Musical Cyborgs: Human-Machine Contact Spaces for Creative Musical Interaction

Sebastian Trump[1]

Nuremberg University of Music
sebastian.trump@hfm-nuernberg.de

Abstract. The concept of *Musical Cyborgs* follows Donna Haraway's "Cyborg Manifesto" to describe a non-binary approach for human-machine collaboration with blurred borders between biological and cybernetic worlds. Interface dimensions of embodiment, instrumentality, authenticity, creativity, learning, and aesthetics therein unfold between intentional and self-organizing autonomy and are discussed with their specific requirements, conditions and consequences.

Keywords: Cyborg Human-Machine-Interaction Co-Creativity

1 Introduction

How can musical collaborations between humans and artificial intelligences be described ontologically? In what way could an approach be structured that assumes a non-hierarchical, equal creative process in performing with machines?

The theoretical frameworks of posthumanism (Braidotti, 2016) set the context for critically examine anthropocentric categories and assumptions towards a possibility of more-than-human[1] collaborations. A common and useful approach to describe diverse human and non-human actors in musical creation is Bruno Latour's (2005) Actor-Network Theory (ANT)[2], although partly criticized for its tendency to disguise hierarchical power relations in a flat ontology (Born & Barry, 2018, 446) instead of revealing them. Therefore, it is complemented here with Donna Haraway's (1991) figure of the cyborg to make differences in the ontological status of nonhuman actors more explicit[3].

Following Haraway, the concept of *Musical Cyborgs* is proposed and designed here as a setting of co-creativity with blurred borders between biological and

[1] The term "more-than-human worlds" was introduced 1996 in an ecophenomenological context (Abram, 1996) as to describe a multidisciplinary concept of relationships and entanglements between humans and non-human actors.

[2] Two examples in this direction can be found in Bown (2015) and Brown (2016).

[3] Haraway describes the cyborg as a postmodern hybrid of technology and organism, and by this concept emphasizes the disappearance of alleged boundaries such as between humans and animals, between biological and cybernetic worlds, and between the physical and the non-physical. The concept thus goes far beyond the notion of cyborgs as physical combination of human and machine, which is widespread in science fiction.

cybernetic worlds. These *Musical Cyborgs* can enfold in various configurations and create a contact space for joint creative action. The conception invites to look at creative computer systems from a different angle, where humans and machines do not appear as separate entities—connected only by physical interfaces like hardware controllers or sound—but entangled in many interface dimensions. This has implications not only for the philosophical reflection and reception of human-machine partnerships in music, but also for design considerations in creative music systems. Bespoke intelligent interfaces, extensive autonomies and appreciation are needed to allow such artistic dialogues to emerge.

This paper explores the concept decomposed through a two-dimensional representation of selected interface elements (section 2.2) situated in the nexus of two converging forms of autonomy (section 2.1). The selected aspects of this contact space are certainly not to be seen as being comprehensive, but rather, on the contrary, as pieces of a large puzzle open for extension and discussion.

2 Musical Cyborgs

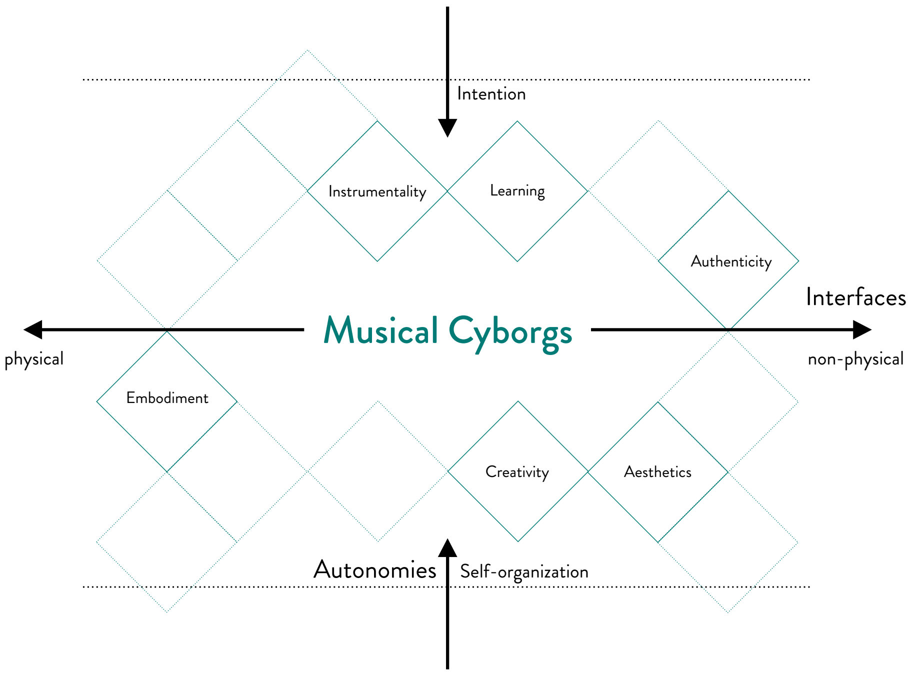

Fig. 1. Contact space of *Musical Cyborgs* between intentional and self-organizing autonomy interfacing through embodiment, instrumentality, authenticity, creativity, learning, and aesthetics.

Figure 1 shows a schematic and simplified illustration of the concept of *Musical Cyborgs* with the two axes *Autonomies* and *Interfaces*. These are framing the attempt of a non-dualistically structured "cyborg semilolog[y]" (Haraway, 1991, 163) which dismantles "the difference between natural and artificial, mind and body, self-developing and externally designed, and many other distinctions that used to apply to organisms and machines." (Haraway, 1991, 152).

With two kinds of autonomies acting on the *Musical Cyborgs* from above and from below, various overlapping interface dimensions seem to align along a widening axis between physical and non-physical. However, this is by no means meant to imply a binary opposition, but merely to suggest the relationship of the respective interface to materiality and embodiment[4]—"Cyborgs are ether, quintessence" (Haraway, 1991, 153).

2.1 Agency and Autonomies

While it is still controversial in the philosophical discourse whether agency can be attributed to artificial intelligences (Schlosser 2019)[5], this question can be answered affirmatively for *Musical Cyborgs*. Hanson's "extended agency theory" (Hanson, 2009, 92) therefore fits very well with theoretical concepts of decentering agencies in various fields (cf. section 2.2) through a network of actors in "joint responsibility" (Hanson, 2009, 97). By the increasing divergence, over time, between an initially human computer program and the resulting artifacts he ascribes shared distributed authorship to these interwoven human-machine artifacts—an idea that Galanter (2020b, 2020a) has also expressed, thus suggesting to also credit machines for co-creatively generated artifacts as the first step towards ethical treatment of artificial intelligences.

Boden (2012) describes two kinds of autonomy, which converge in the *Musical Cyborgs* from above and below (cf. Figure 1): The first type of autonomy (intention) is often associated with free will and a high degree of agency, and thus is usually attributed only to human actors (McCormack, Gifford, & Hutchings, 2019). However, this limitation is relieved if we look at it from an "intentional stance" (Dennett, 1989)[6], thereby also allowing the attribution of intentionality to the artificial systems of cyborgs (Bown, Eldridge, & McCormack, 2009; Schlosser,

[4] This misinterpretation would be particularly problematic in this case, since it is precisely the Cartesian coordinate system that is emblematic for the dualism of mind and matter in Descartes' metaphysics (Robinson, 2020).

[5] Even if artificial intelligences (AIs) have not yet achieved this status ontologically, Inayatullah has argued for their potential of AIs (or in embodied appearance as robots) to become alive (Inayatullah, 2001, 95).

[6] In this approach to the philosophy of mind, Dennett describes the attribution of mental states of complex systems from three possible perspectives: (1) the "physical stance," which seeks to explain behavior in terms of the laws of nature, (2) the "design stance," which uses the design history of a system to describe its purpose, and (3) the "intentional stance," which ascribes to a system the rational pursuit of certain goals (Dennett, 1989, 17). Hence, the ontological status of a rational agent can be assumed from the observation of a system.

2019). It therefore stands to reason that the development of genuinely individual artistic goals seems possible and necessary for autonomous artificial actors. (McCormack et al., 2020).

From the opposite direction to intentional autonomy, other dimensions of agency also unfold from the second type of autonomy, which is primarily characterized by self-organizing distributed processes. This kind of autonomy is particularly strong and independent in many computer-based systems, including especially generative and A-life approaches (e. g. Young & Colton, 2020; Miranda, 2011; Whitelaw, 2004), as well as in technical architectures such as artificial neural networks or concepts of metacontrol (de Campo, 2014). Stimulated by "perturbations producing constancy" (PPC, Boden, 2012, 176), they seek homeostasis and often appear opaque in their concrete manifestation.

In order to facilitate increased agency, especially in artificial creativity, Jennings (2010) argues specifically not for more independence but deeper entanglement in a co-creative network (Brown, 2016), as described in the concept of the *Musical Cyborgs* here. Since "autonomy might require more, not less, interaction" (Jennings, 2010, 500), the following section will examine some particular interfaces for this purpose in more detail.

2.2 Interfaces

The creative collaboration of the *Musical Cyborgs* unfolds many, partly overlapping aspects from physical to utterly non-physical dimensions, each of them as a human-machine interface with its own structure, but intertwined rhizomously. Consequently, the interface dimensions presented below only provide fragmentary perspectives on their interrelationships, but their different conditions and implications make them worth examining in isolated form.

Embodiment Probably the most obvious and, at the same time, the most entrenched in physicality human-machine interface of the *Musical Cyborgs* is formed by the organic body and physical hardware. These can physically connect through biometric technologies such as *Electromyogram* (EMG, e. g. Donnarumma, 2017; Tanaka & Knapp, 2017), *Electroencephalogram* (EEG, Miranda, 2014), skin conductance (e. g. McCormack, Gifford, Hutchings, Llano Rodriguez, et al., 2019) or different kinds of wearables (e. g. Laetitia Sonami's "Lady's glove": Sonami, 2014). Embodied interactions in a broader sense can take place haptically and tactilely between spatially separated elements (e. g., a hand and a motorized fader), or provide a contact space for interaction only in one-sided physical presence, e. g., through camera-based detection of body movements. Musical robots like the marimba-playing improvisor Shimon by Hoffman and Weinberg (2010) or digitally-enabled hybrid pianos (Brown, 2018) impart the machine in the cyborg with considerable physical agency through an autonomous body and disguise their collaborative genesis, which then becomes visible again in joint performance.

Other aspects of cyborg physicality arise from its hardware components: Does software run on only one computer or in an assemblage of multiple systems?

How much computing power is available to the actual devices involved? These questions are part of the "machine condition" (Colton, Pease, Guckelsberger, McCormack, & Llano, 2020) of the *Musical Cyborgs* and seem of equal importance as the human-bodily elements of a musical performance.

Instrumentality Following Robert Rowe's (1993) seminal categorization of interactive systems, the underlying paradigm range between "instrument" and "player" particularly seems to relate to the conception of *Musical Cyborgs*. While in the player paradigm a high degree of agency becomes explicit for the machine elements (cf. also the bodily dimension involved), configurations of human-machine collaboration can also emerge along the whole spectrum towards instrumental function. Instrumentality is no contradiction to the autonomy of cyborgs if we acknowledge the ontological status of their elements as independent actors and dismiss the idea of control in favor of that of an encounter.

For performer Laetitia Sonami, her earlier "desires of an embodied expression of control and power" (Sonami, 2014) have "become more of an exchange between the instrument and me, the performer. Not just forcing my intentions onto it, but letting it inform the composition and performance." (Fiebrink & Sonami, 2020)

Similarly, (digital) musical instruments—as they gradually achieve instrumentality (Hardjowirogo, 2017)— already gain independence with lesser intentional autonomy (situated towards the "instrument" end in Rowe's paradigm dimension) through an instrumental agency in *Musical Cyborgs*. Magnusson (2010) highlights the equally important non-physical epistemology inherent in a musical instrument as having complementary properties to Birnbaum's (2005) more intention-driven approach to an instrumental dimensional space in a hermeneutic relationship to the instrument.

Authenticity For the *Musical Cyborgs*, the challenge on interfacing in authenticity lies mainly in balancing between their human and computer characteristics. Contrary to the widespread doubts about authenticity in computer art because of its general dependence on generic and repetitive algorithmic processes (McCormack, Gifford, & Hutchings, 2019), Colton et al. (2020) suggest promising approaches towards a more individualized consideration of the "machine condition." To achieve more balance, computers should therefore also be able to accumulate impressions, life experiences and observations of their environment—although quite different to those of human actors and concerning e. g. the state of their hardware, encounters in computer networks, or recordings of sensors data—and refer to them in creative collaboration.

In his concept of the "creativity tripod," Colton (2008) promotes the three qualities of skill, appreciation, and imagination as constitutive for a person or group—such as the *Musical Cyborg*—to be perceived as creative. Appreciation can be seen as an essential prerequisite for the increase of authenticity and can become explicitly visible in certain cyborg settings, e. g. as an inherent feature in improvisational settings due to feedback cycles in material selection of human and machine participants. In the same vein, Sonami underlines the challenge to listen actively to the sound suggestions of her artificial performance partner and to continue the exploratory dialogue between them as they perform together (Fiebrink & Sonami, 2020).

Creativity While many preliminary discussions have already been made about the conditions for creative agency in Artificial Intelligence and A-Life[7], the description of co-creative joint processes of humans and machines seems to be far more complex—moving seamlessly between organic and technical substrates in the case of *Musical Cyborgs*. However, according to the observations of Csikszentmihalyi (1996), who exposes creativity as a social and systemic phenomenon, it should be rather difficult to examine creative artifacts and their development reduced to one individual creator. Instead and we should consider collaborative genesis as the standard case.

All three types of creativity[8], as introduced by Boden (1991), can each be associated with particular approaches in computational creativity, but differ in their relation to co-creative processes. Referring to Colton's "creativity tripod," (2008), the ability for "imagination" is a crucial quality for becoming effectively creative. But especially the recent parametric approaches for computational creativity like deep learning require a huge amount of examples as training data for manifold recombination capabilities and thus leave less room for genuine imagination through interactive co-creation[9]. Also for joint creative exploration, Fiebrink and Sonami (2020) emphasize the importance of wideness in machine learning, meaning untrained spaces of possibility where the unexpected in the encounter of human and machine in the cyborg can take place. A path to innovative transformative creativity in the more-than-human entanglements of *Musical Cyborgs* could thus pass through an assemblage of various technical or biological components and process, not limited by the current state of development of artificial intelligences.

Learning Interfaces for mutual learning emerge in *Musical Cyborgs* in various forms: The common mechanisms of machine learning require a large amount of usually humanly compiled training data and thus mark a hierarchical division between teacher and learner. However, Fiebrink (Fiebrink & Caramiaux, 2017; Holland & Fiebrink, 2019) points out that this layered process is often inadequate

[7] The ability of artificial intelligences to act creatively on their own is often doubted, but has been supported by Boden (1991) with the argument that—since there is no magic involved in creativity—there is also the theoretical possibility for a complete modeling. Bown and McCormack (2011) pointed out that, also here, a less anthropocentric approach is needed to give Artificial Life in the Arts more leeway for creative agency.

[8] (1) "Combinatorial creativity" is recombining existing items to create new elements, (2) "exploratory creativity" is searching through an existing conceptual space, and (3) "transformational creativity" is transforming an existing conceptual space.

[9] In this regard, Pachet, Roy, and Carré (2020) also state their observation that "the most interesting music generation were not obtained with the most sophisticated techniques."

in a musical context and thus developed tools that allow interactive feedback and adaptivity of the training data in a "human-in-the-loop" model. This approach integrates seamlessly with a cyborgian concept for creative collaboration and emphasizes the need for multifaceted interfaces over algorithmic extensions.

But it is not only connections to the physical world—from computer vision to machine listening—that create the potential for learning: The amazing rise of Google's AlphaGo software shows how the 2016 defeat of former Go champion Lee Se-dol does not mark the end of an development but rather the beginning of a new human-machine learning process. Go masters are now also studying genuine machine strategies and game moves in order to improve their own skills. In "centaur chess", cyborg teams are already established and outshine human players (Center, 2020; Shin, Kim, & Kim, 2021). As an essential element of Colton et al.'s concept of the "machine condition" (2020), events in the learning process itself could also be the subject of creative production.

Aesthetics The most challenging aspect in the creative practice of *Musical Cyborgs* is certainly to establish appropriate conditions for the emergence of relational aesthetics among all participating actors. This aesthetic should not be hierarchically structured by, for example, only considering simulation of human aesthetics, but rather enable and appreciate genuine contributions of artificial intelligences in collaborative creative processes—particularly when "the emergent artificial aesthetics themselves seem alien and unrelated to human notions of beauty" (Galanter, 2012, 286). To achieve this necessitates the autonomous development of a human-machine aesthetic value system[10] by which creative artifacts can be judged to satisfy Boden's (1991) two criteria of creativity, novelty and value. This non-binary approach reveals that therefore methods like the Turing test[11] seem inappropriate for evaluation and, aiming at the differentiation, might even exclude machine actors from equal participation in creative processes (Colton, Cook, Hepworth, & Pease, 2014).

Complementary to the question of an aesthetic value system, it is—as an element of intentional autonomy—equally important to allow the artificial intelligence of the cyborg to make aesthetic selection decisions autonomously. In this context, Sonami (2014) reflects her shift in relationship to technology in her

[10] A promising approach to this was explored by Romero, Machado, and Santos (2009) in the "Hybrid Society" project. In this virtual community, all participants—human and artificial—act as creators and critics, placing bets on created artifacts that appear attractive to other members of the society. A matrix of relationships emerges, specific affinities between creators, their products, and critics become visible, even creating subcultures within the hybrid society. The possibility of mutual influence in this heterogeneous network of interactions in a cultural ecosystem incorporates encouraging components to develop a relational aesthetic value system and new styles therefrom.

[11] Turing (1950, 433) proposed this "Imitation Game" as a test scenario to distinguish between a human and a computer conversation partner by a human interrogator asking questions in a virtual chat scenario.

performances from a desire to "dominate an unknown" through "control and power" towards an appreciative collaboration.

3 Outlook

This article was not intended to provide an exhaustive alternative systematics of approaches to machine creativity, but rather a complementary, non-dualistic perspective on the relationship between human and machine in creative production focussing on posthumanistic aspects. It can be a point for departure in the further specification and elaboration of the various human-machine contact spaces of *Musical Cyborgs*. In particular, further research seems worthwhile to add more pieces to the puzzle of the various interface aspects. In particular, the comprehensive comparisons of existing systems in Tatar and Pasquier (2019) or Gifford et al. (2018) provide a substantial basis for evaluating and extending the concept described here.

Furthermore, if one follows the idea of an inseparable unity of human and machine in the creative production of the *Musical Cyborgs*, it reveals that even without speculation about future universal artificial intelligences, equal cooperation is already possible, if we leave aside the deficit view on our technological partners. Therefore, Haraway (1991, 150) envisions her cyborg concept as "an argument for pleasure in the confusion of boundaries and for responsibility in their construction."

References

Abram, D. (1996). *The spell of the sensuous: Perception and language in a more-than-human world*. New York: Vintage Books.

Birnbaum, D., Fiebrink, R., Malloch, J., & Wanderley, M. M. (2005). Towards a dimension space for musical devices. In *Proceedings of the 2005 conference on New interfaces for musical expression* (pp. 192–195). National University of Singapore. Retrieved 2016-04-28, from `http://dl.acm.org/citation.cfm?id=1085993`

Boden, M. A. (1991). *The creative mind: Myths & mechanisms.* New York, N.Y: Basic Books.

Boden, M. A. (2012). *Creativity and art: Three roads to surprise.*

Born, G., & Barry, A. (2018, November). Music, Mediation Theories and Actor-Network Theory. *Contemporary Music Review*, *37*(5-6), 443–487. doi: 10/ghnd4r

Bown, O. (2015). Attributing Creative Agency: Are we doing it right? In *ICCC* (pp. 17–22).

Bown, O., Eldridge, A., & McCormack, J. (2009). Understanding interaction in contemporary digital music: From instruments to behavioural objects. *Organised Sound*, *2*(14), 188–196. doi: 10/bmprzx

Bown, O., & McCormack, J. (2011). Creative Agency: A Clearer Goal for Artificial Life in the Arts. In G. Kampis, I. Karsai, & E. Szathmáry (Eds.), *Advances in Artificial Life. Darwin Meets von Neumann* (pp. 254–261). Berlin, Heidelberg: Springer. doi: 10/brnkp3

Braidotti, R. (2016, November). The Critical Posthumanities; Or, Is Medianatures to Naturecultures as Zoe Is to Bios? *Cultural Politics*, *12*(3), 380–390. doi: 10/ggx5t2

Brown, A. R. (2016). Understanding musical practices as agency networks. In *Proceedings of the Seventh International Conference on Computational Creativity.*

Brown, A. R. (2018, January). Creative improvisation with a reflexive musical bot. *Digital Creativity*, *29*(1), 5–18. doi: 10/gfwqdf

de Campo, A. (2014). Lose control, gain influence-Concepts for Metacontrol. In A. Georgaki & G. Kouroupetroglou (Eds.), *Proceedings ICMC—SMC—2014* (full paper ed., pp. 217–222). Athens.

Center, M. (2020, July). *Garry Kasparov on AI, Chess, and the Future of Creativity (Ep. 22).* Retrieved 2021-04-06, from https://medium.com/conversations-with-tyler/garry-kasparov-tyler-cowen-chess-iq-ai-putin-3bf28baf4dba

Colton, S. (2008). Creativity Versus the Perception of Creativity in Computational Systems. In *AAAI Spring Symposium: Creative Intelligent Systems.*

Colton, S., Cook, M., Hepworth, R., & Pease, A. (2014). On acid drops and teardrops: Observer issues in computational creativity. In *Proceedings of the 50th Anniversary Convention of the AISB.* London: Society for the Study of Artificial Intelligence and Simulation of Behaviour.

Colton, S., Pease, A., Guckelsberger, C., McCormack, J., & Llano, M. T. (2020, September). On the Machine Condition and its Creative Expression. In *ICCC 2020.* Retrieved 2020-10-05, from https://aaltodoc.aalto.fi:443/handle/123456789/46598

Csikszentmihalyi, M. (1996). *Creativity: Flow and the psychology of discovery and invention.* New York: HarperCollinsPublishers.

Dennett, D. C. (1989). *The Intentional Stance.* MIT Press.

Donnarumma, M. (2017). On Biophysical Music. In E. Miranda (Ed.), *Guide to Unconventional Computing for Music* (pp. 63–83). Springer International Publishing. doi: 10.1007/978-3-319-49881-2_3

Fiebrink, R., & Caramiaux, B. (2017). The machine learning algorithm as creative musical tool. In R. T. Dean & A. McLean (Eds.), *The Oxford Handbook on Algorithmic Music* (p. im Druck). Oxford: Oxford University Press. Retrieved 2017-07-02, from https://arxiv.org/abs/1611.00379

Fiebrink, R., & Sonami, L. (2020, July). Reflections on eight years of instrument creation with machine learning. In R. Michon & F. Schroeder (Eds.), *Proceedings of the international conference on new interfaces for musical expression* (pp. 237–242). Birmingham, UK: Birmingham City University. Retrieved from https://www.nime.org/proceedings/2020/nime2020_paper45.pdf

Galanter, P. (2012). Computational Aesthetic Evaluation: Past and Future. In J. McCormack & M. dInverno (Eds.), *Computers and Creativity* (pp. 255–293). Berlin, Heidelberg: Springer. Retrieved 2016-09-29, from http://link.springer.com/chapter/10.1007/978-3-642-31727-9_10 (tex.ids: Galanter_ComputationalAestheticEvaluation_2012) doi: 10.1007/978-3-642-31727-9_10

Galanter, P. (2020a). Machine Patiency and the Ethical Treatment of Artificial Intelligence Entities. In *Proceedings of the 8th Conference on Computation, Communication, Aesthetics & X* (pp. 13–32). Porto, Portugal: Universidade do Porto.

Galanter, P. (2020b, September). Towards ethical relationships with machines that make art. *Artnodes*(26), 1–9. doi: 10.7238/a.v0i26.3371

Gifford, T., Knotts, S., McCormack, J., Kalonaris, S., Yee-King, M., & d'Inverno, M. (2018, January). Computational systems for music improvisation. *Digital Creativity*, *29*(1), 19–36. doi: 10/ggs8mm

Hanson, F. A. (2009, March). Beyond the skin bag: On the moral responsibility of extended agencies. *Ethics and Information Technology*, *11*(1), 91–99. doi: 10/bfb3ct

Haraway, D. J. (1991, January). A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century. In *Simians, Cyborgs and Women: The Reinvention of Nature* (pp. 149–181). New York: Routledge. Retrieved from http://www.stanford.edu/dept/HPS/Haraway/CyborgManifesto.html

Hardjowirogo, S.-I. (2017). Instrumentality. On the Construction of Instrumental Identity. In T. Bovermann, A. de Campo, H. Egermann, S.-I. Hardjowirogo, & S. Weinzierl (Eds.), *Musical Instruments in the 21st Century* (pp. 9–24). Springer Singapore. doi: 10.1007/978-981-10-2951-6_2

Hoffman, G., & Weinberg, G. (2010, April). Shimon: An interactive improvisational robotic marimba player. In *CHI '10 Extended Abstracts on Human Factors in Computing Systems* (pp. 3097–3102). New York, NY, USA: Association for Computing Machinery. doi: 10.1145/1753846.1753925

Holland, S., & Fiebrink, R. (2019). Machine Learning, Music and Creativity: An Interview with Rebecca Fiebrink. In S. Holland, T. Mudd, K. Wilkie-McKenna, A. McPherson, & M. M. Wanderley (Eds.), *New Directions in Music and Human-Computer Interaction* (pp. 259–267). Cham: Springer International Publishing. doi: 10.1007/978-3-319-92069-6_16

Inayatullah, S. (2001). The rights of robot: Inclusion, courts and unexpected futures. *Journal of Future Studies*, *6*(2), 93–102.

Jennings, K. E. (2010, November). Developing Creativity: Artificial Barriers in Artificial Intelligence. *Minds and Machines*, *20*(4), 489–501. doi: 10.1007/s11023-010-9206-y

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory.*

Magnusson, T. (2010). An Epistemic Dimension Space for Musical Devices. In *NIME.*

McCormack, J., Gifford, T., & Hutchings, P. (2019, March). Autonomy, Authenticity, Authorship and Intention in computer generated art. *arXiv:1903.02166 [cs]*. Retrieved 2021-03-27, from http://arxiv.org/abs/1903.02166

McCormack, J., Gifford, T., Hutchings, P., Llano Rodriguez, M. T., Yee-King, M., & d'Inverno, M. (2019, May). In a Silent Way: Communication Between AI and Improvising Musicians Beyond Sound. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1–11). New York, NY, USA: Association for Computing Machinery. doi: 10.1145/3290605.3300268

McCormack, J., Hutchings, P., Gifford, T., Yee-King, M., Llano, M. T., & d'Inverno, M. (2020, April). Design considerations for real-time collaboration with creative artificial intelligence. *Organised Sound*, *25*(1), 41–52. doi: 10/ggsjkj

Miranda, E. (Ed.). (2011). *A-life for music: Music and computer models of living systems* (No. v. 24). Madison, Wisconsin: A-R Editions.

Miranda, E. (2014). Brain–Computer Music Interfacing: Interdisciplinary Research at the Crossroads of Music, Science and Biomedical Engineering. In E. Miranda & J. Castet (Eds.), *Guide to Brain-Computer Music Interfacing* (pp. 1–27). London: Springer. doi: 10.1007/978-1-4471-6584-2_1

Pachet, F., Roy, P., & Carré, B. (2020). Assisted music creation with Flow Machines: Towards new categories of new. *arXiv preprint arXiv:2006.09232*.

Robinson, H. (2020). Dualism. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Fall 2020 ed.). Metaphysics Research Lab, Stanford University. Retrieved 2021-04-07, from `https://plato.stanford.edu/archives/fall2020/entries/dualism/`

Romero, J., Machado, P., & Santos, A. (2009). On the Socialization of Evolutionary Art. In M. Giacobini et al. (Eds.), *Applications of Evolutionary Computing* (pp. 557–566). Berlin, Heidelberg: Springer. (00006) doi: 10.1007/978-3-642-01129-0_62

Rowe, R. (1993). *Interactive music systems: Machine listening and composing.* Cambridge, Mass.: MIT Press. Retrieved 2016-07-15, from `http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=49130`

Schlosser, M. (2019). Agency. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Winter 2019 ed.). Metaphysics Research Lab, Stanford University. Retrieved 2021-03-22, from `https://plato.stanford.edu/archives/win2019/entries/agency/`

Shin, M., Kim, J., & Kim, M. (2021, January). Measuring Human Adaptation to AI in Decision Making: Application to Evaluate Changes after AlphaGo. *arXiv:2012.15035 [cs, econ, q-fin, stat]*. Retrieved 2021-04-06, from `http://arxiv.org/abs/2012.15035`

Sonami, L. (2014). *And now we leave gloves and other wearables to (small) dictators.* Retrieved 2020-09-01, from `https://sonami.net/?page_id=674`

Tanaka, A., & Knapp, R. B. (2017). 2002: Multimodal Interaction in Music Using the Electromyogram and Relative Position Sensing. In A. R. Jensenius & M. J. Lyons (Eds.), *A NIME Reader* (pp. 45–58). Springer International Publishing. doi: 10.1007/978-3-319-47214-0_4

Tatar, K., & Pasquier, P. (2019, January). Musical agents: A typology and state of the art towards Musical Metacreation. *Journal of New Music Research*, *48*(1), 56–105. doi: 10.1080/09298215.2018.1511736

Turing, A. (1950). Computing machinery and intelligence. *Mind*, *59*(236), 433–460. Retrieved 2016-10-01, from `http://www.jstor.org/stable/2251299`

Whitelaw, M. (2004). *Metacreation: Art and artificial life.* Cambridge, Mass.: MIT Press.

Young, J., & Colton, S. (2020). Controlling Self-organization in Generative Creative Systems. In J. Romero, A. Ekárt, T. Martins, & J. Correia (Eds.), *Artificial Intelligence in Music, Sound, Art and Design* (pp. 194–209). Cham: Springer International Publishing. doi: 10/ggr8pb