Creating Bionicity: Artificial Intelligence and Telematic Music

Richard Savery - Music 236

The intersection of telematic music and musical artificial intelligence (AI) presents a unique sonic and conceptual environment, capable of creating new posthuman creative communities. Our bodies are no longer an outside element of the telematic network, instead 'the human body is in the network'.[1] This network has no reason to be limited to only human performers; by combining humans with musical artificial performers we are capable of achieving new forms of interaction. This relationship will have benefits for both human and computer collaborators.

I believe that through the combination of AI and telematic music, we are capable of creating the beginning of Roy Ascott's concept of bionicity. 'Bionicity is the convergence of artificial and living systems into a unified consciousness'.[2] Telematic music creates a networked world where both the human and computer performers, composers and audience members can enter a new form of equal embodiment. This relationship will demonstrate 'connectivity', defined by Ascott as when 'the artificial collaborates with the natural in a new synthesis of being'.[3]

Oliveros describes telematic as referring to 'the interface with computers and performers over distance'.[4] For the purpose of this paper, I consider telematic music to be realtime musical interactions between performers in different locations, connected via a networked system. Telematic music explores and allows for new forms of musical creation and immersion. Schroeder and Rebelo[5] argue that networked performance presents opportunities similar to the

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[1] Franziska Schroeder and Rebelo, Pedro *Sounding the Network: The Body as Disturbant, (*Belfast: Leonardo Electronic Almanac Vol 16 Issue 4-5, 2008) p.1.
[2] Roy Ascott *"*Technoetic aesthetics: 100 terms and definitions for the Post Biological Era" in *Telematic Embrace. Visionary Theories of Art, Technology, and Consciousness by Roy Ascott* ed. Edward A. Shanken (University of California Press 2003) p.375.
[3] Ibid p.376.
[4] Pauline Oliveros "The Collective Intelligence of Improvisation" in *Arcana V music, magic and mysticism* ed. John Zorn (New York:Hips Road 2010) p.292.
[5] Schroeder and Rebelo, *Sounding the Network*

advent of the recording studio and its concurrent shifts in musical attitudes and practice. These shifts created by telematic music are 'articulated by the superimposition of acoustics, the socially dynamic and the musically unknown'.[6] Regardless of the wider musical impact telematic music will have, it does offer an environment capable of exploring new sonic worlds.

Musical artificial intelligence is becoming increasingly commonplace and successful. Software such as David Cope's Experiments in Musical Intelligence (EMI)[7], accurately emulates classical composers, while John Al Biles' program GenJam[8] uses genetic algorithms (a process that mimics natural selection) to improvise be-bop based solos with a human performer. In Voyager by George E. Lewis 'improvisers engage in dialogue with a computer-driven interactive "virtual improvising orchestra" '. [9] Musical artificial intelligence can usually be distinguished somewhere between two main concepts, either exploring human qualities ('a model of human behaviour'[10]) or acting in a 'superhuman' manner.[11] For the combination of telematic music and artificial intelligence I believe creating superhuman artificial musicians will present more diverse and relevant results. As Marsden argues 'it is precisely because it is artificial (other-than-human) that it is useful'.[12] Rowe compares the creation of music systems to the creation of chess computer programs: "No one would suggest that Deep Blue {in 1997 Deep Blue defeated world champion Garry Kasparov} should be made to play worse if it then would better match the data from experiments on human chess players".[13] If successful musical outcomes are created, then like Deep Blue there is no reason to use strictly human based musical thinking.

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[6] Ibid. p6.
[7] David Cope, *Computer Models of Musical Creativity.* (Cambridge: MIT Press, 2005)
[8] Eduardo R Miranda and John Al Biles eds. *Evolutionary computer music*. (London: Springer, 2007) p. 137-170
[9] George E Lewis *Too many notes: Computers, complexity and culture in voyager.* (Leonardo Music Journal 10 (2000): 33-39.) p.33
[10] Alan Marsden, "Music, Intelligence and Artificiality" in *Readings in Music and Artificial Intelligence* ed E.R. Miranda (Amsterdam: Harwood, 2000) p.26.
[11] Ibid.
[12] Ibid. p.8.
[13] Robert Rowe. *Machine musicianship.* Massachusetts: MIT press, 2004. p. 237

As stated, telematic music explores new ways of understanding music and creates a tenable environment for musical AI, using superhuman computer techniques. All music and sonic worlds created in the telematic and AI music will still be linked to a musical tradition, but present new ways to approach these traditions. In my discussions, I will focus on music that has improvised elements or is interactive and will primarily deal with audio and sonic issues. As Miranda states about AI (although could be equally emphasised for telematic music), 'An artificial intelligence-based interactive music system should promote the exploration and discovery of new outcomes'.[14] I will explore how the equal disembodiment of sound for AI and telematic music creates a new ground for collaboration, a format for creating a version of collective musical intelligence and a way to explore new outcomes in both mediums.

Disembodied Sound

In both telematic music and AI, information is disembodied, transmitted and created in new forms with potentially significant musical impacts to performance styles and aesthetic choices. Sound content becomes disembodied once it leaves the source of creation; at the latest it occurs once the sound wave has been converted to an audio signal through a microphone. In AI and telematic music this sound is usually then converted into a digital signal which is either processed or sent across a network. This disembodied sound is devoid of at least some of the original gestural and physical implications. It has been argued that 'images of gesture help to codify qualities of sound' [15] which is true for some content, although some gestural aspects are lost. Preparatory actions such as the movement of a pianist from a higher position to a lower position are not contained sonically, or if they are, they cannot be perceived till after the event. All musical activity does face some degree of disembodiment between the

[14] Eduardo Reck Miranda and Marcelo M. Wanderley,*New digital musical instruments: control and interaction beyond the keyboard.* (Middleton, Wisconsin: AR Editions, Inc., 2006) p. 244.
[15] Roger Mills and Kirsty Beilharz. *Listening Through the Firewall: Semiotics of sound in networked improvisation.* (Organised Sound 17, 2000) p.22.

generation of sound and transferring aurally to a listener. However in AI and telematic music, this disembodiment is heightened in scale and is ingrained in the musical processes.

To reach other performers and an audience, this sound must be digitally transmitted in some form, either through a computer system or across a network. For a computer program this sound information has become a stream of data that no longer resembles the original audio source and is instead a digital representation of the audio content. This sound or musical content will retain its meaning, even when certain parameters, such as human gesture are removed. George Lewis describes the 'bidirectional transfer of intentionality through sound" that takes place in his computer improviser Voyager. Lewis describes that this 'emotional transduction'- constructs performance as an intentional act embodying meaning and announcing emotional and mental intention. In this way, I believe, the emotional state of the improvisor may be mirrored in the computer partner, even if the actual material played by the computer does not necessarily preserve the pitch, duration or morphological structures found in the input.'[16] I understand this statement to mean that all musical content, be it rhythmic, timbre or pitch material carry an emotional content and intentionality, that isn't lost when reinterpreted through a network or computer system. Even when some gestural content is lost, the sound will contain a derivative of its original intention.

The sonic content, once carried across or listened to within a network or computer framework is then recreated, repurposed or reinterpreted. For a computer program this content can be reused or incorporated into new music. In a telematic performance this material will still be altered at some stage, at a minimum through speaker placement and positioning the sound. Information may also be lost or changed in the transition from sound to a digital signal and back to sound. In the telematic medium it is possible for some of the gestural content to be reestablished through video, although this reattachment can only take place after the material has been disembodied. These issues are not unique to either mediums and have been discussed by many authors at length. In early discussions of electronic music, Boulez considers

[16] Lewis, *Too Many Notes*, p.5.

the idea and impact on gesture when the sound comes through speakers. Boulez describes: "We are here faced with definite limitations; the psychological reactions of an audience to which music is fed by loudspeakers can hardly be avoided where the audience is deprived of the possibility of associating a sound with a gesture." [17]

Perhaps the most important similarity between AI and telematic music is the enforced transfer of disembodied information into a digital system or network, inherent in each paradigm. In this way no single force can control and witness the process of musical creation; the creation is separate from the listener, performer and composer. This presents a unique ground - especially for improvised music or music with a high level of interactivity - to involve many equal collaborators. This new networked space has the capability of becoming the body of musical AI where each component, human and computer, can function equally and collaborate. Musical AI can be truly embedded into this system, where all musical content is equally disembodied, before being re-synthesised in new forms.

The Performer, Composer and Audience

Both telematic music and AI question the role and impact of the performer, composer and audience. The role of the human composer is reworked in the telematic medium; Kim-Boyle describes that the composer has changed to the 'designer'.[18] Kim-Boyle elaborates that 'composers of network-based music often share a common interest in democratizing performance'[19]. In this regard, the role of the composer and performer often becomes obscured and even the audience is often far away from their role in a recital style performance. Musical AI often also blurs the line of composer and creator; in Voyager is Lewis still the composer and creator or is Voyager responsible for the composition, or is it an external improviser working with the program? It is this combined ownership of work between multiple parties that is highly

[17] Peter Manning, *Electronic and Computer Music,* 4th ed,(Oxford University Press, 2013) p.61.
[18] David Kim-Boyle (2009): *Network Musics: Play, Engagement and the Democratization of Performance,* Contemporary Music Review, 28:4-5, 363-375, p.363.
[19] Ibid. p.364.

applicable to the telematic medium, which itself almost enforces high levels of collaboration. Without any one composer controlling the work it is possible to create new forms of interaction and new forms of composition. The archetypal figure of a single dominant composer is only one of the many possible forms of composition.

Sonic Mapping

Cross-domain mapping occurs as information is transferred from one domain to another, for example matching audio waveforms created by a violin to written notation.[20] Cross-domain mapping happens necessarily as audio is transferred to a digital system. Musical and sonic content can be transferred in multiple non-sonic ways, such as MIDI, OSC or other forms of notation. Western Classical music notation can also be used to transfer material from one location to another, while some information is lost (such as aspects of timbre), information is always degraded to a degree when changing domains. There is no way to contain all information within the one system (as shown in 1931 by Gödel's Incompleteness Theorem), there will always be information lost, but also potentially gained in the movement between locations and systems.

Telematic Musical Turing Test

The Turing test is a cornerstone of AI, created by Alan Turing in 1950 [21]. The test is designed to judge whether a computer system exhibits intelligent behaviour, by asking an interrogator to differentiate between a human and computer through a series of questions, separated by a terminal. The terminal is imposed to limit the forms of communication to a text based conversation. Telematic music currently can only exist with limited forms of

[20]Lawrence M. Zbikowski, *Conceptualizing music: Cognitive structure, theory, and analysis.* (Oxford University Press, 2005)
[21] Turing, Alan M. *Computing machinery and intelligence.* (Mind 1950) 433-460.

communication; even low latency video and audio lack many of the human qualities of conversation.

Musically, the Turing test and telematic music can explore how human musical identity is carried sonically. The first part of Turing test is run with a male and female on the other side to the interrogator, with both the male and female aiming to convince that they are the female. It is hard to imagine that such differentiation could ever take place musically. While a musician's personality is evoked in their style, I don't believe it is possible to recognise the identity of an unknown new person. Real world examples shown in the change of membership in orchestras since blindfolded auditions were introduced (an increase in female hires between 30% and 55% from 1970 to 1997[22]) demonstrate that at least some conceptions associated with different backgrounds are preconceived.

While I don't believe that the need to differentiate between human and computer performer is of real musical importance, computer performers present a boundary many audience members can not transcend. In the reception of his program EMI (that emulates Western Classical Composers), Cope mentions an occasion where a negative review was published before the concert had taken place. After discussion with the critic, who had no interest in actually attending the concert, Cope came to the conclusion: 'Listeners often qualify their listening experience to the point that the experience bears little resemblance to listening at all. For them, computer-created music represents more of a philosophical challenge than an aesthetic experience.'[23]

Aesthetic and musical judgement is based strongly on our identification of the medium and our perception of the performer. Their cultural position is tantamount to how we interpret a performer, this can be seen in the cultural value of someone imitating Charlie Parker as opposed to Charlie Parker himself. Kundera in his essay on the art of the novel describes that a composition in the style of Beethoven would be 'laughable' while referencing that our 'historical

[22]Claudia Goldin and Rouse, Cecilia. "*Orchestrating Impartiality: The Impact Of 'Blind' Auditions On Female Musicians,"* (American Economic Review, 2000, v90(4,Sep),) 715-741
[23] David Cope, *Computer Models of Musical Creativity,* p. 351.

consciousness is so thoroughly inherent in our perception of art'.[24] An audience's perception of a performer is based on a myriad of factors such as the impression of authenticity (as shown by Kundera) and our social perception. In a musical telematic Turing test these values are questioned and force the audience to hear each musical idea as part of the larger collaboration (which will also have its own preconceived notions).

Collective Musical Intelligence

As has been discussed, musical information is disembodied in both telematic music and artificial intelligence. Through networked systems this musical content can be re-embodied in the forms of new spaces and systems. These new systems can form a type of collective musical understanding, where each component (human or computer) contributes to the musical environment, particularly in interactive or improvised environments. Oliveros states:

> Creative music improvisation communicates collective musical intelligence as an energy field. Whether an individual soloist or ensemble is improvising, there is a mining of musical information stored deeply in the collective consciousness of humanity.[25]

Oliveros' quote describes human music improvisation, but I believe in telematic music this musical intelligence can contain AI. By Oliveros' definition 'intelligence is the ability to utilize and purpose detectable information or data from inner or outer sources'.[26] It is worth noting that intelligence is difficult to define and most definitions are in some way contentious.[27] Oliveros' definition is certainly not universal and intentionally or otherwise, is fairly sympathetic to musical AI. In telematic music, sound has been reduced to a pattern of data or information that is shared between performers, inner and

[24] Milan Kundera *The Curtain: An Essay in Seven Parts.* (Faber & Faber, 2007) p.4.
[25] Pauline Oliveros, *The Collective Intelligence of Improvisation,* p.292.
[26] Ibid. p293.
[27] Alan Marsden, *Music Intelligence and Artificiality,* p.6.

outer sources are combined into a central system represented through the network. Due to the centralised nature of this information, musical AI can utilize and purpose music in anyway suitable. By this definition of intelligence, programs such as Voyager certainly represent a version of an intelligent system.

I consider the 'collective consciousness of humanity' something that is contained in both human performers and computer performers. This consciousness is our knowledge and linkage to previous and current generations. All creativity stems from the work of others and our collective conscious is the combined knowledge passed on through musical generations. I believe that Cope presents a similar ideology of an established knowledge base, although in a much more analytical manner: 'Creative Process results from a series of negotiations between contextual influence and illusional and structural processes'.[28] That is that our mining of musical information uses processes to explore the contextual influence (Cope's version of the collective consciousness).

Computer performers, like human performers are extensions and carriers of our own historical and cultural knowledge base. When describing Voyager, Lewis notes: 'A closer look at a given musical software system reveals characteristics of the community of thought and culture that produced it'.[29] In this way AI, like human performers are part of the collective consciousness and linked to our contextual influence. This is why the convergence of telematic music and AI has such a wide potential to create bionicity; information is equally shared and new music created through a combined knowledge base. This information can create a unified thought process and central guiding agent, with multiple human and computer agents creating new musical thought. Computers and humans can equally contribute while performing as a leader, equal collaborator, supporting artist or moving between roles.

[28] David Cope, *Computer Models of Musical Creativity,* cp.11.
[29] George E. Lewis *Singing the Alternative Interactivity Blues.* (Front 7.2 (1995)) p.3.

Transhumanism

In 1923, J.B.S. Haldane wrote Daedalus or Science and the Future, with ideas that became some of the fundamental concepts of transhumanism. 'We are working towards a condition when any two persons on earth will be able to be completely present to one another in not more than 1/24 of a second. … Developments in this direction are tending to bring mankind more and more together, to render life more and more complex, artificial, and rich in possibilities --- to increase indefinitely man's powers for good and evil.' [30] Haldane's writing has obvious relations to what is now telematic music, with the increased speed of communications system allowing these new possibilities to take place.

Transhumanism is a broad movement that is not easily summarized, however can be thought of as the concept that the human race can use technology to move beyond its current physical and mental limitations. Combining AI with telematic music doesn't alter the human physically, although our transition to become part of the network concurs with this way of thinking. Through the merging of the human in the network with musical AI, we can increase our own collective musical intelligence. This new form of intelligence need not necessarily create better works, but will allow for new forms of collaboration. It will also allow for new perceptions and frameworks for understanding telematics and AI but also more traditional forms of music.

Hayles argues even as we have become posthuman, where we privilege 'informational pattern over material instantiation'[31] our own knowledge is embodied in our being. For Hayles the 'reification of information'[32] or the idea of information losing its body, makes the transfer of knowledge from human to computer impossible. That is the inner workings of the brain could not be isolated into a system without information being lost. Through telematic music however,

[30] J.B.S. Haldane *Daedalus or Science and the Future.* (EP Dutton, 1924)
[31] Katherine N Hayles *How we became posthuman: Virtual bodies in cybernetics, literature, and informatics.* (University of Chicago Press, 2008) p.2.
[32] Ibid p.148.

we can retain our own embodiment and transfer this embodiment into a networked environment as we join and apply our sonic skills to the network.

Telematics allows our knowledge base to expand theoretically anywhere. although there are obvious social and cultural restrictions implied through the financial ability to join. AI allows us to also include new computer-based music creation but also contain the influence of other composers' works. In a potential future performance Voyager could be used without George Lewis and his musical voice and cultural background will still be contained in musical explorations. This of course calls for musical AI that is capable of working in different environments; while not currently completely viable, this is becoming more commonplace. In Voyager, Lewis's musical conception (or at least part of) can be embedded in telematic music to create a network where 'the artificial collaborates with the natural in a new synthesis of being'.[33]

This will, I believe, allow for the beginning of the creation of bionicity or 'the convergence of artificial and living systems into a unified consciousness'.[34] This convergence can be thought of as the meeting of the artificial and living, both of the past and future into new systems of musical creation. These systems represent Ascott's (self-admittedly optimistic) view of telematic art as 'a yearning to embrace the individual mind by a larger field of consciousness'.[35] It will also explore the "desire to transcend linear thought by reaching for a free-flowing consciousness of associative structures'.[36]

Equal Embodiment

Through the equal and created embodiment of humans and musical AI in networked music it is possible to discover new forms of musical creation and consciousness. Musical AI's embodiment can occur in the form of telematic music, with the result of creating a collective

[33] Roy Ascott "Technoetic aesthetics" p.376.
[34] Ibid.
[35] Roy Ascott "Weaving the Shamantic Web: Art and Technoetics in the Bio-Telematic Domain" in *Telematic Embrace. Visionary Theories of Art, Technology, and Consciousness by Roy Ascott* ed. Edward A. Shanken (University of California Press 2003) p.357.
[36] Ibid.

musical intelligence. Whether or not bionicity is achieved in this work, by combining AI and the network we are capable of exploring 'consciousness as both the context and content of art' [37] through the combined mediums. While this may seem abstract and far removed from standard musical creation all forms of musical creation are linked to our own background.

> Computers represent tools with which we extend our minds and bodies. We invented computers, the programs, and the data used to create their output. The music our algorithms compose is just as much ours as the music created by the greatest of our personal inspirations. [38]

Through the intersection of musical AI and telematic music we are able to explore new sonic possibilities and conceptual techniques. This work can be self-referential and highly collaborative between all agents and create frameworks for considering previous creations. Ultimately we can create new forms of creative communities built around our artificial and real world embodiment.

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[37] Ascott, Roy. *Reframing consciousness.* (Intellect Books, 1999) p.67.
[38] David Cope, *Virtual music: computer synthesis of musical style* (MIT press, 2004) p.138.

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