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How Artificial Intelligence Can Shape Choreography:
The Significance of Techno-Performance



Figure 1: *Beethoven Complex* Rehearsal at the Arts & Science LAB, Sphere Hall.

Introduction

This article considers the use of artificial intelligence (AI) in contemporary Japanese dance performance through a detailed discussion of the development of *Beethoven Complex* (2020). This online dance performance, choreographed by the authors of this paper, was streamed at The Tokyo University of the Arts Center of Innovation (COI) in 2020¹ during the COVID-19 pandemic and used an automatic music composition system that incorporated AI. Recent choreographic works using AI have focused on the interaction between humans and AI agents by AI based on analysing data about human bodily movements². In this article, our interest lies in the nature of the relationship between AI engineers and artists within the creative process. Because the value system of AI engineers may diverge from that of the choreographers or dancers who use AI, when we shift our enquiry to the technological determinism that manifests in creative processes mutually produced by AI and artists, a more complicated picture of such collaboration emerges than the simple application of technology towards the generation of creative outputs. Such complication is reinforced by the fact that AI is generally considered an industrial problem rather than an artistic problem, and dance theories that include AI highlight “the trajectory of AI towards automated systems for choreography” (Plone 2019, 7–8). This article responds to the fact that the effects of AI on human behaviour in creative contexts are still poorly understood. Inspired by the work of practitioners who have used AI³, we discuss the nuances of the discomfort caused by using AI in our choreographic work *Beethoven Complex* and reflect on the discoveries made in the creative process shared by the AI engineers, choreographers and dancers.

To explore the tension outlined above, this article draws on Jon McKenzie’s notion of “techno-performance,” one of the three performance paradigms he outlines in *Perform or Else* (2001). According to McKenzie, techno-performance foregrounds the “contradictory demand” technology makes on performing agents and confronts the demand with a “trade-off” involving different criteria of effectiveness (McKenzie 2001, 97). This article examines the context of artist-engineer relations in techno-performance via the contemporary Japanese example *Beethoven Complex* and how such relations expose problems of effectiveness latent in AI technology in terms of the creative process. Furthermore, the impact of techno-performance depends not only on the AI’s technical performance but also on how the performance is situated within a socio-political context. Our observations are therefore based on how we might read techno-performance as described by McKenzie in the advanced information-capitalist society of the 21st century. For example, the explosion of streaming during the COVID-19 pandemic has resulted in a domain in which technology and art are increasingly entangled. Because this entanglement presents creative possibilities that come under the theoretical and practical umbrella of techno-performance, this essay considers the phenomenon through a techno-performance lens with particular reference to the creative process. Specifically, we examine how AI functions in collaborations between engineers and artists. That is, instead of examining how AI can create dance, this paper explores how AI can illuminate the creative process by which choreographers or dancers relate to the technology.

However, as noted above, in an atmosphere of technological determinism, problems arise when AI engineers and the choreographers or dancers who use AI do not share the same value systems, as it creates difficulties in sharing a creative process. For example, an artist’s need to emphasise the creative process may clash with an engineer’s ambitions for the new

technology they are developing. The subsequent tension between engineers and artists foregrounds the perception of dissonance, which, as Eckersall, Grehan and Sheer argue in *New Media Dramaturgy*, produces “the possibility of a perception of the agency of the inorganic” and offers “perception as a productive point of view promoting an expanded repertoire of empathic engagement rather than an unconscious privileging of the human over non-human forces” (Eckersall, Grehan, and Scheer 2017, 10-11) in NMD. As the AI-human interactivity multi-layers performances of engineers and artists, the dissonance influences the behaviour of engineers and artists, and the understanding of the concepts reconstituted by AI opens up and meanders the human-AI creative process. In *Beethoven Complex*, AI-human interactivity created both human-to-human and techno-human dissonance, enlarging suspicions about AI-mediated techno-performance. To illuminate the heightened perception of this dissonance given rise to by AI-mediated techno-performance, we speculate about who or what ultimately determines the impact of techno-performance.

The Significance of Techno-Performance and the Dissonance between Humans and Non-humans

When *Beethoven Complex* was planned, the director and composer Rui Ogawa and one author of this article, choreographer Natsumi Fukasawa, were employees of COI at Tokyo University of the Arts (Ogawa was a specially-appointed associate professor and Fukasawa, a specially-appointed researcher). The first author of this paper, choreographer Shuntaro Yoshida, received his PhD from Tokyo University of the Arts and was invited to join the project as a choreographer. The AI engineer, Noriko Otani, is a professor at Tokyo Metropolitan University and was invited to this project as an AI engineer through a connection with Ogawa at Japan Artificial Intelligence Music Society. The majority of the staff at COI of Tokyo University of the Arts involves arts-related researchers and engineers, but there is also a staff member who specialises in robotics engineering. Other agents include participating companies, a video and audio equipment manufacturer, JVCKENWOOD Corporation, and a musical instrument manufacturer, Yamaha Corporation, which have been involved in collaborative research and social implementation at the Centre. COI is among the rare places in Japan that aims to integrate art, science, and technology. Its Science and Technology-Based Radical Innovation and Entrepreneurship Program is a project launched in 2013 by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and the Japan Science and Technology Agency (JST) that aims to develop a platform for national innovation through industrial-academic collaborations and to produce outcomes that could not be realised by companies and universities alone.⁴ The COI’s stated mission is “Creating innovation for the ‘Synesensory’ through inspirational art and science and technology”, and the project aims to “deliver contents widely and has developed infrastructures both in Japan and abroad by collaborating with the education, healthcare, and welfare service sectors”.⁵

One of the COI's core research themes is investigating the relationship between AI and the performing arts and promoting digital performance, robotic theatre, and AI-powered concerts. COI is researching and developing a state-of-the-art approach to creating a society in which AI and people coexist. Its “AI-based animation synchronisation technology” that synchronises animation with the tempo of live music performances constitutes the world’s first practical application of a technology developed at the COI.

This system, which plays back animation in response to changes in the speed of a live performance, was first developed in collaboration with Yamaha Corporation. Using this technology, live animation concerts of *Vivaldi's The Four Seasons* have been held in Japan and abroad, including in Los Angeles and the Annecy Animation Festival. Furthermore, COI is developing a concert where human performers and AI perform together on live video (Japan Science and Technology Agency 2020, 21-22)⁶.

The fusion of cutting-edge AI technology and art has presented an opportunity for engineers to create new mechanisms and confront challenges and has also created a place for artists to explore innovative expression. Two decades after McKenzie introduced the notion of techno-performance, technological innovation, the new service economy, and neoliberal immaterial labour continue to permeate society in the global age. At the same time, AI-dance interactivity has moved from doubts about AI autonomy to interrogating how AI functions with human agents rather than unconsciously privileging its status in a particular relation. Although collaboration between AI and dance is now discussed extensively in terms of education, ethics, and aesthetics, it must also examine how the output of AI affects the very behaviour of engineers and artists and what the creative process is like in interactive collaboration, as much as the interactivity of AI and dance spheres. Indeed, when considered in the context of Japan's industrial-academic collaboration programme and the accelerated growth of information capitalism brought on by the current pandemic, the collaboration between AI and dance increasingly represents the colonisation of techno-performance. The impact of techno-performance is determined by the dual domination of human decision-making, which is generated by the determinism of technology through AI, and the domination of the state in terms of its investment in technology and its development. In the threat of colonisation of techno-performance by AI programming, we examine the nature of the collaborative relationship between engineers and artists in the context of McKenzie's forecasts of the future and focus on how such interrogation expands our understanding of techno-performance in a 21st-century context.

Collaboration between AI and choreographers

The interactivity of computers and performance begins in earnest in digital performance after the 1990s (Dixon 2004; Benford and Giannachi 2012; Birringer 2016, 2017; Eckersall, Grehan and Scheer 2017; McKenzie 2017). But, the first generation of such interactive assemblages would be Merce Cunningham's computer-based choreography system in which a computer-coded system for choreography used an algorithm. In this interactivity, "choreographers can generate individual movement sequences and compose entire dance pieces on computers and then 'download' them in the studio into dancing bodies" (McKenzie 2001, 42). Following the first generation, Performance scholar Johannes Birringer (2017) identified the second generation of second interactivity of choreographic systems and AI. He emphasised "sensorial dialogue insofar as human enaction and machinic processes each have their own anatomy, being able to self-reorganise in constant dynamic relationship" (474).

However, the interactivity of AI and choreography is now moving into its third generation. Recent developments in AI allow researchers to distinguish between deep learning (DL), in which the AI itself creates the dance, and machine learning (ML), in which AI derives the optimal solution to a problem. However, scholars have raised the issue of the lack of clarity

over the calculation process surrounding the computational process involved in DL (Jian and Sakai 2021, 506). Humans can only understand AI by observing its choices and subsequent behaviour, meaning it is “observable as an actor” (Caramiaux and Donnarumma 2020, 20). In a DL system, both the choreographer’s and engineer’s autonomy are important, and collaboration between the two parties is complex. Conversely, ML results in questions concerning how to make the AI function; rather than the AI creating the dance, the dance is determined by the relationship between the AI and the choreographer or dancer. Optimising this collaboration depends not only on the AI technology but also on the interaction between the choreographer and the AI’s output, which involves questioning the AI technology itself. This process defines the third generation of interactivity between AI and choreography.⁷

Israel & Israel (2019), produced by the Yamaguchi Centre for Arts and Media (YCAM)⁸ in collaboration with flamenco dancer Israel Galván, exemplifies current research on ML and dance. YCAM is not an educational institution but a media and technology research centre that explores expression through technology. This project probed the contrast between technologists, who determine the impact of techno-performance, and dancer, who extend the rhythms of incomplete AI. In *Israel & Israel*, the AI learned from the virtuosic performance and responded by creating its own imperfect rhythms, leading the dancer to develop new types of movement (Galván and Tokui 2018; Kawamata 2019). Another example is British choreographer Wayne McGregor’s *Living Archive: An AI Performance Experiment* (2019), in which he and engineers developed an AI system that learned from videos of his choreographic works. According to McGregor:

The Living Archive unleashed the creative movement potential stored at the molecular level within former works, amplifying the spectrum of possibility for choreographic decision-making and bringing dancers of the present into contact with traces of their predecessors. (McGregor 2019)⁹

In this case, it should be noted that the choreographer determined the outcome of the techno-performance, given that the dance company took the lead in harvesting and reordering sequences of material from previous works. A third example is the work of the Institute for Research and Coordination in Acoustics/Music, including two hybrid performances of computational music and choreography, *Corpus Nil* and *Human Methods*, using ML. These works problematised how “scientific research practice can feel normative and standardised” (Caramiaux and Donnarumma 2020, 5) to “stress how artistic intervention in research can complement standard scientific methods in leaving more room for unexpected challenges and nuanced conceptual questioning” (Caramiaux and Donnarumma 2020, 5). These three projects are characterised by AI techniques that utilise ML and aid in reflecting on human decision-making through artistic performance in novel ways.

Furthermore, these examples of collaboration between AI and dance provide insights into the creative process engendered by the inclusion of AI in choreography, especially in terms of how the impact of techno-performance is negotiated between engineers and choreographers. However, while these AI-driven choreographic works have increased as AI technology has developed, little research has examined the creative exchange between AI and choreographers. That is, while choreographers often engage with the engineer’s techno-performance in the context of the artistic development of an AI-based dance,

understanding the process of creation is imperative for determining how engineers and choreographers can collaborate in ways that do not conflate the techno-performance's purpose with how choreographers use the technology. In particular, the process of collaboration between artists and engineers on which this research focuses depends on a definition of AI "dance" that describes the intertwining of AI and choreography. Having established this, the following sections investigate how AI is used as a creative tool in our choreographic work, *Beethoven Complex*.

AI in *Beethoven Complex* and the automatic music composition system

COI's *Beethoven Complex* was made available online as part of a music concert project called "AI Beethoven",¹⁰ which used Beethoven's works as its subject matter. The project explored the various possibilities of AI through an online concert featuring four AI-produced works. This online event demonstrated two artist-AI relationships: the artist allowing AI to compose and the artist using AI as a tool. *Beethoven Complex* is an example of the latter and was created through collaboration between an AI engineer, a composer, choreographers, and a video editor (Fig. 2).¹¹



Figure 2: A scene from *Beethoven Complex* (Performers: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020).

The form of AI used in *Beethoven Complex* has been described as an “automatic music composition system” by AI engineer and scholars Otani et al. (2013, 1). The system’s starting point is the result of the AI’s learning that was facilitated by training it on Beethoven’s and other composers’ music. Following this, the project’s composer and choreographers interpreted and constructed the dance from the generated score (Fig. 3). The automatic music composition system’s purpose is not to create a song with mass appeal but to create music that reflects a single individual’s preferences. Otani et al. hope to eventually make this system publicly available. Notably, another Otani project—“Collaborative Composition Between Professional Musicians and an Automatic Music Composition System”—involved her using AI to collaborate with musicians to integrate techno-performances with craft performances. AI systems, she suggests, help artists “increase their creative resources and expand their opportunities and the range of their creative reflection” (Okabe and Otani 2019, 74).



Figure 3: An excerpt of a score generated by training the automatic music composition system on Beethoven’s and Bach’s scores.

The automatic music composition system generated the music after analysing a vast number of Beethoven’s scores. According to the composer, Rui Ogawa, the resulting score became a lead for Ogawa’s process, a score from developed his score and generated music for Part A (see following paragraph) independent of the choreography. At the same time, AI engineer Noriko Otani creates graphic representations based on the notation generated by AI, and we then embarked on the notation made by Otani to create the choreography. Thus, we incorporated both Ogawa’s music and the graphic representations based on notation by AI on which it was based into the choreography. The critical element was the genetic algorithm that defined the AI tool that drove the automatic music composition system. This algorithm used a model of living organisms’ evolutionary processes and mechanisms to identify optimal solutions through repeated genetic manipulations, including selection, crossover, and mutation. The AI could begin composing when sufficient notation data was provided and processed. The new piece of music generated comprised a melody and a chord progression.

The following pieces were used to create the motif score for *Beethoven Complex* through the use of the automatic music composition system:

Part A: Beethoven, Piano Sonata No. 1 (Op. 2 No. 1) and Bach, Cello Suite No. 1 (BWV 1007);

Part B: Beethoven, Piano Sonata No. 2 (Op. 2 No. 2) and Györgi Ligeti, *Musica Ricercata* No. 7; and

Part C: Beethoven, Piano Sonata No. 3 (Op. 2 No. 3) and Arvo Pärt, *Tabula Rasa*.

For the above music, Ogawa commissioned Otani, who used AI's automatic composition system to produce an AI-generated score. Otani's role was to make the AI score productive and effective for Ogawa. Meanwhile, according to Otani, because the music with which Ogawa was working was unoriginal, he adapted the generated music. In other words, to create the final composition, Ogawa interpreted the AI-generated score and incorporated his tastes in order to express himself.

However, although this process supported the artists' creativity through AI, there was a discrepancy between the automatic music composition system's techno-performance output and Ogawa's music. Ogawa recalled that he wanted the "AI Beethoven" project to demonstrate how other composers could use AI tools, exemplifying the differences between AI researchers' and composers' perspectives. Further contributing to this divergence, Ogawa's reconstructions based on AI-generated notation interwove Beethoven's music with that of composers Beethoven never met, including Bach, Györgi Ligeti, and Arvo Pärt.¹² While instrumentalising AI in the creative process, Ogawa grappled with techno-performance by integrating music from famous composers. Ogawa directed the project and recruited AI engineer Otani, the choreographers and others involved in this work. We expected to use an AI-produced score for Ogawa's music and were frustrated that the AI results were not directly relevant. We demanded AI and dance interactivity through the use of AI technology in the process, but Ogawa expected us to create the choreography with his music. Meanwhile, Ogawa distanced himself from AI technology and created his music alone in a pure manner. Therefore, his process invoked a second authorship through the use of an automatic machine.

The choreography produced by the automatic music composition system and the human composer

The music generated by the automatic music composition system was a non-human score created using an AI and reproduced Beethoven's works as interpreted by the AI. The choreography in *Beethoven Complex* was based on the AI-optimised score. That is, it relied on the score produced by the AI, and the dance was interpreted by a human using the AI, thereby creating a double dissonance in the choreography's development. This dissonance indicates the composer-choreographer's disagreement with AI's idea of time and the tension that developed between the AI-produced score and Ogawa's music. As choreographers, we held many discussions with the engineer and rehearsed many proposals, testing and verifying or discarding them.

We also probed the compositional framework of *Beethoven Complex* and the collaboration between the composer and the engineer. They confirmed the existence of a shared framework by inquiring about the characteristics and properties of Otani's automatic music composition system and the mechanism of genetic algorithms. We created the choreography from graphic representations based on the notation generated by AI (see Fig. 4 and Fig. 5) for the rules for the up and down rows, which were the rows in which arrows were used to indicate whether a note needed to be higher or lower than the preceding

note. This was in addition to other graphic representations that concerned the melody derived from the training process.

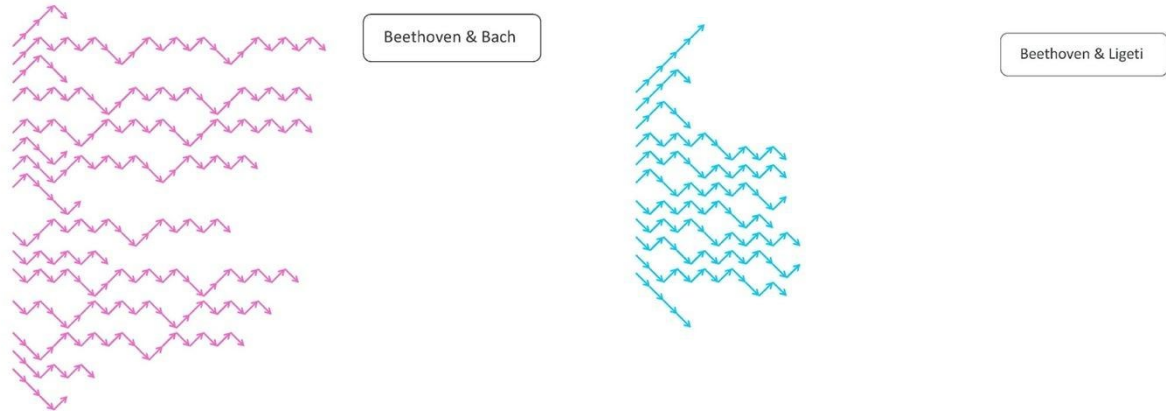


Figure 4: Diagram of the score generated by the automatic music composition system (Parts A and B).

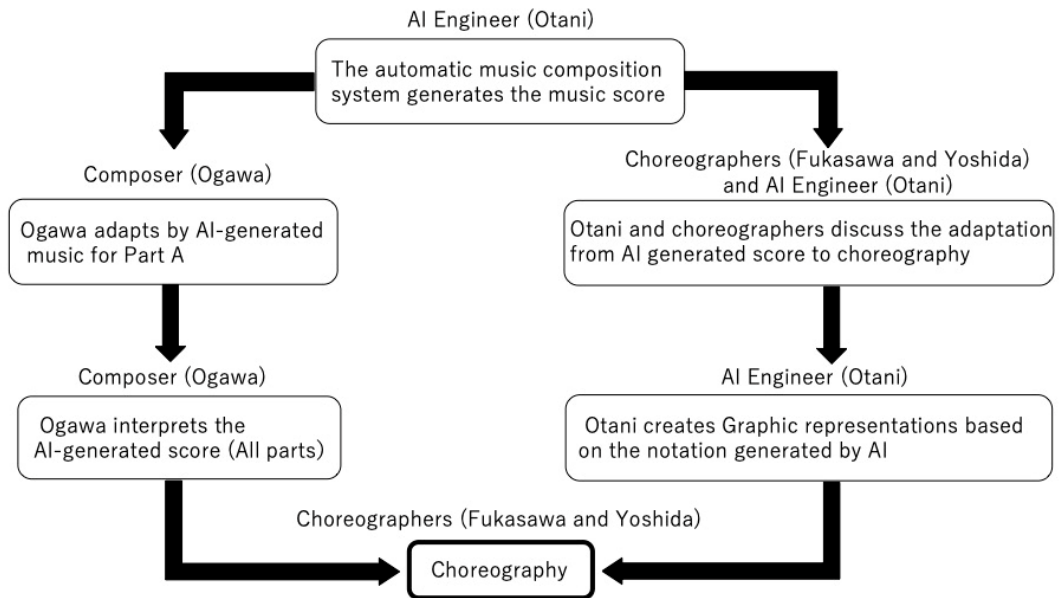


Figure 5: The artistic development process in *Beethoven Complex*.

The need to understand how the AI established the priorities regarding data acquisition for choreography in the context of Otani’s automatic music composition system led Otani to produce notation that served as a framework for the choreography. This suggests that Otani took a position that emphasised the independence of the choreographer rather than a position of technological determinism. By adopting Otani’s processes as an engineer

creating a piece of music that automatically optimises Beethoven's music, the superimposition of ideas derived from Beethoven's characteristics onto the human creating the AI while retaining the relationship with Beethoven's chosen music was facilitated (Fig. 6). However, Otani wanted the AI to feature a linear temporality. Given that optimisation results from a series of actions, Otani enumerated the objective factors choreographed by the AI. Consequently, while focusing on the score, the choreography was determined not only by the composition of the new work based on Beethoven's works but also by the gap between the music created by the automatic music composition system and the music created by Ogawa. In other words, the choreographic practices were embedded in an undetermined creative process and relied on the indeterminacy that arose from the entanglement of the AI techno-performance and Ogawa's creation that incorporated the AI-produced score.



Figure 6: A scene from *Beethoven Complex* (Performer: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020).

Fukasawa experimented with choreographing the notated figures generated and visualised by the automatic music composition system while adhering to the work's theme. She explored the possibility of a new body language by searching for ways to create materials for movement from the figures. For example, she increased the vocabulary of bodily movements by aligning them in space with the directionality of the figure's vectors by taking the arrows as representative of the dancers' spines and moving their heads and backs up and down on a large scale (Fig. 7). Furthermore, by incorporating rhythm into the figure, Fukasawa explored the body in time. However, various difficulties and contradictions arose during the attempts to match the choreographed dances to Ogawa's interpretation of the musical data.



Figure 7: A scene from *Beethoven Complex* (Performer: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020).

The available choreographic choices were amplified by the simultaneous establishment of relationships between the choreography and the automatic music composition system and between the figures built by the AI using Beethoven's music and the composer's interpretation of the musical data. On the other hand, generating choreography also required difficulties in decision-making regarding dance movement and rhythm between the AI-produced score and Ogawa's score. Thus, there was a dual task of generating choreography for each score in order to mediate the body in space and time. Yoshida negotiated the balance by breaking the task apart and incorporating the choreography—which moved back and forth between the automatic music composition system's score and the score created by the composer—into an exploration of cacophony between human and non-human.

Meanwhile, suppose the genetic concept adopted by Otani's automatic music composition system is extracted and used as a lens to view the whole project. In that case, Beethoven's distinctive music can be said to have survived conceptually. This leads to a discussion regarding the aspects of Beethoven's historical compositions being reflected in the choreography and the work's composition. This includes the aspects that differ from the "Beethoven paradigm," which is the universalist fallacy applied to an artistic work's historic trajectory under names such as Beethoven. Instead of aligning with this paradigm, Lydia Goehr's approach of viewing Beethoven's works as a concept and not as consistent and universal was adopted (Pakes 2020, 10). In the case of *Beethoven Complex*, the use of AI provided access to the conception of Beethoven's works as notations that were

reconstructed and processed by an algorithm rather than as universally recognisable styles or modes that remained fixed.

Furthermore, the notation provided by the AI guides the dance movements in parts A, B and C. In A part, hand and foot figures in Yoshida and Fukasawa's solo were guided by the imitation of graphic signs. In addition, the repeated notations are formed by the dual shapes of their movements. In part B, the notation of up and down arrows is reflected in the movement of Fukasawa's solo spine, and is linked with Yoshida's entire body movement. In part C, the notation representation exists as a form covered with a glass wall (Fig. 8). These figures in the visual notation were replaced with body shapes and rhythms, with the faithful choreographic representation of the music being performed simultaneously. According to Pakes (2020), these choreographies concretely reimagined Beethoven's heritage, and Yoshida and Fukasawa reshaped and recomposed the choreography with Beethoven's music being seen as AI technology. This provides insights into a choreographic experience that uses an indifferent notation generator (Otani) outside of the temporal circumstances with which choreographers and composers work to create a dance with music. The dissonance of AI-based choreography creates a strained relationship between AI's conceptual reconstruction of Beethoven's works and the choreographers' practices. Dissonance here refers to the discrepancy between the score created by the AI and the rhythm of the choreography created by the human.

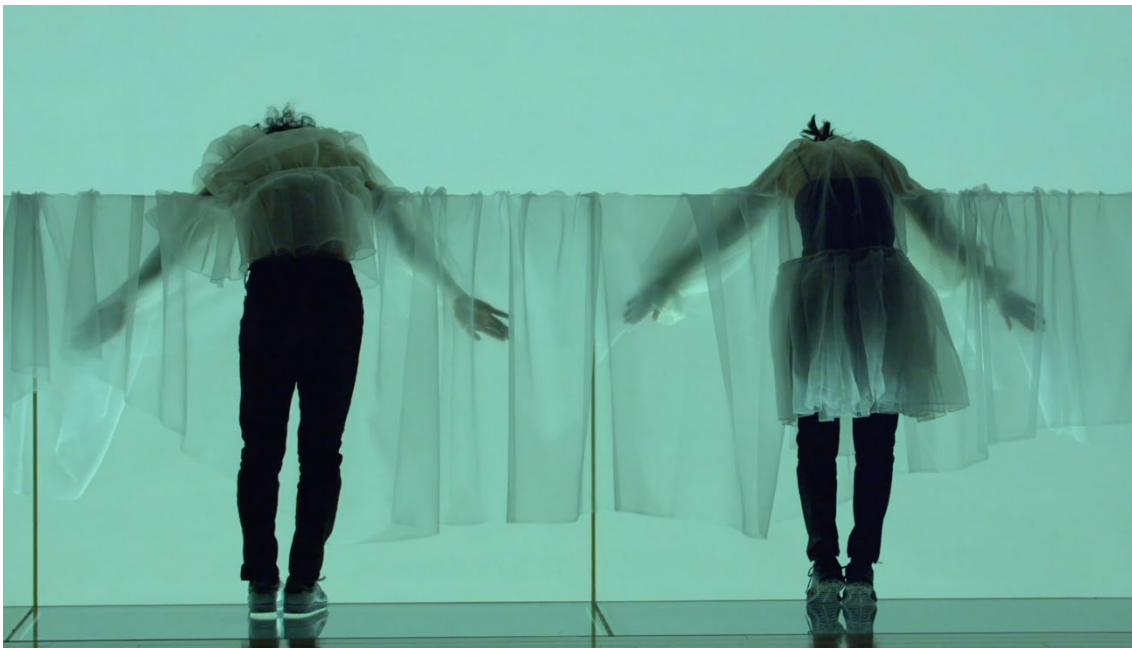


Figure 8: A scene from *Beethoven Complex* (Performer: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020)

As mentioned, Ogawa's piece—derived from the score generated by the automatic music composition system and incorporating his tastes—was divided into three parts. In Part A, aspects of the original Beethoven Piano Sonata and Bach Cello Suite were not easily discernible when compared to the AI-produced score, indicating that the music had been completely transformed into modern music. In contrast, when we devised choreography

incorporating the visual notation created by Otani and discussed their progress with Otani and Ogawa, both sides delegated the performance to us. Discussions were held on Ogawa sharing the images for each part and our incorporation of the visuals we received from the music. Therefore, there was a clear division of labour between the engineer, composer, and choreographers during the collaborative process. More specifically, for Part C, Ogawa demanded that the choreography not be slow; to match the tempo of the music, he wanted the choreography to incorporate quick movements of the body. However, Part C's choreography ultimately adopted a delayed choreography, leaving room for human determinism (Fig. 9). These different visions are a result of the tension between the AI-produced score and Ogawa's music because the discrepancy between composition and choreography represents a difference in the AI's approach to time. For example, a temporal impropriety in choreography was caused by the speed of the choreography being different to what was intended by Ogawa. However, the choreography still had to match the time inherent in his composed piece. In Part C, the dance movement foregrounds time and reorganises perception by slowing the tempo of Part A. This slow movement, while physically exhausting, also manifested the notation provided by the AI, which responded by involving Ogawa and AI time. However, the AI did not account for this time anxiety as it is not bound by time in the first place. Thus, the temporal dissonance of the choreography accompanying Ogawa's composition created a discrepancy in the AI's understanding of time in the creative process.



Figure 9: A scene from *Beethoven Complex* (Performer: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020).

Thus, in the creative process of AI-driven choreography, the decision-making process shifts to allow for the consideration of the representation of choreography in terms of practice, thereby moving away from the privileged, unconscious use of AI by humans to a dialogue between engineer and choreographers, enabling conscious human determinism. That is,

the choreographers have the decision-making power and can overrule the biases of the engineer through this negotiation. For example, we discussed how the project could make the most of the Sphere Hall in the Arts & Science LAB where the work was filmed, which was a question beyond the engineer's scope. We also discussed costumes, eventually combining shirts and dresses made of soft white gathered tulle, which could be considered anachronistic, with black skinny jeans and trainers and make-up. The set was a dystopian atmosphere of artificial leaves and inorganic colours from the near future. These choices were made to create a piece that intertwined aspects of Beethoven's time with the present (Fig. 10). Additionally, a 10-metre piece of soft white tulle, the same material as the costumes, was used for not only the stage design but also as part of the choreography, enveloping the dancers and transforming the space in conjunction with their movements. Although these devices were transformed into a post-human performance in the visualisation process, the collaboration between the engineer, composer, choreographers, and visual artist was enabled by focusing on the techno-performance's impact. Thus, the actual collaborative process between the parties in the techno-performance context did not result in technological determinism; instead, the choreographers and dancers were free to craft their choreographic performances however they wished. Otani was excited to see the kind of dance that could be created from the shapes. She expected that AI's techno-performance would empower our choreographic system in the creative process. Beyond the collaborations with the engineer associated with conventional techno-performance, this process ensured effective collaboration across disciplines, with the intermingling of techno-performance and craft performance synergising the conscious performances of the engineer and the choreographers in the creative process to ultimately create "added value" (Dickinson and Sullivan 2013, 164). Notably, the outcome (and the creative process itself) became even more unpredictable when the project's filmmaker entered the conversation.



Figure 10: A scene from *Beethoven Complex* (Performer: Natsumi Fukasawa and Shuntaro Yoshida; Site: Arts & Science LAB, Sphere Hall; Date: 20 November 2020).

The significance of using AI in the creative process

Although the creative process responsible for *Beethoven Complex* used AI as a tool, the choreography itself treated the AI as an actor, and, negotiating between technological and artistic determinism, the AI-based choreography became a mechanism through which the AI engineer, composer, and choreographers engaged in their collaborative efforts. The AI-produced score enabled the choreographers to represent the dissonance between humans and non-humans through the techno-performance's impact on crafting performance interventions. The AI reconstructed the Beethoven paradigm, but the AI did not extract an authentic Beethoven piece from these great musical works. Therefore, the concept of Beethoven's work was changed in the AI's conceptual reconstruction, which was then superimposed on the choreography, thereby representing the dissonance between the AI-produced score and the composer's score. The AI changed the concept of Beethoven's works to avoid his work's historical trajectory and to avoid his works being seen as consistent and universal. The choreography had the challenge of negotiating between the AI and the composer in the creation process without a recursive performance of "remembering" Beethoven's music. The creative process was intertwined, embedded, and layered with Beethoven's historically located compositional paradigm, the canon of musical performance, the choreographer's craft performance, and the AI's techno-performance. Articulating this stratification of performance, McKenzie writes:

What's proper to the performance stratum is its heightened sense of temporal impropriety. That is, what's historically specific about the age of global performance is its flagrant anachronisms. Consider the experience base on which it draws: centuries of historical research; the mechanical reproduction and now the digital storage, processing, and transmission of words and deeds; the explosion of cultural, scientific, and organisational research; the proliferation of fractal subjects and objects... (McKenzie 2001, 249)

McKenzie's analysis is closely connected to the choreographic temporal "impropriety" in the creative process of *Beethoven Complex*. The particular intertwining of historical music, AI transcripts, the engineer's modifications, the composer's revisions, and dynamic choreographic attempts at synchronicity in this creative process are highlighted as difficulties in AI-based choreography as they show the dissonance and choreographic "impropriety" in the interaction between humans and non-human elements. This implies that we should not merely consider the impact of techno-performance in scientific technological terms. Otani participated in the uncertain collaboration between AI and humans because we required the different performance of AI to output graphic visualisations except for generated score, not the techno-performance of the automatic music composition system. The use of AI in the creative process of multiple performances reveals new forms of dissonance between humans and non-humans.

The most significant aspect of this AI-driven creative process is the intertwining of various performances. However, it was also interesting to observe whether the collaboration between players in the fusion of techno-performance and craft performance could facilitate the failures of performance and dissension in the process. Additionally, the pandemic conditions required the techno-performance's impact to be evaluated in terms of accessibility. Since the pandemic began, widespread online distribution has sparked

increased interest in archived material and the online distribution of legacy works. This trend, especially the notion that the public negotiates techno-performances' impacts, acquires significance in the context of techno-performance. Audiences' interest in the "dance" of AI derives from the cacophony of human body movements choreographed by AI and is sustained by online distribution. The new distribution paradigm introduced by the COVID-19 pandemic suggests the emergence of a new discipline defined by audiences. Engineers or technicians are to expose techno-performance to the public and trade-off directly with the public without unconsciously privileging AI. In other words, the more viewers use technologies such as Twitter and YouTube, the more likely they will participate in techno-performance. Furthermore, this proliferation of technology in the everyday world, augmented by events such as future pandemics, means ongoing instability or unpredictability in the evolution of advanced technologies such as AI. We experienced choreographic instability as we oscillated between the score created by the AI and Ogawa's score. Otani had to trade off the effects of techno-performance with the choreographer, thus reframing AI as an artistic issue, which, in turn, triggered suspicions about the integration of techno-performance. When this experience is intertwined with an audience's discomfort with the cross-border perspective of advanced technology, it moves into a new framework of a feedback loop between choreographic anxiety and the audience's response.

Conclusion

This essay has presented a case study of the creative process and eventual broadcast of *Beethoven Complex*: a work of the third generation of interactivity between AI and dance. The choreography represented the collaboration between the engineer and the choreographers, which emphasised the impact of the AI's techno-performance by preserving the music produced by the AI through the composer's reinterpretation of the generated score. Otani's responsibility as AI engineer in *Beethoven Complex* was not to privilege AI techno-performance or make it an industrial issue but to address artistic issues while making trade-offs with choreographers. Otani provided the graphic notation that differed from the automatic music composition system, creating a trigger of suspicion about the integration of AI's techno-performances. In other words, her responsibility was to be a player not only in the techno-performance of AI but also in translating AI differently, providing choreographers and the public with elements intertwined with the concept of the work.

The impact of techno-performance during the COVID-19 era is dependent on the response of the audience, who access this work within the dual context of Japan's industrial-academic collaboration programme and the accelerated growth of information capitalism resulting from the pandemic. While this undoubtedly represents the colonisation of techno-performance desired by the state and corporations, *Beethoven Complex* enacted the dissonance that exists between humans and non-humans. This moves the question from one of technological determinism to one of artistic determinism before eventually arriving at audience determinism, where it is necessary to ask if and how the audience recognises and interprets that dissonance. That is, if the global strategies of post-COVID-19 digitalisation follow pragmatic ideologies that are deeply embedded in the discourses and policies of states and corporations, the determination of the impact of techno-performance

might be divorced from the technological and artistic determinisms engendered by the creative process, which is an issue of serious concern.

At the time of writing, the integration of techno-performance and craft performance in AI and dance remains underdeveloped. Furthermore, considering the trajectory of dance and technology over the last two decades, it is apparent that AI remains in its infancy. Despite the rapid development of AI in Japan, it has primarily been applied to information management, medicine, and welfare rather than the arts. Thus, we argue that the relationship between AI and dance should be developed more radically and aim to elicit a new investigation of the relationship between AI and dance for audiences. Most importantly, research should transform collaboration between choreographers and engineers by connecting this collaboration to everyday performances, enabling an approach to techno-performance that derives from the creative process.

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Notes

¹ See a video link of *Beethoven Complex* (00'46''-10'06''):

<https://geidai.biz/dms/details/eventA.html>.

² Cf. *Living Archive* between Wayne McGregor and the Google Arts & Culture Lab, and *LuminAI* project at Georgia Institute of Technology.

³ The *Beethoven Complex* is inspired by the works created by the collaboration between practitioners and AI engineers, such as “Israel & Israel” (2019), “Glenn Gould As A.I.” (2019), and “Mai Hi Ten Yu” (2017).

⁴ See: <https://www.jst.go.jp/tt/EN/platform/coi.html>.

⁵ Tokyo University of the Arts Center of Innovation (COI),.

See: http://innovation.geidai.ac.jp/en/geidaicoi_about.html?id=content_about_blockwrap1.

⁶ The COI also drove the production and performance of playwright and director Oriza Hirata’s android-theatre piece “Sayonara” as well as the dance-based concert “Mai Hi Ten Yu”, which used an AI-based piano performance system to translate human movement into musical expression to further improve music flow. The “Mai Hi Ten Yu” AI system can identify a dancer’s movement in real time by analysing signals from four types of sensors attached to the dancer’s body. According to Yamaha (2018), who collaborated on its development, this system “has an original database that links melody and movements, and, with this database, the AI on the system creates suitable melody data (MIDI) from the dancer’s movements instantly. The system then sends the MIDI data to a Yamaha Disklavier™ player piano, and it is translated into music” (Yamaha Corporation 2018).

⁷ In recent years, AI programming has been discussed from an ethical perspective by introducing the concepts of political correctness, identifying biases in the people who program AI, and indicating that such biases should be consciously avoided in order to eliminate biased data (Hao 2020).

⁸ See: <https://ontomo-mag.com/article/interview/israelgarban20181113/> and <https://www.ycam.jp/en/events/2019/israel-and-israel/>.

⁹ This was an experimental work that attempted to generate new choreography using AI. It was developed in collaboration with Google Arts & Culture. Having learned the different bodies performing McGregor’s choreography, the “living archive” system was able to respond to new movement phrases and suggest multiple original possibilities for the next phrase (McGregor 2019).

In 2004, McGregor produced a dance work using AI for the project “Choreography and Cognition” (DeLahunta, Barnard, and McGregor 2009).

¹⁰ “AI Beethoven” is a music concert project launched as part of the project by the Center for the Performing Arts and COI at Tokyo University of the Arts. The two organisations were planning to hold a concert and lecture based on Beethoven’s works at the Tokyo University of the Arts in 2020 in order to commemorate the 250th anniversary of Beethoven’s birth. This music concert project was launched as part of the “Geidai Project”. Due to the COVID-19 pandemic, the concert was abandoned. “AI Beethoven” was streamed online free of charge on December 16, 2020, which is Beethoven’s birthday.

See: <http://innovation.geidai.ac.jp/en/information/201216/>.

¹¹ The credits for *Beethoven Complex* are as follows: AI engineer: Noriko Otani; Composer: Rui Ogawa; Choreographers and dancers: Natsumi Fukasawa and Shuntaro Yoshida; Make-up artist, hair stylist, and costume designer: Sabawo; Cameraman and editor: Yoshitaka Shimada.

¹² Concerning intellectual property surrounding automatic composition by AI, AI does not possess any rights, whether the product is content or technical information, because it is recognised as having been generated autonomously by AI. With regard to the copyright related to the automatic composition by AI used in this creation, Ogawa consulted with a lawyer specialising in copyright law who is an advisor at the Tokyo University of the Arts before the creation of this work. This consultation confirmed that if the AI adapted or generated the music to such an extent that the original music used by AI to generate this automatic composition could not be recognised, this would not be a problem, and the music could be used.

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