues of latency and how this translates to the synchronisation and coordination between musicians. (e.g., Bartlette, Hedlam, Bocko and Velikic, 2006; Carot, Werner and Fischinger, 2009; Chafe, Cáceres and Gurevich, 2010) Even though there has been an increased attention towards NMP the later years, there are as far as we know no established practises for constructing generalized frameworks for NMPs in various musical situations.

1.2 A technical framework for our networked music performance:

Since 2005 Department of Information Security and Communication Technology and Department of Music at The Norwegian University of Science and Technology (NTNU) have cooperated in investigating high quality multimedia over IP networks through the project “Nettmusikk”. Technical work has emerged into musical applications including several music performances and concerts, teaching, and "real time" music productions¹. To enable these activities a local network consisting of a mixture between dedicated fiber lines and a VLAN around the city of Trondheim has been set up to reach different key buildings constructed for music performance and production. In addition to this network, several of these buildings have installed audio and video equipment optimized for production and performance within this context. This means that there is established a comprehensive *"virtual" NMP studio* across our city which has been, and is, used to explore NMP in wider and smaller scales (Engum and Wittner 2018). Many widely used system solutions, both commercial and open source, for music

¹ <https://musikk.hf.ntnu.no/2017/12/11/nettmusikk/>

production and collaboration, rely on discovery protocols² to find and connect to peer nodes. Such protocols are designed to run in LANs. When scaling outside our “virtual” NMP studio LAN to reach access points behind home routers on public networks, we have applied VxLAN tunnelling for maintaining system integration between the different nodes, gathering and distributing all traffic from a main studio seated inside the LAN. Finding solutions for cooperating over public networks has been important to the musical activities described in this paper, since most of the performers have been connected from behind home routers during performance.

1.3 Magnify the Sound:

The experience gained from the “virtual” NMP studio described above establishes very good premises for the artistic development of the ensemble “Magnify the Sound.” The ensemble consists of Trond Engum on guitar and electronics, and Carl Haakon Waadeland on drums/percussion. We have performed together since 2010 in various constellations exploring the interplay between acoustic instruments and live processing in a free improvisation context. As musicians/researchers we have also taken part in the projects: T-EMP Communication and interplay in an electronically based ensemble³ (2011-2014), and Cross-adaptive processing as musical intervention⁴ (2016-2018), both projects conducted at NTNU. Magnify the Sound combines a continuation of experiences from these different constellations and projects with an aim of developing a new artistic expression through interaction with a specially designed performance system that serves as a collective networked instrument for the ensemble. To better understand the affordance of this instrument we will start by briefly describing the fundamental functions of the ensemble’s performance system and how this is further augmented into a collective networked instrument.

2. From joint multi-instrument to a collective networked instrument

2.1 The joint multi – instrument: Facilitating technology for new musical expression

² <https://openconnectivity.org/developer/specifications/upnp-resources/upnp>

³ <https://www.researchcatalogue.net/view/48123/48124>

⁴ <http://crossadaptive.hf.ntnu.no/index.php/about-the-project/index.html>

Before we explain how the collective instrument was augmented for use in an NMP context, we shortly describe how its fundamental functions and musical affordances have been developed as part of the ensemble's artistic expression. The basic performance system consists of a computer, an audio interface, and different interfaces for controlling real time processing of acoustic drums and electric guitar. In its basic form we can compare the system to a digital live mixer with built in effects, where one musician live processes input sources in real time using different controllers. The instrument does not produce sound or playback on its own and is therefore dependent on input signal from the performers. The system can receive several inputs, and single inputs can be routed to several different channels at the same time. Single inputs can also be combined before routed to different channels. Each channel can be muted or activated and can receive control messages for adjusting volume, panning and sends to other channels. The channels are inserted with series of different effects, where single effects in these chains can be activated or not during performance, affording several combinations of which effects that run through each other or in parallel at any given point. In addition, there is a series of effects outside the channels that can be fed from the sends on each channel. Inside most of the single effects there is a variety of parameters that are mapped to be controlled static or dynamically during performance. Controlling amount of overdrive within one effect and adjusting delay time within another could be two examples amongst the many possibilities of parameter control. The processing techniques implemented in the system are in principle tailor-made to the playing style of the mentioned performers and their instruments but have also been used in many performance settings with other musicians and instruments. The choice of processing techniques spans from extensive use of different convolution techniques, granular synthesis, pitch manipulations, delays, reverbs, and overdrives to name a few.

Viewing this system and interaction in an electroacoustic music tradition is best compared to a mixed music scenario, where acoustic instruments are captured by microphones and manipulated by different processing techniques in real time. Similarities in this comparison are that the processing system itself is precomposed and the system can be activated or not to change the timbre or to accompany the acoustic instruments during performance. One of the main differences is that both performers in this case are detached from the direct sound of their instrument during performance, which has consequences on many levels. This will be further discussed later in this article.

[Insert here: **Figure 1.** Joint multi – instrument. Continuous lines being audio signals and dotted lines control messages.]

Figure 1 shows the system design in its most basic form when both musicians are at the same physical location. The musical interaction is based on improvisation, and there is a series of effects that can be activated and manipulated both on single instruments and on the totality during performance. This means that the instrument is not put in a static setting but affords several combinations and manipulations of effects that can be activated or not during an improvisation. This undetermined structure affords a large degree of flexibility and variation, and in addition, the instrument is always *in development to meet new musical needs*. Even though this system opens for large variations in its use, the choice of effects and how they can be manipulated are selected and fine-tuned through years of practise and rehearsal. The joint multi-instrument has become a fundamental contributor to significant characteristics of the ensemble's sound. A crucial aspect of the interplay between the drums, the guitar, and the joint multi-instrument is the *interdependence* between them: The sounding output of the joint instrument might have a larger impact on the musical choices and the musical performance than the separate sounds of each musician's individual instrument. Thereby, the joint multi-instrument also has a major effect on the musicians' way of performing, and on the ensemble's aesthetic expression. This will be discussed further later in this paper. Examples of live performances showing the interplay with the joint multi-instrument can be seen at a presentation Magnify the Sound gave at a conference arranged by Kulturrådet (The Norwegian Cultural Council) (2019)⁵ and a concert at ICLI: International Conference on Live Interfaces (2020)⁶. To obtain a close relationship between the individual instruments and the joint multi-instrument, it is a necessity that the latency between input and response is kept as low as possible. In this case both the system design and the choice of processing techniques support that premise.

To seek further artistic achievements and new possibilities of artistic expression, we have extended our instrument by integrating the network as a crucial part. Thereby, the network has become a critical material of our artistic work. In the following we will demonstrate how our concrete decisions of augmenting the multi-instrument with NMP functionality and involving more performers have enabled the ensemble to find new ways of working artistically, and consequently obtained new artistic results.

⁵ <https://www.youtube.com/watch?v=W-1qIPJNM7s>

⁶ <https://youtu.be/ZvbG5WJFuz8>

2.2 The collective networked instrument

Our collective networked instrument (CN-instrument) came to life by merging the two described practices that were existing within Department of Music, NTNU: The NMP competence and framework, and the joint multi-instrument of Magnify the Sound. There were two quite different reasons for creating this new instrument. The fundamental *artistic motivation* was, as mentioned above, to make the network an integrated part of our joint multi-instrument to explore new forms of music making and seek new artistic practice and expressivity. Secondly, we were faced with an uninvited *practical need* of a networked instrument because of the physical separation between people caused by the Covid-19 pandemic, which struck Norway in March 2020. At that time Magnify the Sound was recording an album, and suddenly we were not allowed to be together in the same physical room. Therefore, it became impossible to continue our musical practice in a traditional manner, and our activities needed to be moved into an NMP context to complete the recording of our album.

Since the CN-instrument grew out from our already established artistic practises, it became natural that these perspectives gave the premises for the instrument's system design. Firstly, because the musical interplay is not based on pre-composed material or fixed synchronisation points, the need for a tight response time between the performers was of high importance. This to facilitate that the musicians could follow each other and the musical development. Secondly, the response time between the acoustic input and the joint multi-instrument needed to be kept as low as possible to maintain the gestural interaction and perceptual connection between the musical intentions and the sounding results. These *artistic conditions* led to the *technical premises* for constructing the CN-instrument: It should have low latency, a large flexibility concerning signal routing, and listening conditions that detached the performers from the direct sound of their acoustic instruments. The importance of detachment from the acoustic sound will be discussed in depth later in this article. In addition, this system was constructed to be operated from three different locations, of which two of the locations were connected through public network. The development of the CN-instrument was done in two steps:

The first step was to recreate the traditional studio session for recording the album, and at the same time expand the instrument to include concert performance in an NMP context.

[Insert here: **Figure 2.** Enabling for recording and live performance. Continuous lines being audio signals and dotted lines control messages.]

As shown in Figure 2, the system for recording and live performance involved a 3rd performer, an audio engineer, performing live production behind a home router by remotely controlling signal routing and mixing through the NMP studio at Department of Music, NTNU. The drummer (musician1) was physically placed in the NMP studio listening through headphones. Musician 2 (guitar, live processing) was running the joint multi-instrument behind a home router. This setup was used for two recording sessions and a concert at the NowNet Arts Online Performance series 2020, May²⁷

The second step of developing the instrument involved the inclusion of live visuals by inviting a video artist as a 4th performer in our sessions.

[Insert here: **Figure 3.** Enabling for live audio/video performance. Continuous lines being audio signals, medium dotted lines being video signals, and small dotted lines control messages.]

As shown in Figure 3, musician 1, musician 2 and the audio engineer still have the same functionality and level of control through the CN- instrument as in Figure 2. In addition, the video artist remotely controls the VJ software running inside the NMP studio. The remotely controlled VJ software receives live video from musician 1 and musician 2, and these live video feeds are then mixed with pre-recorded video and then synchronized with the sound. This system was used when performing two concerts late in 2020: Dokkhuset⁸ Trondheim, in October, and NowNet Arts Conference⁹ in November 2020. In these concerts the performers were placed at four separate locations where they operate various parts of the CN-instrument in real time.

⁷ <https://nownetarts.org/series-2020>

⁸ <https://youtu.be/EWt4skw2Pww>

⁹ <https://nownetarts.org/conference-2020>

3. Methods and artistic results

3.1 Methods

The methods in our artistic work have been inspired by earlier experiments and experiences related to our performances with live electroacoustic ensembles. We apply a blend between musical performance and technological development based on the performers' experience through interaction with the CN-instrument in various musical situations (cf. Figure 3). The process is far from linear and can be viewed as an iterative interplay and dialogue between the performers and the instrument/system (illustrated in Figure 4). A valuable tool for the method is to document the performances through sound and video, making it possible to comment not only on the experience directly after a performance, but also for listening in retrospect when detached from the performance situation. The experiences and suggestions for improvement will then be applied both to the musician's performance and to the technical set up of the CN-instrument's behaviour. Examples of this cyclic dialog can involve everything from discussing artistic choices, tuning the behaviour of the joint multi-instrument, adjusting the individual listening conditions, balancing the sound production, adjusting camera settings, and so on. All communication and adjustments of instrument behaviour has been done over the network during the whole process.

[Insert here: **Figure 4.** An illustration of how the working process within a session can be generated.]

This method is dependent upon proper solutions for communication and listening conditions for the participants to be fruitful. To give further insight into how this method is applied in our work, we will point to four examples in our video documentation, focusing on some of the various aspects that can occur during a session, how we discuss them, and how this is further implemented in our practice.

Video example 1: Testing the inclusion of a new acoustic instrument (glockenspiel). Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums and glockenspiel

Video example 2: Processing finger cymbals and discussing challenges related to live processing the drums while playing the guitar. Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums.

Video example 3: Tuning the collective networked instrument. Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums.

Video example 4: Integrating video with music and tuning the total output. Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums, Johan-Magnus Elvemo, live visuals, Otto J. Wittner, network operator

3.2 Artistic results

The ensemble's NMP activities have so far resulted in several music productions and concerts since March 2020. Overall: *Four recording sessions* that have resulted in a full-length album for release in 2021, and *three concert performances*. Since the concerts led us to develop the full functionality of the present CN-instrument, this paper will focus on two of the concerts when reflecting upon and discussing our networked performances and artistic results.

The first of these two examples was performed at the NowNet Arts Online Performance Series 2020, May 2.¹⁰ Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums. The ensemble did a 20-minute performance using the first CN-set up as shown in Figure 2. The concert took place over Zoom, where the sound from the CN-instrument was sent through one client in this video conferencing system. The sound from the instrument was delayed and synchronized with the camera feeds from the performers, placed at three separate locations. The concert was followed by two internet jams with members of the NowNet Arts Lab Ensemble with performers located in Canada, USA, and Belgium.

The second example is a performance from the NowNetArts Conference in November 2020, November 5.¹¹ Featuring: Trond Engum, guitar and live processing, Thomas Henriksen, audio engineer, Carl Haakon Waadeland, drums, Johan-Magnus Elvemo, live visuals, Otto J.

¹⁰ <https://youtu.be/4sEeoYSBiKA>

¹¹ <https://youtu.be/dsqArYwLSso>

Wittner, network operator. The ensemble did a 20-minute performance with additional live visuals using the present CN – setup as shown in Figure 3. In this concert the performers were placed at five separate locations. Also, in this example the sound and video were synchronized inside the CN-instrument before transmitting through one Zoom client to the audience.

It is worth mentioning that the process that led to the artistic results has consisted of time-consuming work concerning a vast number of technical issues and facilitation of the CN-instrument. The instrument itself has many different software and hardware that are interconnected and running from separate locations at the same time. Using time to set up effective communication lines between the local stages has been of utmost importance to support an effective workflow during the different sessions. At this point the instrument answers to our original artistic ideas but is still flexible and affords expansions for further development and use.

So far, we have described the basic structure of our CN-instrument, the methods used and some of the artistic results. We will now discuss how the CN-instrument and the network establish new musical situations, and how this changes the perception of our roles in the musical interplay. Moreover, we reflect upon how the network acts as an artistic material for music making, and we discuss our experiences from internet jamming.

4. Discussion: New performance and music making within the network

4.1 A networked interactive music system

Our CN-instrument is *an interactive music system* and is as such part of a tradition within electroacoustic music that has lasted several decades. – A very interesting presentation and outline of the development of various interactive music systems (IMS) is given by Drummond (2009). He points out that the term ‘interactive’ is used with quite different meanings within the field of music and new media arts. According to Rowe’s definition in his book “Interactive Music Systems” (Rowe 1993), a characteristic feature of an IMS is a computer music system “listening to”, and responding to, a performer, - whereas Chadabe, referring to his own interactive work, proposes the term ‘interactive composing’, and underlines that the musical product from these interactive composing instruments is a result of a *shared control* of both the performer and the interactive system (Chadabe 1997). As Drummond (2009) comments, interactive systems are often classified related to different degrees of participation/inclusion of performer, system and audience, and there has also been a focus on describing interactive

systems in terms of digital musical instruments, where mappings between inputs and outputs (e.g., gestural input and sonification) are typical constituents (cf. Miranda and Wanderley 2006). – Summing up, Drummond concludes:

The interactive compositional possibilities explored by early practitioners still resonate today, for example – the concept of shared control, intelligent instruments, collaborative conversational environments, and the blurring of the distinctions between instrument building, performance, improvisation and composition. (Drummond 2009: 132)

A fundamental consequence of our interaction with the CN-instrument is, by definition and construction of the instrument itself, that *this interaction takes place over the internet*. – What then, characterises our networked performances? Generally speaking, a networked music performance is commonly said to establish an interaction of three spaces:

1. A local stage (where each individual participant is physically placed)
2. A remote location (referring to the position of the others)
3. A mediating, in-between space (where the networked activity is happening)

Figure 5 illustrates a typical NMP setup for Magnify the Sound. The two musicians are separated by physical/social distance from each other, as well as from the audio engineer, the video artist, the network engineer and the audience. They are all connected through the mediating space.

[Insert here: **Figure 5.** Illustration of an NMP setup for Magnify the Sound]

Interaction with the CN-instrument happens at neither of the performers'/participants' local stages, - it takes place in the mediating space. When the participants in the artistic interplay illustrated in Figure 5 are playing on their own personal/individual instrument, or interacting with controllers situated at their local stages, they are all at the same time performing on, and interacting with, a common networked interactive system. This has dramatic consequences for

the performance of the different participants and affects the way the performers experience their artistic contribution.

4.2 Fragmenting and reshaping the acoustic and electroacoustic premises.

Before we discuss the performative consequences for the participants and how their experience of their contribution changes when interacting with the CN-instrument, we will first look at how the acoustical environment and technical framework changes compared to a traditional performance situation. We will then discuss why the network contributes to create a new performance situation for the ensemble that can't be recreated in a traditional performance context.

In Figure 5 we show the connection between the participants placed at different local stages. All local stages have different acoustic environments in terms of room size, acoustic treatments and so on. They also have different technical frameworks ranging from number of microphones used and microphone placements, to listening conditions and network quality. - The drummer performs from a medium-large studio acoustically treated for sound recording. The drums are captured through multiple microphones, mixed, summed and sent back to the performer through headphones. The choice of listening through headphones in this situation is important for two different reasons. Firstly, for *separating the microphones and drums from other sources in the room to avoid bleeding through microphones*, secondly to *detach the performer from the direct sound of his acoustic drums*. From the CN-instrument perspective this affords the possibility to have separate control over the acoustic drum production, and at the same time controlling which parts of the drums that are sent as input for live processing. Further, the lack of bleeding from other sounds in the room prevents live processing unwanted sources on the same channels as the drums during performance. From the performer's perspective the detachment from the acoustic instrument brings the auditive and performative focus closer to the CN-instrument. The drummer's headphones mix is identical to an audience perspective and corresponds with what is sent out from the CN-instruments main output.

The electric guitar and live processing are performed from a home studio connected to the CN-instrument via public internet. Neither the guitar nor the joint multi-instrument uses microphones placed at this location, and therefore avoids challenges related to separation and bleed through microphones. Since the acoustic sound of the electric guitar is inconsiderable in this context it is also easier to detach the performer from his instrument in order to get closer to the CN- instrument. The performer listens to two separate speaker systems in order to create the

illusion of playing with the drummer in the same physical room. One system represents the acoustic sounds of the drums, and the other represents the combination of processed drums and guitar. The joint multi-instrument receives input from the acoustic drums and the guitar and then transmits the processed results on separate channels back to both one of the speaker systems and the CN-instrument.

The audio engineer monitors and controls all in and outputs to and from the local stages, and mixes all channels before sending to the main output of the CN-instrument. The video artist listens to the CN- instruments main output while monitoring and controlling all video feeds from the local stages before mixing them and feeding them to the CN-instruments main visual output. - In addition, there is a dedicated communication system with sound and video for keeping fluent communication between musical activities. This system is running outside the CN-instrument and the content is in this case represented identical at all local stages (cf. Figure 6).

[Insert here: **Figure 6.** Illustration of the listening and communication system]

As seen in Figure 6 the homogenous acoustic and technical environments normally experienced at a concert stage or in a recording studio are changed. *The traditional practice of balancing the performance inside the same physical room is shifted towards balancing several physical rooms into one virtual room which in this case represent the totality of the performance.* When performing in a traditional context playing amplified music together at the same physical stage, the possibility for separation between sound sources, bleeding between microphones and controlled listening environment for individual performers are difficult to obtain, and in most cases impossible. At the same time these same issues are further reinforced through the processing system since bleeding between separate incoming live inputs are further reinforced when adding different processing techniques. During the described activities all participants communicated through two separate systems: One system dedicated for musical performance (sound and video) where the main musical and visual output also reach the audience, and one dedicated for communication between the performance activities (sound and video).

In any musical interplay there is a potential danger when the focus of the performer is pointed more towards the instrument itself than on the musical output. Balancing this dual focus has been a challenge throughout the whole work. Fortunately, the time span between building, learning, and interacting with the CN- instrument has gradually decreased during the process, and as a result led us to focus more on instrumentality and new directions within our artistic

practice. In other words, putting time into rehearsing and performing through this system has moved us closer to our common instrument, resulting in a more intuitive and direct interaction in performance situations. In addition, expanding the ensemble with an audio engineer and a video artist has extended the functionality of the CN-instrument and at the same time changed the interaction between the musicians and between the musicians and the instrument. The musicians no longer only react to the sound but also to the output from the video artist and vice versa. This interdependence between musicians, audio engineer, video artist and instrument leads to a mutual responsibility for the interaction in the performance situation. By taking these elements into account, we could argue that *the network itself has become an inherent part of enabling interaction within the ensemble*. Instead of preparing a conventional concert in a room with physical placement on the stage, we are separated and can arrange the local stages into a new flexible virtual stage. Furthermore, the feeling of a closer connection to the sound of the CN-instrument has helped to shift our focus more towards instrumentality than on the instrument itself. Because of this, and even though we have been physically separated, the sense of being present at the same “virtual” stage has gradually increased during the process. - So, how do these changes affect our experience of performance and the perception of our roles in the musical interplay?

4.3 New experience of performance: A phenomenological and (or) somatic transformation

When the drummer in our NMP-setting is hitting a drum, the audio output is not necessarily an ordinary “boom” drum sound, but rather a sound created because of the guitar player processing the sounds of the drum set. This is something the drummer must consider when playing. The drummer’s instrument is here not just the drums, - it is the integration of the drums and our common interaction with the collective networked instrument. This establishes a totally new musical situation as compared to performing on the acoustic drum set.

In the ordinary, usual way of performing music, each musician interacts with her or his instrument in a communicative interplay with the other musicians, - and this has been made possible due to years of practice through which the instrument has become a prolongation of the musician’s body. This is also pointed out by Alperson, when he argues: “Musical instruments are not objects divorced from performers’ bodies, so much so that, in some cases, it is difficult to know where the body ends and where the instrument begins” (Alperson 2008: 46). Furthermore, he states: “The performer’s musical instrument is better understood as an amalgam of material

object, the performer's body, and bodily disposition as habituated by the developments of various musically related skills" (ibid.). However, in musical interaction with our presented joint, CN-instrument, this interlocking relationship between musician and personal, individual instrument is radically changed. - The musician's interaction with own instrument has consequences for, or is manipulated by, the sound or action generated by another musician, in unilateral or bilateral ways. Thus, the musician loses control of the sonic output of her or his instrument, and the unified body of musician and instrument is chopped up. This may, indeed, be very frustrating: Our usual, habitual and embodied interaction with your instrument may now *not* give the musical results that you want and expect. - A such feeling of losing control in music performance may often happen when performing with an interactive music system. As touched upon earlier, Drummond (2009: 124) points out that a different notion of instrument control is presented by interactive systems from that usually associated with acoustic instrument performance and refers to the concept of *shared control* as more appropriate for many of these settings.

In Magnify the Sound we do not only have a common responsibility for the musical development, but we also have a shared responsibility for *the sound* itself. In particular this is the case for the output of the processed drum set sounds. Based on this basic premise for our musical interaction we have experienced that in our performances within various contexts with our CN-instrument, there is a new and very exiting potential of musical expression related to a change of our perception of our performance and the way we interact with our instruments. Instead of *I am performing on my own instrument*, we shift to *we are performing on our common networked instrument*. In this way the somatic experience is not my instrument being a prolongation of my body, but rather an extended instrument, consisting of the totality of our musical/technological setup, being a prolongation of an enlarged body of all participating musicians. Seen as such, *the network establishes a new kind of embodiment in our musical interaction*, and we perceive a *phenomenological shift* from *individual instrumentality* to *shared instrumentality*, which is "...involving an assemblage of multiple instruments and combining the intentionalities of more than one performer..." (cf. Peters 2017: 75). - This phenomenological and (or) somatic transformation also challenges our experience of *proximity*, - to our own instrument, to our fellow musicians, and to our audience. To exemplify: When the drummer is interacting with the CN-instrument, he is, so to speak, moving away from his drum chair and into the mediating

space, thereby losing proximity to his local stage, and gaining larger proximity with the remote location. A similar phenomenological transformation is experienced by the other participants. Thus, the fundamental musical and interactive constituents of our performance and performative actions take place in the mediating, in-between space, *with “equal” proximity to each participant’s local stage and remote location.* - It is also in this mediating space we meet our audience.

Although we argue that artistic proximity and our meeting with the audience happens in the mediating, in-between space, *we are* physically and socially separated from each other and from the audience in our NMP. This *does* make a difference in our perception of the communication, - with our fellow musicians/artists as well as with the audience, as compared to a situation where we are all together in the same physical room. This has phenomenological as well as somatic aspects. – Interesting studies of effects of physical separation on the subjective experience of musicians have been undertaken by Iorwerth and Knox (2019). They conducted empirical investigations of three pairs of classical musicians that were recorded in acoustically isolated spaces with audio and video links. The themes found to be most challenging for these separated musicians were musical issues (e.g., tuning and blending, and reduced risk-taking), communication, and social interactions (ibid.: 297). In the various performances with our CN-instrument we can, to different extents, relate to the findings of Iorwerth and Knox. – One important difference between the musicians in the Iorwerth and Knox investigation and Magnify the Sound is that the former are classical musicians whereas we, the participants of Magnify the Sound, have background from various genres within rock and jazz. We have years of experience with studio recording, and the musical situation of physical separation is not unfamiliar to us, in contrast to what is the case for the classical musicians. We did not feel tuning and blending as problematic themes, and contrary to the classical musicians we often experienced an *increased* risk-taking in our performance, due to a feeling of being safe and not “disturbed” by sensing the physical presence of other musicians – nor the audience.

One very challenging issue within NMP is the *less degree of visual communication.* In a networked performance with Magnify the Sound we do see each other, but the transmission of video has a latency which excludes the possibility of performing synchronized physical gestures among the musicians. Moreover, we lose more intimate nuances of facial expression and body

language in the communication of musical intention and interaction. We, thereby, have to rely (even more!) on *listening* and *auditive information* in our musical interplay. These aspects of NMP are also discussed and studied by Mills and Beilharz in a situation of a networked improvisation where the participants do *not* see each other, and they argue that the sound artists and musicians “...must rely on listening and the semiotics of sound to mediate their interaction and the resulting collaboration” (Mills and Beilharz 2012: 16). It is interesting to note that Iorwerth and Knox (2019: 289) also report that the musicians in their study rarely used the video link while playing. Moreover, the minimal use of the video link when playing is stated as a common reaction to NMP by Cáceres and Hamilton (2008). – However, whereas we used visual communication to a very little extent during performance, the visual communication was important when we were rehearsing and discussing musical choices and strategies between recording-takes (see video examples 1-4 in Section 3.1 above). A similar observation is also commented by Iorwerth and Knox (2019: 294) where they remark that even though the video link was rarely used when playing, it was more often used between takes.

A very exciting somatic and phenomenological experience is also related to a combination of our shared control of the CN-instrument and the reduced degree of visual communication: Sometimes when playing we have a feeling of losing ourselves, we are not able to identify our own individual contribution to the music, and we hear musical results that we could not predict. Moreover, we can, at times, be very surprised when we in retrospect listen to a musical session we have performed and experience that we hear or perceive the presence of a “*third musician*”, - a contribution to our musical expression that neither of us, individually, are able to identify with. This “guest” into our musical interplay lives in the mediating space and emerges out of our shared, common interaction with the CN-instrument. This experience is intimately related with the fact that we in our performances are real-time composing/ improvising with our interactive CN-instrument. – Already in 1997 Chadabe writes of early examples of interactive instruments: “... , and when the music is interactively composed while it is being performed, distinctions fade between instrument and music, composer and performer. The instrument is the music. The composer is the performer.” (Chadabe 1997: 291). Following up, Drummond points out that this statement focuses on the shared creative aspect of interactive music systems, and he states: “The musical output is created as a direct result of this shared interaction, the results of which are often surprising and not predicted.” (Drummond 2009: 125).

4.4 Where is our audience?

In the described performance situations, our audience has shared the same audio-visual content coming from the virtual stage as we have, but even though we and our audience receive the same content, the relationship between us and audience is dramatically disconnected for several reasons. Firstly, we have no visual feedback from the audience, except for eventually written comments that can appear in a chat, and therefore leaves out the expected experience of immediate response. Secondly, there is no connection between what is presented and *in what environment the individual listener/viewer is* during our performance. As an example, we might perform a mellow ambient piece with small percussive details whilst an individual listener is running through an airport listening through phone speakers at 7am in the morning. - The point being that we and our audience are not necessarily connected through the same environmental context, and that this increases the distance of artistic proximity between performers and audience at many levels. All these elements work against the immediate responses you get from an audience in a normal live situation.

4.5 The network as an artistic material for music making

In its nature NMP establishes a physical distance and separation in the relationship between the participants in a performance situation. However, if we look at the traditional acoustic environments and technical frameworks found in most concert venues and performance stages compared to the potentials of constructing a virtual stage combined of different local stages, *the proximity to the sounding and visual result can in many ways be perceived larger in the virtual concert venue than in the traditional concert hall*. Also, this separation is often a goal in many studio- and live recording situations. - As we have discussed, physical separation between performers and between performers and the audience affects both musical and interpersonal communications in many ways, but there is also a large degree of artistic potential both concerning sound and visual appearance within this gap. In that respect, trying to recreate already existing practices will not be as fruitful as establishing *new practices* since it is impossible to overcome the aspects of latency and physical separation within NMP contexts. In our experience there is no doubt that NMP opens for several creative possibilities concerning acoustic environments and controllable sound separation:

- Instead of imagining one physical room there is a potential to blend different rooms into one. “Rooms” in this context are not limited to the acoustic environments on each local

stage, but any room where the sound, or parts of the sound, can be projected and retransmitted through microphones.

- The listening conditions can, as demonstrated, be individualized, and not exclusively reproduce the same result to the different participants.
- As also touched upon, the separation of real time video feed from the performers opens for a variety of different possibilities of visual representation that would be challenging, and in most cases, impossible in a performance situation were the participants share the same physical stage.

We have here focused mostly on new aspects related to physical separation. We will now discuss how material properties of the network influenced our performative choices of musical parameters within a context of tele-improvisation.

4.6 Tele-improvisation, internet jam, and a perception of sound as affordances

As mentioned earlier (Section 3.2), after a concert with Magnify the Sound at the NowNet Arts Online Performance Series, May 2, 2020, we performed two internet jams with members of the NowNet Arts Lab Ensemble. The participants in these jams were a keyboard player from New York, a guitarist from Belgium, a visual artist from Canada (making different expressions in her face in communication with the music), whereas we (Magnify the Sound) were, as usual, situated at different locations in Trondheim, performing on guitar and drums feeding into the CN-instrument. We had never met or played with these artists before. It is important to note that these “external” participants in the internet jam had heard our concert preceding the jam, so they were presented for our way of performing and our musical aesthetics. Moreover, since they were all members of the NowNet Arts Lab Ensemble it is fair to say that they to a large extent shared our musical and cultural references. – This is a crucial point to be made because Roger Mills has conducted interesting studies of how cross-cultural musicians experience tele-collaborative engagement in an online jam session, and he concludes that culture plays a vital role in structuring experiences of distributed interaction (Mills 2019: 193-194).

The two jams were based on free improvisation. Whereas auditory delay has not been problematic for performances with Magnify the Sound when all participants were at different locations in Trondheim, latency was, indeed, a challenging issue in these two tele-improvisations. – Because we had not played together before and latency was problematic for

coordinated actions, both jams started with a large degree of *horizontal* contribution to the musical interplay, in other words, we played “after one another” in a kind of call-response manner, inviting each other into the musical conversation. This is a different approach from the suggestions outlined by Wilson (2020) where she with reference to composed music presents strategies to enable *vertical* harmony despite latency in NMP. - The approach in our internet jams is also very different from how we (Magnify the Sound) perform networked music together from separate locations in Trondheim. This is due to the fact that we, as a band, have rehearsed together and known each other through years of musical cooperation, and because latency is not an issue in our more local networked performances. - Other characteristic features that emerged in our tele-distributed interaction were our focus on sound quality/ texture/ timbre (e.g., bell-like, metallic, industrial, river-like), sound duration, density of events, motivic work, and energy/ dynamics. When rhythmical elements were introduced, for example when the drummer was performing a groove/ quasi-groove, the other participants often responded by playing something on the top of (or under) the drummer’s contribution that complemented what the drummer was doing or performed a similar rhythmic expression that was not musically dependent on synchronization, for instance when the visual artis made rapid-changing facial expressions in a rhythmically interplay with the drummer’s quasi-groove.

It is very interesting to compare our subjective experiences and observations of these two internet jam performances with Mills’ empirical case studies of distributed interaction and tele-improvisation. One of his key findings is that networked performers perceived qualities of sound as *affordances* in their interaction:

Networked performers interact in a geographically distributed field of electronic and acoustic musical sound. “Affordances” in this context (...), are emergent openings and sonic invitations that contain significant qualities and patterns that act as signs to online performers. (Mills 2019: 194)

Moreover, Mills writes: “... articulatory parameters in sound acted as affordances for directing performers through different stages (...) of an online jam session.” (ibid.), and he presents a table

demonstrating different articulatory sound parameters and stages of tele-improvisation (Mills 2019: 110-111). – In this table we read for instance that Mills discovered that sequentiality (call and response), durational tones, legato articulation, soft to moderate volume, and imitation are articulatory sound parameters that act as affordances in the initiation stage of the tele-improvisation, whereas sequentiality moving to simultaneity, increase in volume, instruments taking figure-like aural perspective act as affordances in the development stage, and homophonic musical texture and repetition of rhythmic patterns are articulatory sound parameters that establish additive musical texture, and build density and tension in the progression stage (ibid.: 110). – The application of these sound parameters in tele-improvisation and distributed interaction resonates well with the subjective experiences and observations of our internet jams. Seen as such, our perception of sound as affordances supports Mills’ empirical findings.

It should at this point be noted that only the musicians in Magnify the Sound, Engum and Waadeland, interacted with the CN-instrument in the above discussed performances. Our experiences, reflections and discussions in this section therefore highlight and point at interesting aesthetics related to the material properties of a network in tele-improvisation and network jamming, not at the interaction with the CN-instrument in itself.

5. Conclusions

In this paper we have presented experiences and reflections related to performing improvised, live processed electroacoustic music within a context of networked music performance. A new collective networked instrument is created, and by pointing at artistic results we have shown that the instrument is fundamental to the music making and artistic expression of Magnify the Sound and is also of major importance to the musicians’ perception of their musical roles. The construction of the instrument has been an iterative interplay between the performers and the instrument, in an intersection between musical and technological needs and parameters. Although we believe that we have demonstrated and discussed how our collective instrument has facilitated new ways of performance and music making within the network, the instrument itself, as well as our way of performing with the instrument, can certainly undergo further development and change.

On the technical side it is, obviously, desirable to stabilize the technology to make our performances more technological “secure” in order to move our focus away from instrument

functionality. Moreover, it would be nice to have closer integration between sound and video, for instance by connecting the two adaptively or cross adaptively, and in addition establish cross mappings from the control interfaces to both audio and video.

On the artistic side we could to a larger extent take advantage of our separated, different local stages, for example by exploiting the local acoustics and audio-visual environments, and we might create a virtual common stage in the mediating space consisting of all the local stages. It would, moreover, be interesting to invite new performers into our CN-instrument and include delay as part of the performance. Also, we could perform at different virtual stages (e.g., video conference systems, social media platforms, streaming platforms), and customize the artistic expression and the CN-instrument to these various settings. It would, of course, also be nice to be able to establish a closer relation to our audience.

Performing on the CN-instrument involves the interaction of many participants and handling different software and hardware that are interconnected and running from different locations at the same time. Thus, there is a very large degree of artistic and technological interdependency happening, and many things “can go wrong”. The performance situation is in many respects fragile, and we often feel that we are performing and *improvising inside a house of cards*. - Listening in retrospect to a musical session we have performed, we sometimes experience that we hear or perceive the presence of a “*third musician*”, - a contribution to our musical expression that neither of us, individually, are able to identify with. This “guest” into our musical interplay might be both welcomed or not, - she just emerges out of our common interplay with the CN-instrument. There lies a great challenge, as well as an artistic desire, to get to know this guest better.

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