INTERFACING THE NETWORK: AN EMBEDDED APROACH TO NETWORK INSTRUMENT CREATION

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ABSTRACT

This paper discusses the design, construction, and development of a multi-site collaborative instrument, *The Loop*, developed by the JacksOn4 collective during 2009-10 and formally presented in Oslo at the arts.on.wires and NIME conferences in 2011. The development of this instrument is primarily a reaction to historical network performance that either attempts to present traditional acoustic practice in a distributed format or utilises the network as a conduit to shuttle acoustic and performance data amongst participant nodes. In both scenarios the network is an integral and indispensible part of the performance, however, the network is not perceived as an instrument, per se. *The Loop* is an attempt to create a single, distributed hybrid instrument retaining traditionally acoustic interfaces and resonant bodies that are mediated by the network.

The embedding of the network into the body of the instrument raises many practical and theoretical discussions, which are explored in this paper through a reflection upon the notion of the distributed instrument and the way in which its design impacts the behaviour of the participants (performers and audiences); the mediation of musical expression across networks; the bi-directional relationship between instrument and design; as well as how the instrument assists in the realisation of the creators' compositional and artistic goals.

1. INTRODUCTION

This introduction is not an attempt to provide a comprehensive review of the field of network performance, rather it outlines some general trends in order to provide a context for the work.

Early examples of distributed performance such as the Telematic Circle [1] sought to recreate traditional concert settings over the network by creating a shared environment, or telepresent performance, via the transmission of high-quality video and audio assets over high-bandwidth networks. Such performances often used traditional acoustic instruments in their attempt to produce a performance in which the boundaries between local and remote spaces dissolved into a single co-located experience or shared environment. This is exemplified in projects such as the Playing Apart study [2], which aimed to promote situated types of musicianship over the network. This study aimed to better understand the conditions of playability over a network, especially when long distances were involved. It also devised ways of introducing new technologies and principles to facilitate the playability and increase interactions between geographically displaced musicians despite high latency values. The study used two contrasting pieces of music (slow/fast) allowing experimentation across several aspects of distanced performance, such as dealing with large latencies. The study also investigated the impact of interactive technologies, such as spatialised monitoring, video, and simple display using motion capture technology, upon the musicians' ability to convey gestures via the network.

As networked performance tradition matured, there was a realisation that the acoustics of the network could be utilised as part of the formal compositional process. Early studies of network acoustics [3] stated that, depending upon the distance between nodes and resulting latency, the network can generate acoustical features ranging from reverberation to echo like effects. This paradigm was exemplified in Renaud's *Renditions* [4] a multi-site composition which exploits the delay of the network as a catalyst for musical exchange. A related example is Rebelo's Netrooms [5], which utilises the network to extend/blend the natural colours of co-located spaces into a hyper-acoustic. In both scenarios the acoustic properties afforded by the network are exploited for an artistic purpose and the acoustics of the network become an integral part of the performance.

A different approach that has been developing in parallel to the above is the use of the network as a structuring device for improvisation. In this scenario, participants exchange control data in lieu of acoustic information, resulting in a composition mirroring the real-time decision making process of the ensemble. An exponent of this technique is PowerBooks_UnPlugged [6], an ensemble that performs with software called Republic [7], a SuperCollider [8] library that facilitates collaborative live coding and sound synthesis across the collective's laptops. Similar software based approaches to structuring networked performance are incorporated into Renaud's Frequencilator [9], a real-time system providing spectral and temporal structure to a distributed ensemble through an elaborate cuing system.

2.   THE JACKSON4

As a network-based quartet, the JacksOn4 formed out of the desire to maintain an ensemble despite its members moving to separate parts of the world. The members of the group have not shared a common physical space for over six years and, as a consequence, the group's entire musical practice has been conceived and developed solely over the network.

This is in contrast to *"most telematic music projects [which are] simple transformations of traditional onsite music practices – meaning that the music was conceived in traditional acoustic environments and later reproduced in a telematic environment"* [10]. Further, the novelty of connectivity, which drove the majority of past telematic projects, no longer intrigued us. Also, the use of networks as an externalised channel to relay control or acoustic data between sites did not seem to treat the network as an instrument, but rather relegated it to its traditional role as a communications system.

Therefore, the initial aim of the JacksOn4 was to create an instrument that embodied the conceptual and practical aspects of network at its core by designing a ubiquitous and multi-user networked instrument. To fulfill these goals the group sought more direct, tangible acoustic interfaces, a departure from their previous laptop-based practice. Similarly, the group wished to incorporate physical bodies that would resonate as traditional acoustic instruments do. However, it was important that these physical bodies acted as a direct connection to the network, serving as a physical interface for an exploration of the network itself.

3.   THE LOOP: A DISTRIBUTED NETWORK INSTRUMENT

In its current configuration *The Loop* consists of four acoustic nodes connected in series creating a feedback loop. Each node is comprised of three components: an acoustic interface, a contact microphone, and an audio

transducer. Intrinsic to the instrument is the networked loop linking one node to the next. This is implemented through the JackTrip [11] audio application. At the local node, the interface is excited (struck/plucked/bowed) and the attached contact microphone picks up the waveform. This signal is sent over the network to the next node in the series, where it is used to drive a transducer affixed to the remote acoustic interface. This process is repeated again and again, with sound created at one node transmitted through the network to the acoustic body of the next node. In this way, the instrument can be considered one acoustic entity that is distributed across multiple sites.
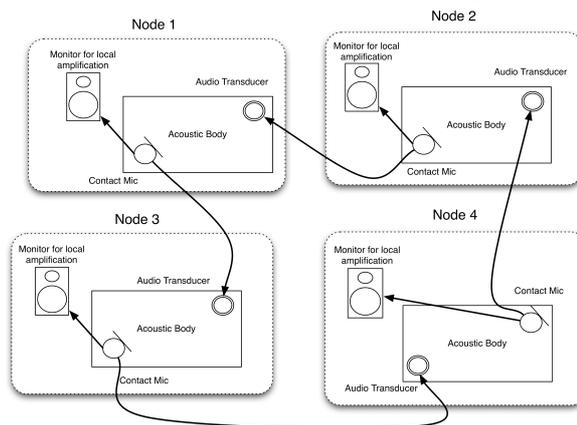

Figure 1. A diagram of the current JacksOn4 signal routing for performance of *The Loop*.

As each node is both an acoustic resonator and a device for creating sound, performers can hear the sound as it passes through their node and choose to modulate it or add to it through direct physical interaction with the local acoustic interface. This reinforces the idea of the distributed instrument as a single instrument and affords many opportunities for tactical/tactile interactions between participants who continuously contribute to the overall resonance/feedback of the system.
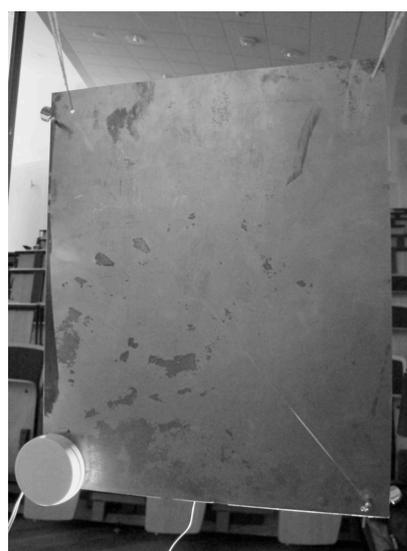
Figure 2. An acoustic node: a metal plate with contact microphone, transducer and string.

A typical performance, such as that presented at NIME 2011 [12], begins with a brief structured improvisation during which the acoustic interfaces are used to excite the network. As material is processed and reintroduced into the feedback loop, the composition mutates from the original concrete sources to abstract invention. This process continues through successive generations until a predetermined time or a point at which the composition naturally concludes. The result is the performance of an integrated meta-instrument that provides the potential for a collaborative, emergent composition, with no one artist being the sole performer or composer. In this sense, we believe we are creating truly authentic compositions of, for, and by the network.

As ensemble members are distributed, remote acoustics and network characteristics also shape the performance. At NIME 2011, three performers were onstage in Oslo while one performer contributed from Norwich, UK. Other performances have seen similar configurations such as two players in Bournemouth, UK, one in Norwich, UK, and one in Tromsø, Norway. In concert, remote participants are represented locally by a single loudspeaker, which is strategically placed on stage en lieu of the remote performer. This allows the local audiences to hear the movement and transformation of audio through the networked instrument, as if all four nodes occupied a single space. In addition to the purely acoustic audio material introduced into the system, the ensemble has taken to augmenting the performance with live electronics generated by applications such as Max/MSP [13], PureData [14], and SuperCollider [8]. As we are using computers to establish the instrument's connectivity, it seems like a natural affordance. A Max/MSP patch acts as a control panel for each performer, allowing the transmission of processed or unprocessed audio to the network via the Jack Audio Server [15] and subsequently JackTrip [11].


Figure 3. Stage plan of *The Loop* as presented at a concert in Bournemouth, UK. Remote members are represented onstage by loudspeakers.

4. THE IMPORTANCE OF INTERFACE

Through our explorative process, we have discovered that the design of an instrument for networked musical activity necessitates special consideration. We argue that the musical instrument *is* the interface to the network, and this interface is what we use to communicate our musical gesture. Thus, instrument design affects how we relate to and explore the network in performance. As Boyle states, "While interactions between participants of network-based works can occur over spatially distributed or localized environments, and the interactions and explorations themselves can be synchronous or asynchronous, the design of *the interface through which these explorative behaviours are mediated is of equal importance*." [16] It is our contention that if an instrument inherently embodies the network, then gestures afforded by that instrument will be more suitable for networked performance than any other approach. In the development of *The Loop*, we came to define the interface as a collection of tangible objects capable of exciting and resonating an acoustic waveform. It is this physical interface with which we interact, and we consider the hardware and software components (e.g. JackTrip), that merely provide connectivity, to be of secondary importance.

In Heidegger's [17] terminology, in the general act of performance, one can consider the musical instrument to be 'ready-to-hand'. For the musician performing with the instrument the distance between the performer and the creation of music collapses, such that he feels directly connected to the act of music creation. One could argue that the performer enters an altered state of consciousness in which there is a merging of action and awareness and any perceived division between the performer and the acoustic environment disappears. By incorporating acoustic interfaces and feedback, *The Loop* allows the network to withdraw into the instrument such that the network itself becomes part of the body of the instrument. In this conception, the performer has no conscious experience of the instrument or the network as an independent entity; rather, the instrument (and the network) becomes phenomenologically transparent [18].

This approach can be contrasted to the use of traditional acoustic instruments in networked performance, where you could argue that rather than acting as part of acoustic body of the instrument itself, the network functions only to enhance the acoustic reach of the instrument. Consequently, when performers accustomed to traditional acoustic scenarios play across the network, the natural performative flow is broken and the relationship between the musicians and the instrument changes. In this situation, the musical instrument becomes 'present-at-hand'. In this scenario the instrument stops becoming transparent and the participants (performers and audiences) become aware of its presence as a tool for mediating the network. Linked and complimentary to this is Bourdieu's [19]
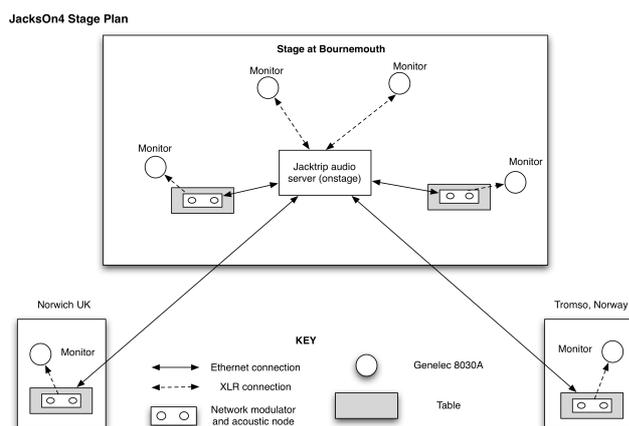
concept of habitus, the "practical sense" that "inclines agents to act and react in specific situations" that is "the result of a long process of inculcation". From a performance viewpoint, the habitus of a performer has been established through long hours of instrumental practice during which the relationship between motor action and sensory perception has been built. In performing over the network this relationship between action and perception is challenged, and for a while at least, this difficulty in performing produces a breakdown of this conventional relationship.

We are not suggesting that performers cannot adapt to these new scenarios, or even that this breakdown of relationship is always undesirable, but we believe *The Loop* provides the sort of instrument that inherently and transparently sits and works within the network. In addition, it is an instrument designed and created by musicians who have only known this network performance tradition. In a way, they have become virtuosi of their own creation and, consequently, *The Loop* provides the opportunity for developing a unique style of composition.

5. THE INSTRUMENT AS COMPOSITION

From a compositional standpoint we were interested in making an instrument that embodied some of the musical challenges of performing networked pieces into its design, such that the construction of the instrument itself could be interpreted as the starting point of the compositional process. Historically, instruments have been developed to solve both practical and musical problems encountered by the composer: Cage's wish for a portable percussion ensemble resulted in the prepared piano, while Wagner's desire to blend the timbre of the trombone with that of the horn created the eponymous Wagner tuba. As a distributed improvising ensemble, our compositional challenges were to coordinate individual musical effort across the network and ensure the presentation of a coherent musical event comprised of contrasting improvisational styles.

A networked performance, in which participants (both performers and audiences) are distributed across multiple sites, presents many challenges to coordinated music making. Many have argued that the greatest hurdle to distributed performance is latency, and this is certainly true with music that has generally adopted a top-down approach to the compositional process, with a single individual (conductor or composer) dictating the activities of all involved. However, as an ensemble improvising collectively, the JacksOn4 follows a bottom-up approach with the composition the result of a collaborative effort. In this case, the challenge is to channel the musical decisions made by a group of individuals into a unified whole.

As Mooney [20] suggests, each musical instrument can be considered to present a combination of affordances and constraints, a set of actions and gestures that are easier to achieve than others. The score (or composition) provides an extra list of constraints on the activities of the performer that must also take into account the affordances of the musical instruments, such that one can consider every piece of music to be at the top of a long chain of design decisions that begins with, and thus incorporates the design of, the musical instruments themselves. Further, as expressed by Paul DeMarinis [21], the instrument can begin to take on some of the properties normally associated with the musical score. In the case of *The Loop*, the compositional and instrument design processes were conducted in parallel, and compositional structures were (either intentionally or non-intentionally) embodied into the instrument design from the very beginning. As such, the instrument provides a number of mechanisms that serve to constrain and shape the performance. The primary example of this is the feedback loop connecting the performers, as it is this feedback loop passing through the acoustic bodies of the nodes that makes this instrument one single acoustic entity distributed across multiple sites. This design has a number of implications from a compositional and organisational standpoint.

As musical material is transferred from one acoustic interface to the next, via electroacoustic transduction and digital processes, the temporal and spectral qualities of the original performative gestures are modified. The extent of this change in quality is both a factor of the types of materials the acoustic signal passes through (metal plate/wooden block), as well as the number of nodes a signal mediates before being auditioned. Thus, musical material created at the local node will receive a unique treatment at each successive remote node down the line. This progressive shaping of timbre and gesture provides the composition with an orchestration and arrangement that could not be replicated by (or transposed to) any other instrument. The instrument is one of a kind, and so is the resultant composition. Further, as we are sharing the control of one single distributed instrument, we become more sensitive to each other's contribution to the overall composition. We have to be, because it is relatively easy to overdrive an instrument that is in a state of perpetual feedback. We share a communal responsibility of regulating the progression of the signal through the loop, by either dampening the remote resonant body or intentionally driving more signal through our node by boosting the amplification of the transducer driving our interface. This action of collectively modulating another performer's sound is an activity typically not afforded to performers and is unique to this type of instrument design.

Initially a laptop ensemble, the JacksOn4 have progressed away from computational processes, which theoretically can provide any gesture or timbre possible, and embraced natural acoustic parameters that greatly limit the scope of what is performable. We recognise that *The Loop*, through its incorporation of a feedback

process, along with providing the musicians with an interface to modulate the composition in real-time at the local node, imprints a unique compositional structure upon our improvisations, unifying our collective performances.

6. CONCLUSION

In taking an embedded approach to creating a distributed networked instrument, we have highlighted the tight relationship between instrument, performer, and composition that *The Loop* provides. We feel this tight integration has afforded us the opportunity to go beyond merely performing across the network. By design, the instrument affords the chance to utilise the network in a much more idiomatic way, allowing the network to take on a definitive musical role in our creative practice.

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