THE EMBODIED INSTRUMENT:
FROM WEARABLE INSTRUMENTS TO THE IDEALIZED FORM

Thesis

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Introduction

Musical performance is dependent both on the physicality of a performance and the sonic results of gestures enacted with a musical instrument. Biological, psychological, and social mechanisms underlie the intensity of phenomenological involvement of both performer and audience. Current approaches to performance with wearable gestural instruments are a step towards achieving greater embodiment, as instruments acting as physical extensions of performers' bodies follow the movements of performers and translate them to sonic results. The essentiality of gestures in the performance with a wearable gestural instrument enables establishment of intersubjective space among performers and audience.

The establishment of intersubjective space between performer and audience is an important process through which phenomenological experiences are shared and a major component in the construction of an embodied performance. In the case of electronic music performance, the gestures of the performers serve as inputs to the audience's perceptual system, which is closely tied to the motor system. Perceiving gestures leads to excitation of the motor system, which contributes to an embodied performance. Therefore embodiment is maximized as gestures are taken as input for sound generation, and as sympathetic reactions are generated in the bodies of the audience in response to their perceptions of the performers' bodies. Since gestures are an outward signifier of the "inner space" of the performers, through perceiving the gestures of performers, the audience gains embodied insight to the perceptual experiences of the performers. Thus, instruments that rely on gestural elements to convey information are arguably more embodied than those that do not.

An important class of instruments that emphasize performance gestures consists of gestural instruments, of which wearable instruments are a subcategory. Wearable instruments can be said to be more embodied than instruments that are not since they attempt to place the technology close to the body as if to serve as an extension of the body. However, gestural instruments rely on an *approximation* of the actions and cannot fully capture the full extent of the details of the movements. Sensors are limited by mechanical limitations, and only certain gestural movements and their qualities can be captured through sensors. A total incorporation of the body in performance through mechanical sensors is impossible as sensors are only able to gather a certain resolution and quality of data. The resolution rate of extant mechanical sensors is woefully underequipped to directly translate the movements of the performers to sonic results. In order to make up for the loss of information, electronic instruments rely on complicated mapping schemes to create an illusion of richness and complexity while obscuring the role of minute gestural articulations that define a genuinely musical experience. The reductionist approach in gestural instruments has rendered the infinitely intricate and detailed nature of music-making to a series of data and the rest discarded as extraneous noise. As Katherine Hayles describes her experiences with virtual reality simulations: "What patterns can the user discover through interaction with the system? Where do these patterns fade into randomness? What stimuli cannot be encoded within the system and therefore exist only as extraneous noise? When and how does this noise coalesce into pattern?"[1] To combat the lack of embodiment, instrument, and performer altogether need

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[1]N. Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago and London: University of Chicago Press, 1999), 27.

be thought as an organic system, which reacts as a whole with the environment presented by the sonic content of a musical performance created by the combination of performer and instrument.

Focusing solely on extension of the body without considering the performer as a system operating in the context of a greater performer-audience system that thrives on multidirectional exchanges leads to a disembodied performance. Ignoring the essentiality of creation of intersubjective space has consequences for the achievement of a truly embodied performance that enables the transfer of phenomenological content from performers to audience. Examples of ignoring the importance of intersubjective space include performances in which musical gestures do not correspond to sonic results as well as approaches in which the performer is a soloist using an individually-tailored, specialized instrument.

Electronic music performance thus requires reframing as negotiation between systems through mutual ontological construction, establishing permeable boundaries between systems through which exist channels of communication that enable exchanges. The roles that performers and audience play in a performance setting is constructed by and through interaction between the two, blurring the line between subject—the performers—and the object, in this case the audience. The relationship between the instrument and the performer can be coalesced into a living system, and the same can be said for the relationship between performer(s) and the audience. Relationships between all systems depend on the degree of the depth of the intersubjective space, a concept that necessitates the use of an interdisciplinary examination in order for a critical analysis towards the goal of achieving greater embodiment in electronic music performance to take place.

Embodied performance is best described as a successful larger ecosystem that take into account biological, psychological, and social exchanges of information. An ecological approach is necessary to capture the complexity of performative acts, transferences, and fluctuations as well as determination of identity in a system. Therefore, to move electronic instruments to a more embodied realm, care must be taken to move away from a solo performance approach to another that allows formation of dynamic relationships between performative bodies. Empathetic and sympathetic communication thus becomes an important avenue for achievement of embodiment. In order for true embodiment to occur, the extent of communication through biopsychosocial means between the performers, and between the performers and audience must be considered, and more communicative permeability in the boundary between the two must occur. This permeability in boundaries can be achieved through various means, but all embrace the central concept of intersubjective space, which allows audience immersion in performance through transfer of the phenomenological experience of the performers to the audience. In other words, performance is made convincing through the effective transfer of the experiential universe created through performance to the audience.

Wearable gestural instruments serve as a suitable intermediary to an idealized embodied instrument due to their extensive usage of gestural elements while corporeally incorporating an instrument out of present attempts. An ideal embodied instrument is one that fulfills both of these criteria — that such an instrument 1) is part of the body natively, not merely an afterthought or an addition or a prosthetic; and that 2) possessing such an instrument results in emergent social qualities through interaction among agents also possessing similar instruments. In this thesis, I will use wearable gestural instruments as an illustration for a desire towards the two characteristics, and how wearable instruments satisfy or fail to satisfy these characteristics. By invoking the concept of intersubjective space I will attempt to illustrate the future of electronic music performance.

The Body and the Corporeally-Constructed Society

In his seminal essay, Marcel Mauss speaks of the "techniques of the body," in which he asserts that "the body is man's first and most natural instrument," with which one constantly adapts to achieve certain goals through a series of actions, which is not only shaped by the individual, but also by their societal context.[2] Mauss describes the inescapable breath of cultural and societal consequences created through action, and the resulting cultural consequences that in turn shape our actions. Most importantly, Mauss situates the body as a constituent part of a societal environment in which it enacts and reacts.

Accordingly, physical bodies have shaped societal structures with distinct sociological consequences. Previously ignored in traditional classical sociology, the issue of embodiment in sociology has been morphing from an "absent presence" to occupying the foreground.[3] The body became a secondary characteristic to the self, a possession, in which the subject was described as *having* a body but not necessarily *being* a body.[4] With the heavy-handed influence of liberal humanism which championed the rational

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[2] Marcel Mauss, "Techniques of the Body," trans. Ben Brewster. *Economy and Society* 2 (1) (1973): 75.

[3] Chris Shilling, *The Body and Social Theory* (London, Thousand Oaks, and New Delhi: SAGE Publications, 2003), 17.

[4] Hayles, 4.

mind over the body, the body took a backseat to the mind which was seen as the throne upon which the essence of self sits. However, the body is not merely a possession of the self, but instead *is* self; it actively shapes the essence of the self and takes control in rejection of a mind-body duality, which makes the mistake of positioning the body as secondary to the rational mind. The corporeal condition sculpts the self, not only solely through a unification between the two but also through the involvement of the environment with which the body determines the subject's interactions. The body determines the gamut of possible interactions with the environment, which in turn shape the mind which then is inseparable from the body itself. A compelling construct for supporting the idea of a body-constructed society is corporeal intentionality, a concept that is also supported by biological evidences such as mirror neurons and other mechanisms of imitation.

Corporeal intentionality refers to an action-based interpretation of the world; Leman argues that it can be "conceived as an emerging effect of action/perception couplings, the underlying engine of which can be defined in terms of a sensorimotor system."[5] In other words, corporeal intentionality is constituted of a subject's attribution of intentional qualities to objects that are derived from knowledge from bodily interactions with the surrounding environment, the essence of which is "the articulation of moving sonic forms, with the emphasis on movement in relation to behavioral resonances of the human body."[6] At a base level, it operates a framework of expectations within which corporeal input-output relationships are derived. Through a corporeal lived

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[5] Marc Leman, *Embodied Music Cognition and Mediation Technology* (Cambridge, Massachusetts, and London: The MIT Press, 2008), 84.
[6] Ibid., 84.

experience, over time we accumulate knowledge of expected behaviors from the environment as we navigate the world with our bodies, and corporeal intentionality imbues qualities transferred from those lived experiences onto objects that we encounter. As such, perceptual experiences are tightly coupled to corporeal actions.

The idea of corporeal intentionality becomes essential in understanding the way in which we interact and react to these "moving sonic forms," to which we apply knowledge derived from our own interactions with the world to music. Cross-modal applications of sensorimotor understandings constitute the basis upon which we confer momentum and movement onto sonic objects we encounter. Leman presents the notions of "inner space" and "outer space," which become essential to understanding corporeal intentionality; "inner space" is defined as the sum of the kinesthetic experiences of an individual—their own body movements and sensations that follow those movements—and "outer space" as the external world as sensed via visual, auditory, and tactile receptors.[7] Leman describes the process through which afferent and efferent neurobiological processes bridge inner and outer spaces:

> Let us first look at what happens when sensory trajectories activate motor trajectories. The physical energy of a stimulus provides information to the sensory system, which, on the basis of previous experiences, can form a precept. The coupling with inner space and the activation of a motor trajectory allow the system to react on the physical energy of the environment, through either execution of an action or the simulation of an action […] As a result, the precept becomes an object of an action-directed bias, and via that bias it becomes an object of an action-oriented ontology. This ontology defines an a priori framework for any subjective goal-directed bias, and thus for perception and action.[8]

The keyword here is *action-oriented ontology*. The term explicitly states that an

[7] Leman, *Embodied Music Cognition and Mediation Technology,* 85–87.
[8] Ibid., 87.

individual's ontology is a product of their corporeal state as experienced through perceptual and motor input-output processes that bridge the gap between inner and outer spaces, and that perceptual and motor processes are intricately linked. Action-oriented ontology maintains that excitation of one of the two processes is possible through excitation of the other, enabling activation of a "motor image of the world that is based on sensory information."[9] Sensory information is thus able to not only affect but *activate* the motor system without requiring prior activation. Leman identifies two processual loops crucial to this cross-system activation: the sensorimotor loop and the action-perception loop.[10] Leman unpacks the definitions of the two loops: "The sensorimotor loop is a low-level loop where the motor activity is basically driven by sensory input from the environment. In contrast, the action-perception loop is a high-level loop that involves the gesture/action repertoire."[11]

The mechanisms connecting inner and outer spaces has been theorized in conjunction in the construct of *presence*, defined as a process that allows controlling behavior through self-monitoring in accordance with one's intentions.[12] Nijs uses Damasio's three levels of consciousness to illustrate that presence, or the process of differentiating the internal world for the external, is divided in a similar manner into three

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9 Idem.
10 Idem, "Musical Gestures and Embodied Cognition," (Paper presented at JIM 2012, Mons, Belgium, May 9–11, 2012), 6.
11 Idem, "Musical Gestures and Embodied Cognition," 6.
12 Luc Nijs, "The Merging of Musician and Musical Instrument: Incorporation, Presence, and Levels of Embodiment," in *The Routledge Companion to Embodied Music Interaction,* eds. M. Lessafre, M. Leman, and P. J. en Maes (New York: Routledge, 2017), 51.
G. Riva, "Enacting interactivity: The role of presence," in *Enacting Intersubjectivity: A Cognitive and Social Perspective on the Study of Intentions,* eds. F. Morganti, A. Carassa, and G. Riva (Amsterdam, The Netherlands: IOS Press, 2008): 97–114.

levels.[13] The first is *proto presence*, in which bodily sensations define the border between self and non-self. The second is *core presence*, in which the response of the environment to one's actions and the expectations of the result of those actions define the border between self and the environment. The final level includes *extended presence*, in which the meaningfulness of the activity define the relationship between self and the present external world.

The *precept*, in the context previously presented by Leman, can be understood as an object in a Guattarian fashion, which as a machinic structure engenders a polyphonic subjectivity.[14] It is the abstracted phenomenological object able to be accessed through both perceptual and motor processes. A collection of corporeal precepts can be equated to an abstract machine, which "are always stamped with the mark of singularity. […] They involve a certain pathic relationship, and convey irreducibly heterogeneous ontological consistencies."[15] If corporeal intentionality assigns corporeal meaning to sonic objects as well as forming abstracted precepts that occupy coordinates in subjective space of an individual, then it stands that as a function of having a corporeal, living body, we are able to carve an intersubjective space through which we share "heterogeneous ontological consistencies" through performance actions. Our corporeal experiences and respective ontologies are not homogenized yet share commonalities across different bodies afforded by the nature of just *having a body* that enables similar perceptual and motor processes across multiple bodies.

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[13] Nijs, "The Merging of Musician and Musical Instrument," 51.
A. R. Damasio, *The Feeling of What Happens: Body, Emotion, and the Making of Consciousness* (New York, NY: Random House, 2000).
[14] Félix Guattari, *Chaosmosis: An Ethico-aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis (Bloomington and Indianapolis: Indiana University Press, 1995), 1-2.
[15] Ibid., 38.

It is also notable that Guattari asserts that subjectivity is *collective*, a potentially tricky adjective that he takes care to define meticulously as to avoid conflation with its common usage: “[t]he term ‘collective’ should be understood in the sense of a multiplicity that deploys itself as much beyond the individual, on the side of the socius, as before the person, on the side of preverbal intensities, indicating a logic of affects rather than a logic of delimited sets.”[16] It is collective in the sense that it is tied together not through a unified, homogenizing force that eliminates individuated characteristics, but rather as a conglomerate of loosely grouped subjectivities that exist beyond the verbal signifiers. In the case of assigning corporeal intentionality to other bodies, the granules of the shared subjectivities are precepts abstracted from perceptual information gathered corporeally and activated through the motor system.

Thus subjectivity should be represented as a heterogeneous culmination of individuated subjectivities, yet at the same time not solely a unitary cultivation of social conditions that surround an individual. Subjectivity, therefore, is a machinic product of intersubjectivity—it is a machine of “assemblages of subjectivation” that refer and allude to “incorporeal Universes” that we “detect at the same time that we produce them, and which appear to have been always there, from the moment we engender them.”[17] According to Guattari, the heterogeneous components of subjectivity are held together to the “existential Territory of my self,” and within that self, the components co-exist.[18] In a similar manner, subjectivities between performer and audience can be seen as constructed of heterogeneous components derived through various means that nonetheless maintain

[16] Ibid., 9.
[17] Ibid., 17.
[18] Ibid.

their individual characters, tied to individual selves, yet exist in a deterritorialized state shared among the subjects. Thus, subjectivity should be thought of as an *inter*subjectivity, extremely fluid in nature and traversing interpersonal spaces, rather than a singularized monolithic entity.

Varying meanings of intersubjectivity have been used interchangeably in multiple contexts, often without consideration for misconstruction of one meaning for another. Several approaches that describe and construct intersubjectivity have been explored: cognitive, behavioral, interactional/performative, and cultural/dialogical.[19] Examination of the sheer variety in disparate approaches result in a requirement in adopting an inclusive definition of intersubjectivity that bridges commonalities and punctuates a central point found in all of the approaches. Gillespie and Cornish settle on defining intersubjectivity as "the variety of relations between perspectives" as a compromise between approaches,[20] which will be the default definition used for intersubjectivity for the purposes of this thesis.

The concept of intersubjectivity has roots in Husserl's *Cartesian Meditations.* A. D. Smith describes Husserl's approach to phenomenology as experienced through intercommunication between subjects: "Husserl can be satisfied with nothing less than establishing a community of other conscious subjects who can together constitute an objective realm. So even the sheer existence of a plurality of other subjects would not meet the task at hand. What Husserl requires is that these subjects should *intercommunicate*, that they should *affect* one another, so as to establish *transcendental*

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[19] Alex Gillespie and Flora Cornish, "Intersubjectivity: Towards a Dialogical Analysis," *Journal for the Theory of Social Behavior,* 40 (1) (2009): 19–20.
[20] Ibid., 19.

intersubjectivity."[21] Smith further unpacks Husserl's idea of a communally established phenomenology: "We become aware of other subjects by perceiving their bodies […] the fundamental recognition of another subject just is the recognition of something *as a body*."[22] In recognizing other bodies, we first perceive that they exist as an object in physical space, then we assign *intentionality* to those other bodies in order to recognize them as other selves similar to us. We perceive the other bodies as having a goal (intention) and also act as willful conscious agents of behaviors that we enact continuously upon the world.[23]

Parallels may be drawn between Guattari's machine of subjectivities and Gallese's idea of the *shared manifold of intersubjectivity,* in that both concepts are attempts to capture the richness of the experiences that we share with others.[24] Gallese defines three levels to explore mechanisms that contribute to empathy: 1) the phenomenological level, 2) the functional level, and 3) the subpersonal level.[25] The phenomenological level refers to the mechanisms in which actions, emotions, and sensations experienced by others become implicitly meaningful. The functional level enables detection of coherence, regularity, and predictability, independently from their situated source. Lastly, the subpersonal level involves matching neural circuits between self and others.

Throughout a musical performance setting, intersubjectivity is established in two

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[21] A. D. Smith, *Routledge Philosophy Guidebook to Husserl and the Cartesian Meditations* (New York: Routledge, 2003), 215.
[22] Ibid., 220.
[23] Thomas Metzinger and Vittorio Gallese, "The Emergence of a Shared Action Ontology: Building Blocks for a Theory," *Consciousness and Cognition* 12 (2003): 550.
[24] Vittorio Gallese, "The Roots of Empathy: The Shared Manifold Hypothesis and the Neural Basis of Subjectivity," *Psychopathology* 36 (2003): 171.
[25] Ibid.,, 177.

directions: first between the performers, then between the performers and the audience. The construction of a "gaze"-able and observable performance state between the performers necessitates a common understanding and merging of perspectives among the performers in order to create a coherent narrative. The performers engage with each other and exchange information about their internal states as well as their external motor intentions through affordances derived from sounds as well as gestures. The audience is then privy to the interaction between the performers, which in turn results in a response that is shaped by the shared experience between the performers. The interactions between the performer as well as the audience sculpt a system of perceived intentions and actions both through the music and gestures.

In a performance, through establishment of intersubjectivity between agents, the boundaries between performers and the audience are blurred. Subject-object relations are dissolved through construction of "machinic subjectivity," to again borrow Guattari's terminology. The bipartite distinction between the subject and the object in which "each object appears in a relationship of binary opposition" is instead replaced with a multiplicity of spectra packaged in the form of a machine of subjectivities.[26] This autopoietic machine of subjectivities produces and maintains reproduction through engendering new subjectivities derived from the merging of subjective space between the subjects.

Therefore, one can conclude that establishment of intersubjectivity is essential for a compelling, embodied performance state. Intersubjectivity provides a foundation to art and its ability to destroy and reconstruct meaning assigned to signifiers, in that the

[26] Ibid., 28.

efficiency of art "lies in its capacity to promote active, processual ruptures within semiotically structured, significational and denotative networks, where it will put emergent subjectivity to work."[27] Establishing an intersubjective space between performers and audience enables a thrilling universe of semiotic play in which corporeal movements destroy and create meanings. Therefore, the manner in which meaning is created through corporeal movements has an impact on the creation of a convincing intersubjectivity. In other words, an embodied performance state is necessary for the performers as to connect the instrument to the performer intimately. Now I will examine what embodiment is as well as how achieving embodiment in performance states is important for electronic music performance in the curious case of wearable gestural instruments.

Embodiment and Performance

Electronic music performance does not necessarily place importance on establishing intersubjectivity through gestural elements and more often employs a variety of styles that may not necessarily prize intersubjective states. As such, the wide disparity in approach to electronic music performance is abundantly clear. First, in order to discuss embodiment in digital musical instruments, it is necessary to discuss the concept of embodiment itself.

Embodied cognition discusses embodiment in terms of how an agent, with its corporeal form, interacts with its environment to produce cognitive effects that are not solely derived from abstract representation of the features of the environment. In other

[27] Ibid., 19.

words, through the condition of being a body navigating an environment, the nature of the agent's cognition is constructed and not just merely augmented or altered. Shapiro cites such an example in describing Gibson's work on visual perception:

> Most of the light that enters our eyes, unless we are looking at stars or the moon, is either diffused light in the atmosphere above us or light reflected from the surfaces of objects surrounding us. Diffused light has very little structure. Its intensity might change as one shifts one's eyes from the center of the sky to the horizon, but this variation must count as a minor bit of structure when compared to the structure present in reflected light. […] This difference in the intensity of the reflected light creates structure that in turn reveals something about its source – the light will contain the information that the surface is not smooth but is instead corrugated.[28]

This information of the *ambient optic array* of light that helps determine structure of its source by the visual system can be misconstrued for representing a variety of sources with similar geometric shapes. In the case of the viewpoint of classical cognition, the agent has no way to differentiate between different objects that give the exact same optic array, and attempts at gathering further information fails as the optic information remains the same. However, embodied cognition takes into account the fact that the agent can *move* in their environment and thus gain information, which yields a completely different set of optic arrays depending on the agent's position. By having the ability to move around, the agent has no need for developing another complicated system to determine the structure of what they are viewing. In effect, the corporeal condition eliminates the need for additional information processing and thinking of the body as being situated within an environment with features helps lessen the cognitive load of the agent.

One of the first descriptions of the corporeal lived experience is included in Merleau-Ponty's *Phenomenology of Perception,* which details the perceptual

[28] Lawrence Shapiro, *Embodied Cognition* (New York: Routledge, 2011), 30.

transparency of the body: "A movement is learned when the body has understood it, that is, when it has incorporated it into its 'world,' and to move one's body is to aim at things through it; it is to allow oneself to respond to their call, which is made upon it independently of any representation."[29] He details three features of the body schema, defined by Gallagher as "a system of sensory-motor processes that constantly regulate posture and movement – processes that function without reflective awareness or the necessity of perceptual monitoring:" 1) behavior is learned when the body reached corporeal understanding, 2) when some features of the body becomes transparent, and 3) when the body responds skillfully to sensorimotor feedback.[30] The first and third features have been described in the first section, in which perception-action coupling enables precept formation which is then shared among agents through intersubjective space. The second feature involves the absence-presence relationship, in which "my body reveals a world to me, that which does the revealing withdraws from view."[31]

Heidegger's idea of the *tool in use* can be extended to illustrate technologies as an extension of the body, using the hammer as an example.[32] When the hammer is in use, its materiality becomes invisible in the face of the hammer being used for hammering; only it being used for hammering is relevant in the mind of the carpenter doing the hammering. In other words, the hammer is no longer phenomenologically present, and

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[29] Maurice M. Merleau-Ponty, *Phenomenology of Perception* (New York: Routledge & Kegan Paul Ltd, 2008): 159–61.

[30] Frederick B. Mills, "A Phenomenological Approach to Psychoprosthetics," *Disability & Rehabilitation,* 35 (9) (2013): 786–87.
P. Gallagher, et al, *Psychoprosthetics: An Introduction,* eds. P. Gallagher, D. Desmond, and M. MacLachlan (London: Springer-Verlag Limited, 2008), 1–10.

[31] Mills, 787.

[32] Martin Heidegger, *Being and Time,* trans. John Macquarrie and Edward Robinson (Oxford: Blackwell Publishers Ltd, 1962), 98.

only the percept of the hammering remains. Likewise, from the perspective of the performer, if the musical instrument is doing its job of "instrumenting" correctly, ideally the instrument should disappear from the phenomenological world of the performer from an embodied view of performance. The idea of the *tool in use* is similar to Leder's absence-presence relationship,[33] which is related to Merleau-Ponty's idea of transparency discussed earlier.

The three levels of presence, earlier described by Nijs, correspond to levels of embodiment in musical performance as first-order, second-order and third-order embodiment.[34] First-order embodiment corresponds to proto presence, in which the morphological characteristics of the body shape physical interactions with the world. Second-order embodiment involves body schema, in which the internally-generated model of the body's interaction with the world enables adapting behaviors to fit expectations. Finally, third-order embodiment, which is body image, combines body schema with the subjective experiences of having a *lived body*.

Third-order embodiment is the key to a meaningful performance interaction between the performers and the audience. The subjective corporeal experiences through an embodied performance state are shared with the audience through intersubjectivity. Therefore the relationship between the performer and their instrument should take place in an embodied state, enabling transference of the subjective experiences of the performer through intersubjective space. Instrument should interact with performer in an embodied state; therefore, the idealized performance state is one in which the instrument acts as an

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[33] Drew Leder, *The Absent Body* (Chicago: The University of Chicago Press, 1996): 13.
[34] Thomas Metzinger, "First-order Embodiment, Second-order Embodiment, Third-order Embodiment, in *The Routledge Handbook of Embodied Cognition,* ed. Lawrence Shapiro (New York: Routledge, 2014): 272–86.

extension of the body of the performer. Through encouraging an embodied performance state, performers can hope to augment the use of the intersubjective space among the agents, allowing the audience to experience the performance through assigning corporeal intentionality to performers. In order to do so, the instrument must enter a prosthetic partnership with the corporeal form of the performer, elevated from the status of being an object in use by the subject. Therefore, wearable gestural instruments, because they are part of the body, are closest to achieving the idealized embodied performance state precisely because it allows the audience to perceive gestural affordances of the performers.

The quality of intersubjective space between performer and audience is a direct product of the embodied gestural relationship between performer and instrument. Greater embodiment in performance state of the performer leads to a more embodied experiential content for the audience, as sympathetic neural processes are activated in response to perceiving the actions as well as the sonic results from the performer. I will examine how an embodied relationship between the instrument and performer can be achieved through thinking of the instrument as an *extension* of the body rather than a mere *tool* to be used for the purposes of performance. Wearable instruments reflect the desire for greater embodiment in performance practices, as they aim to be more of a part of the body rather than a separate object away from the body. The concept of embodiment thus calls for a paradigm shift from thinking of instruments in terms of a tool to a prosthesis. The technology of digital musical instrument should be thought of as if it belongs to the body in an ideal state.

The instrument-performer interaction through action and movement becomes a critical component of determination of a successful digital musical instrument. A "symbiosis between musician and musical instrument […] from a growing integration of instrumental and interpretative movements into a coherent whole that is compatible with the body of the musician and with the movement repertoire of daily life" assumes the foreground in a performance situation.[35] Through embodied interaction between the performer and the instrument through three layers of embodiment (self vs. non-self, self vs. external world, and self relative to present external world), the instrument becomes a natural extension of the body, a process that Nijs calls the "perceptual illusion of non-mediation."[36] As such, maximizing embodiment in electronic music performance becomes an imperative for an ideal performance state both for performers and the audience.

Definitions of embodiment in performance and requirements for embodied performance vary between scholars. Newton Armstrong outlines five requirements for embodied music performance: situatedness, timeliness, multimodality, engagement, and embodiment as an emergent phenomenon.[37] He positions embodiment as achieved through fulfillment of the first four requirements. Others take a more rigorous approach, examining detailed processes that lead to an embodied performance state. Nijs et al. outline three requirements for an instrument to disappear from active consciousness, which they define as having achieved an embodied state between the musician and the instrument: 1) direct perception of the musical environment from which the musician extracts affordances, or relevant cues in the percept; 2) skill-based coping, in which the

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[35] Luc Nijs, Micheline Lessafre, and Marc Leman, "The Musical Instrument as a Natural Extension of the Musician," Paper presented at CIM09, September 2009, 1.
[36] Idem, "The Merging of Musician and Musical Instrument," 52.
[37] Armstrong, 9–10.

musician reacts accordingly to affordances and constraints with a palette of conscious and unconscious actions; and 3) flow experience in which the musician becomes immersed. The functional and relational transparency of the instrument in relation to the musician's body leads to the perceptual illusion of non-mediation.

Wearable Technologies

Wearable technologies have been situated theoretically as somewhere between performance art costume and fashion garment.[38] Similar to performance art costumes, wearables are highly codified and serve as a mediator in the construction and interpretation of the performance and the performer. As in fashion garments, wearables act as external and internal communication mechanisms that can express both personal identity as well as group belongingness. Wearable technologies also serve a technological function for the body that they are attached to in that they either extend or create new functionalities for the body so that its boundaries may stretch beyond the corpus.

Marshall McLuhan, who coined the phrase "the medium is the message," remarked upon the nature of the novel experiences of the technologically altered human: "[o]ur human senses, of which all media are extensions, are also fixed charges on our personal energies, and that they also configure the awareness and experience of each one of us."[39] Addition of technological prostheses on bodies irrevocably alter the way that we interact and perceive the world. McLuhan then comments on the future of garments in this new era: "the electric age ushers us into a world in which we live and breathe and

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[38] Valérie Lamontagne, "Techno-Theoretical Paradigm: Performance, Fashion and Wearables," *DUXU 2014* (2014): 153.
[39] Marshall McLuhan, *Understanding Media: the Extensions of Man,* ed. W. Terrence Gordon (Berkeley, CA: Ginkgo Press, Inc, 2003), 34–35.

listen with the entire epidermis."[40] Technological advances in wearable machines have enabled a literal realization of McLuhan's prophetic visions, in which we have unfettered access to wearable technologies that facilitate extensions of the functions of our bodies and lengthen the reach and capabilities of each appendage.

Wearable technologies share similarities with performance art costumes as they aim to engage the performer-wearer in a semiotic play of both the performance and the apparel.[41] Felix Guattari speaks of performance art as delivering "the instant to the vertigo of the emergence of Universes that are simultaneously strange and familiar."[42] He then goes on to note the ability of performance art to "[draw] out the full implications of this extraction of intensive, a-temporal, a-spatial, a-signifying dimensions from the semiotic net of quotidianity." In other words, performance art breaks down the usual assemblages between form and semiotic communication, leading to a "forward flight into machinations and deterritorialised machinic paths capable of engendering mutant subjectivities." Performance art decontextualizes then recontextualizes something "artificial, constructed, composed." This "machinic processuality" extends to how wearable technologies break down constitutive identities of both machine and body and recombines them in novel configurations.

Through the act of putting on a piece of wearable technology, the wearer is able to extend their characteristics that belong not only to the wearer, but also the technology. The machine becomes part of the body, a previously unknown organ transplanted onto the body of the wearer to perform functions that were unable to be performed before or

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40 McLuhan, 166.
41 Lamontagne, 153.
42 Guattari, 90.

alter preexisting functionalities. The wearable technology is special in that it cultivates a close relationship between the machine and the wearer; by being a literal physical extension of the body, the wearable creates an intimate situation quite different from the relationship between a non-wearable technology and a performer. In other words, through the act of wearing a wearable technology, the machine becomes less of a *tool* and more of an *extension of self*. As the wearable technology becomes part of the body schema, familiarity with the technology increases. In other words, the user of a wearable technology, given enough expertise, incorporates the functions of the technology into the body as they include consideration of the technology in their corporeal understanding of the world. The wearer's action-oriented ontology is changed as the range of actions that can be taken by the wearer is extended. According to Valerie Lamontagne, the resulting "mechano-somatic exchange" is the direct consequence of the "speculative fashion designs that seek to create new experiences for the wearer that are not deterministic."[43]

Rebecca Horn's work with *Unicorn* (1970) and *Finger Gloves* (1972) provides an excellent example of how wearables may modify the way in which the body interacts with its situated environment. *Unicorn* is a performance piece involving a performer walking through a field with a tall, cloth-covered horn as tall as half the height of the body is attached to the top of the wearer's head with stabilizing straps covering both the head, neck, and torso in a cage-like manner. As the wearer walks, their attention is brought to the weight, shape and dimensions of the new prosthetic, who then must alter body movements in order to accommodate the new organ.[44] The wearer becomes a

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[43] Lamontagne, 160.

[44] Madeline Schwartzman, *See Yourself Sensing: Redefining Human Perception* (London: Black Dog Publishing, 2011), 45–47.

hybrid creature, whose mode of physical interaction with the environment is qualitatively changed; in other words, the "situatedness" of the body within an environment and interactions between the body and the environment change due to the addition of this new organ. *Finger Gloves* functions in a similar manner to the wearable in *Unicorn*, with 70cm talons of fabric and wood altering the way that the wearer's hands grasp objects.

The possibilities offered by machinic combinations, both in terms of subjectivities as well as between human and machine, is manifested in other artists' works whose attempts to modify the corporeal form skew more extreme. The Australian artist Stelarc uses a crowd-sourced third arm whose movements are controlled by the audience, aggregated responses channeled through the internet to the performer. Stelarc's subjective corporeal experiences is directly impacted by the will of the audience in that his body is no longer his own to control, but rather its control is ceded to (continue with example).

Within wearable technologies, wearable musical instruments occupy a unique position among wearable technologies in that communication is doubled through two sensory modalities, both through semiotic transmissions through the physicality of the wearable instrument on the body as well as employment of sound as a communication device. Michel Waisvisz's *The Hands* and Laetitia Sonami's *Lady's Glove* represent the first generation of experimental controllers that are gestural-based and also wearable.[45] These two instruments are unique in that they were mot modeled after a preexisting instrument. Rather, the two instruments each create a new language of performance

[45] Bert Bongers, "Physical Interfaces in the Electronic Arts: Interaction Theory and Interfacing Techniques for Real-time Performance," *Trends in Gestural Control of Music* (2000), 51.

unique to the instrument.

Wearable musical instruments speak to a certain desire for an instrument to become incorporated with the body, for it to cease being an independent entity in favor of being of the body itself. The incorporation of the instrument into the performer's body has undeniable consequences in the ways that the performer interacts with the instrument. Wearable instruments are positioned much closer to embodied practice of music than instruments that are contained as a separate tool away from the body as a distinct physical object. The close relationship enjoyed between the body and the wearable instrument enable transference of identity from the wearable instrument to the performer, and vice versa.

As the wearable musical instrument becomes part of the body, the entanglement of identity in both intensifies. The instrument ceases being thought of as an independent agent that cooperates with the performer to create sonic results. The perceived agency of the instrument itself is greatly reduced in favor of increasing the agency of the performer to produce sonic results. The identity of the instrument then shifts from being a tool to being part of the performer. In this, the wearable instrument resembles performance art costume, in which an interplay of various characteristics are imbued upon the performer.

Worth mentioning is the variety available in digital musical instruments in order to frame the position that wearable gestural instruments occupy. Input devices for new digital musical instruments fall under four categories: instrument-like controllers, instrument-inspired controllers, extended instruments, and alternate controllers.[46]

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[46] Marcelo Mortensen Wanderley and Nicola Orio, "Evaluation of Input Devices for Musical Expression: Borrowing Tools from HCI," *Computer Music Journal* 26 (3) (2002): 62.

Instrument-like controllers emulate existing acoustic instruments; instrument-inspired controllers retain some characteristics of preexisting acoustic instruments; extended instruments seek to enhance functionalities of acoustic instruments; and alternate controllers attempt to create a novel instrument not based on any preexisting acoustic instruments.

Commonly available commercial electronic instruments tend towards what is easily produced and reproduced on the industrial level, rather than taking into consideration the playability and form factor for the individual performer. Grid-like and highly geometric shapes dominate the market, prizing stylized presentation over allowance for intuitive playing. Most often, these controllers employ the use of buttons, knobs, and sliders due to their familiarity with the average electronic music performer as well as ease of commercial production.

However, the arrangement of these various input mechanisms make little ergonomic sense since it is difficult to align the fingers and let them fall naturally alongside the grid in an intuitive fashion, disallowing an embodied performance state. The range of gestural movements that are an integral part of musical performance is also highly constrained by the available inputs and the quality of those inputs permitted by these controllers. The lack of design consideration for the performer actively hinders the attempt to create an embodied performance state. The performer is forced to reposition and reconsider the alignment of the fingers in an unnatural configuration. A resultant disjointed relationship between the body and the instrument extinguishes corporeal transparency, with the performer’s attention redirected away from performance to the positioning of the body.

Moreover, design considerations of novel electronic musical instruments have been hampered by a structured pedagogical ideology that encourages more in the development of augmentative designs influenced by preexisting musical instruments, as opposed to creation of novel instruments that may not fall within the traditional paradigm. Marc Leman presents a model of development and improvement of new instruments using what he calls the action-reaction cycle.[47] In this model, instruments follow a cycle of play-listen-judge-change, in which modifications to the instrument are made through audition. Leman also notes a ratchet effect in instrument development, in which the process of instrument-making tend towards a linear pathway, both in the actual process of instrument-making and the history of how an instrument evolves.[48] Makers of new instruments have a marked tendency to base their creations on designs of preexisting instruments and model their shapes after such instruments, despite in many cases the shape being an outdated skeuomorphic form, a holdover from their predecessors. Unnecessary characteristics and constraints, in terms of shape of the instrument, their constituent materials, and the posture required for performing, are imbued in favor of ones that call for a different design approach.

Certain advantages in modeling a new digital musical instrument after an existing acoustic instrument do exist, such as the ability to ease the performer trained on a traditional acoustic instrument to adapt to the new instrument more quickly and easily. Familiarity on a similar instrument greatly enhances time required for proficiency on a new instrument modeled after that instrument. However, design considerations of acoustic instruments are vastly different from those required by electronic instruments, as

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[47] Leman, *Embodied Music Cognition and Mediation Technology*, 54.
[48] Ibid.

acoustic instruments require a physical sound-making mechanism, such as a resonator, and associate a much closer connection between minute motor movements and the resultant sound. Therefore, modeling novel electronic music instruments after existing acoustic instruments defeats the unique opportunities that an electronic instrument may offer. Instead, copying reduces the electronic instrument to a clunky approximation of the acoustic instrument. Thus, in order to design embodied new digital music instruments, novel designs must be created in unconventional forms.

There have been attempts to combat the lack of playability in new digital music instruments. Frameworks have been developed for evaluation of new digital musical instruments using human-computer interaction (HCI) principles in which constitutive characteristics of instruments can be categorized and analyzed through experimentation on response times.[49] Wanderley and Orio identify four characteristics that determine usability of controllers: learnability, which is the time required to learn to play the controller; "explorability," which is the extent to which the controller allows the performer to explore its capabilities; feature controllability, which is the ability of the controller to control sound parameters; and timing controllability, which is the ability of the controller to allow for timely responses in the performer.[50] However, many HCI considerations fall short expectations as they rely on *objectivist/computational* approaches, situating the performer and instrument as apart from each other.[51] As such, a

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[49] Wanderley and Orio, 62–63.
Chris Kiefer, Nick Collins, and Geraldine Fitzpatrick, "HCI Methodology for Evaluating Musical Controllers: A Case Study," *NIME08* (2008): 1–4.
Sile O'Modhrain, "A Framework for the Evaluation of Digital Musical Instruments," C*omputer Music Journal* 35, no. 1 (2011): 8–42.
[50] Wanderley and Orio, 71.
[51] Newton Armstrong, "An Enactive Approach to Digital Musical Instrument Design," Ph.D. dissertation, Princeton University, 2006, 23–31.

new holistic and nonrepresentational approach to evaluating performer experience has been called for in HCI, a trend known as the "third paradigm," in which subjective experiential descriptions of users takes primacy.[52]

Gestural instruments represent a class of electronic instruments based on bodily movements enacted by the performer. Gestural instruments are digital musical instruments that "rely on gestural input captured through information gathered by sensors… [that] can take any form, from that of an acoustic instrument (instrument-like or instrument-inspired controllers) to alternate controllers that do not resemble known acoustic musical instruments."[53]

Modern gestural controllers rely on sensors as opposed to direct generation of sound through physical phenomena. The gestures enacted by performers are picked up by sensors, which are apparatuses that can convert physical energy to electrical energy.[54] Sensors are able to convert a variety of energies, including kinetic energy, light, sound, temperature, smell, humidity, and so on. The converted electrical energy then can be extrapolated to correspond to physical characteristics such as acceleration, pressure, bend, location, and so on. The electrical energy is then converted to the digital domain, representing the energy in the form of a series of numbers that correspond to the voltage information. Sensor-based instruments rely on taking in a stream of data that are translated to sonic results via a sound generator.

However, resolution rate for detecting gestures leaves something to be desired. As Clark criticizes virtual reality, "the modes of sensing and interaction supported by

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[52] Kiefer et al., 3.
[53] Eduardo Miranda and Marcelo Wanderley, *New Digital Musical Instruments: Control and Interactions Beyond the Keyboard* (Middleton, WI: A_R Editions, Inc, 2006), 1.
[54] Bongers, 51.

current technologies often remain limited and clumsy, and this turns the user experience into that of a kind of alert game player rather than that of an agent genuinely located inside the virtual world."[55] The kinds of limitations that virtual reality faces are also faced by wearable gestural instruments as inputs for both are constrained by the sensors they utilize, creating a world in which interactions between the agent and the environment are limited leading to a fracture in the feeling of embodiment. In other words, the input is limited in contrast to the range of possibilities presented by the output, and the constraints pose an active threat to an embodied performance state.

The separation of the input-taking component of the electronic instrument (i.e., the portion that takes in input data from the performer) and the sound-making portion (i.e., the portion that translates the input data to a sonic result) has hampered digital musical instruments. The decoupling of the input-device controller and the sound generator entails that the sound generator is not controlled by "any physical energy, but purely by information represented as numbers," as information travels between the input device and the generator.[56] Therefore, mapping the input from the controller to the sound generator becomes a primary concern in the construction of a digital musical instrument. The reduction of gesture information necessitates the use of mapping schemes that further distort and downsample performance gestures. Moreover, the cleavage between the two components has resulted in separation between the act of performing with an instrument and the musical result, leading to a disembodied form in which gestures do not

[55] Andy Clark, *Supersizing the Mind: Embodiment, Action, and Cognitive Extension* (Oxford: Oxford University Press, 2008), 10.
[56] Uwe Seifert and Jin Hyun Kim, "Towards a Conceptual Framework and an Empirical Methodology in Research on Artistic Human-Computer and Human-Robot Interaction," *In-Tech Education and Publishing* (2008), 180.

necessarily correspond to the sound produced in an immediate, clear manner.

Taking the four usability criteria from Wanderley and Orio into consideration, gestural instruments have the potential to fulfill all four the four criteria for maximal usability. Gestural instruments are relatively easy to learn in the beginning but difficult to master, providing a dynamic learning curve. The explorability of gestural instruments gives a vast array of possibilities as any gesture can be taken as input. Gestures are taken as input, which maximizes feature controllability in that detailed movements are possible as long as enough sensors are equipped to gather information. Lastly, timing controllability can be optimal as processing power of computers improves with technological advances, shortening the time for interpreting input gestures to sonic results as gestures happen.

However, these characteristics are optimal goals not yet achieved by gestural instruments as well as currently available technology. Gestural instruments are not yet technologically advanced enough to yield results that would maximize embodiment. For example, latency in gesture interpretation hinders correlation between gesture and sound as the sonic result is delayed; meanwhile, while the computer is processing the mapping scheme between the gesture input and the sonic output, the performer has moved onto the next gesture. This prevents the audience from directly relating the movements to sound.

Therefore, the ideal digital musical instrument would be one in which detailed gestures are able to elicit compelling and directly related sonic results in a way that establishes an intersubjective space between the performers and audience. Taking these requirements into consideration, the ideal instrument can be posited as one which *is* part of the body. Thus the characteristics of an ideal instrument are as such: 1) is part of the body natively, not as an afterthought; and 2) produces emergent social qualities between its possessors.

The Ideal State

Wearable gestural instruments, while they aim for an embodied performance state, fall short of the ideal expectations of actually being part of the body. While they aim to be *as if* they are part of the body, they ultimately serve as prostheses that attempts to reach ideal embodiment, which is being of the body itself whose experiences can be shared with all agents present in a performance system of both performers and audience. According to Tanaka, musical instruments transcend the status of a tool and are expressive outlets for sharing the experiences of a human being[57], and therefore should aim for an elevation of the relationship between performer and instrument from mere utilitarianism.

Gestural instruments, in their current state, are unable to approach the directness of the input and output relationship complexity offered by even acoustic instruments. Jordà lists "musical output complexity'" and "control input complexity" as concepts that should be explored in advancing digital musical instrument, of which the latter can be connected to the concept of explorability presented by Wanderley and Orio.[58] Input capabilities are limited by available sensor technologies, which are able to glean some aspects of a gesture enacted by a performer but is unable to capture the *totality* of the movement. As a result, the maker of a gestural instrument must make a decision on what

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[57] Tanaka, 389–90.

[58] Sergi Jordà, "Digital Instruments and Players: Part I – Efficiency and Apprenticeship," *Proceedings of the 2004 Conference on New Interfaces for Musical Expression* (2004): 61.
Wanderley and Orio, 71

inputs are considered desirable enough to be mapped to a sonic result within the confines of the limitations of sensor technology, keeping some information and discarding the rest.[59] "The machine would become the prerequisite for technology rather than its expression," in that the machine of the gestural instrument defines the nature of the instrument and its expressive powers serving a secondary role.[60]

For example, Atau Tanaka's BioMuse system takes bioelectrical signals of the body through the electroencephalogram (EEG), electromyogram (EMG) and electrooculogram (EOG).[61] The inputs, which should be intricately detailed as they are taking information from the complex body, are reduced to eight input channels each deriving information from an electrode triplet, which each spits out a single stream of data. Tanaka made a conscious decision on the muscle groups that he deemed relevant; as such, the electrodes are focused on the muscles of the arm.

In electronic music performance, often it is not physically evident *how* the sound is produced even with clear gestural correlations,[62] because the audience is not aware of the physicality in creation of sound with a gestural instrument. In other words, it is difficult to attribute the corporeal intentionality to the instrumental objects, leaving the performance to be flat in affect. Schloss cites the example of virtuosic The Flying

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[59] This applies to makers of acoustic instruments as well but to a much lesser degree. Here I am discussing the consequences for limitations of the sensor technology. Acoustic instruments on the other hand are able to take in the *totality* of the acceptable gesture, in this case meaning they respond to any tiny gradations of a gesture within the accepted confines. I am not arguing that there are limitations on the gestures that an acoustic instrument takes in; rather, that the complexity of input is a magnitude more limited for digital musical instruments.

[60] Guattari, 33.

[61] Atau Tanaka, 391.

[62] W. Andrew Schloss, "Using Contemporary Technology in Live Performance: The Dilemma of the Performer." *Journal of New Music Research* 31 (1) (2002): 2.

Karamozov Brothers, who began as a juggling troupe and began to merge juggling with music.[63] The troupe began to incorporate wearable instruments and sensors developed by the MIT Media Lab in order to further their virtuosity, but the audience was unable to perceive the physical connection between the movements and the sonic results, leading some to believe that the troupe was playing along to a fixed track. Clearly, the most direct relationship between gesture and sound is not the only requirement for embodied performance. Such a direct relationship without consideration for the physicality of sound results in semiotic linearity – in which signifiers (input) are seen as directly pointing towards signifieds (output) – and should be discarded in favor of "machinic segments" that "refer to a detotalised, deterritorialised mecanosphere, to an infinite play of interface."[64]

Another way that the wearable gestural instrument—as well as other forms of instruments and manners of electronic music performance —fail is the push for a solo performance approach. Contemporary electronic music performance downplays the role of social implications in music-making, with performance approaches primarily focused on solo endeavors. A notable commonality among many wearable gestural instruments is that their focus is on extending the body's ability to enact upon the world, and therefore is most commonly oriented towards showcasing the ability of a single performer with their instrument. The intent is to enhance some aspect of the body's ability to interact with its surrounding environment through extension and augmentation of the body through the wearable instrument. However, the soloist/augmentation approach neglects the interconnectivity and intersubjectivity that invariably becomes established between

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[63] Ibid., 2–3.
[64] Guattari, 30.

performer and instrument, between the performers, and between the performer(s) and the audience and is thus fundamentally crippled and disembodied.

The soloist approach is primarily concerned with showcasing the performer's mastery of a single, specialized instrument while leaving the audience to perceive the performer as a spectacle with little commonality between the audience and the performer. The soloist approach exacerbates the distance already established by the performance setting by framing the interaction between the performer and the instrument as a sort of a mystery. The relationship between performer and instrument is obscured as the audience does not share in the experience of having interacted with the specialized instrument, thus making it more difficult to establish a situation in which the audience is able to vibrate in reaction to the performer's gestures. In other words, the audience has no experience handling the specialized instrument, and therefore the percepts of the action are not incorporated into the corporeal experiences of the audience.

Another important aspect in which wearable gestural instruments fail is the lack of a haptic feedback that is inherent in an actual body part. Perceptual abilities through gestural instruments is limited, and compared to acoustic instruments which display an inherent mechanical-acoustical coupling, gestural instruments must rely on mostly musical feedback, and if available, synthesized tactile feedback or sonic pressure.[65] Thus, a systems approach that treats the performance system of performers and audience is necessary, one in which interactions between the constituent parts of this system are considered to be in an organic state.

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[65] Tanaka, 400.

Conclusion

I anticipate two distinct directions in which new electronic musical instruments will proceed: 1) towards AI and development of an independent agent capable of performing music-making in collaboration with the performer; and 2) total integration of the instrument with the performer, with embodiment being the marker of the degree of successful envelopment. Seifert and Kim are of the former camp, in which they predict a future in which the artist will move away from the role of a creator of *artworks* to a creator of *experiences*; that is, the artist will create interactive and virtual environments in which participants derive their own experiences within the given framework.[66]

As Clark remarks, "[t]he promised, or perhaps threatened, transition to a world of wired humans and semi-intelligent gadgets is just one more move in an ancient game. It is a move, however, that provides a wonderful opportunity to think longer and harder about what it *should* mean to be human."[67]Whether the direction of electronic music performance is towards an interactive environment or a body integrated instrument, the truth is that "[t]he only acceptable finality of human activity is the production of a subjectivity that is auto-enriching its relation to the world in a continuous fashion."[68]

This thesis is not an argument for "reterritorialisations of subjectivity," as Guattari puts it; I do not wish to enforce a future in which singularity in subjective experiences is the goal, to erase individuated gradations through force-fed singular machinic hybrid forms for every individual. It is only through a wish for greater substantiations of an experiential potentiality that I present this possibility, this new

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[66] Seifert and Kim, 184.
[67] Clark, 142.
[68] Guattari, 21.

bodily form, so that we may examine our extant modalities of transmission and communication, and consequently how we carve our own respective ontogenetic pathways as well as with and through each. It is most certainly not my intention to subjugate a population to an imperialist corporeal modification, towards a dystopian goal of homogenized populations isolated and obliviated of responsibilities and desire for self-determination. My goal instead, that I think to be a noble pursuit, is to engender a crystalline web of possibilities upon each vertex sits finely stacked bundles of Universes, of new semiotics and signifiers, and communicative methods of traversing between chasms that allow each and every one of us to gaze out from our respective occupied islands onto the vast explosion of the Universe of phenomenological Universes.

"The only acceptable finality of human activity is the production of a subjectivity that is auto-enriching its relation to the world in a continuous fashion."[69]

"Curiously, in acquiring more and more life, machines demand in return more and more abstract human vitality […] Computers, expert systems and artificial intelligence add as much to thought as they subtract from thinking."[70]

"We need to free ourselves from a solitary reference to technological machines and expand the concept of machine as to situate the machine's adjacence to incorporeal Universes of reference."[71]

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[69] Guattari, 21.
[70] Ibid., 36.
[71] Ibid., 31.

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