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Final Project:

The Influence of Artificial Intelligence in Dance Choreography

In recent years, the use of technology and artificial intelligence in the humanities and arts has increased greatly. One area that has seen this growth in development is dance, especially in regards to using artificial intelligence and machine learning to aid in choreography. AI was first introduced to make the notation process easier for choreographers and dancers, but has recently expanded to creating its own choreography based on data it is given. Three recent projects that explore this new integration of technology and dance are Merce Cunningham's use of *Lifeforms*, Wayne McGregor's collaboration with the Google Arts and Culture Lab, and the Georgia Institute of Technology's *LuminAI* project. These three projects use artificial intelligence in different manners in order to ultimately achieve becoming a new tool to be used by choreographers. These new innovations raise many ethical implications that we must confront as technology becomes more ubiquitous, and we have to learn to coexist with it. Ethical implications include limitations of AI to be creative, use of AI as a creative or compositional tool, and morality of using AI to create art. It is these types of questions that make the conversion about the use of AI in dance both interesting and complex.

One of the first applications of computer programming for dance was the use of "interactive and graphical movement systems" to capture dance notation systems as a supportive tool for the choreographers and dancers (Schiphorst 13). The initial challenge encountered during this process was the lack of standardization of dance notation, for multiple notation systems are in use today. Dance notation is a symbolic representation of movement, so it was

important for computer programs to have user interfaces that could represent these symbols visually for the users (Schiphorst 13). It was decided that the user interface was the most important aspect of the program because it was "the only channel of communication between the system" and the user (Schiphorst 19-20). As technology has improved, there has been a shift towards using artificial intelligence to create choreography rather than capturing notation.

In 1964, Jeanne Beaman and Paul Le Vasseur "used a computer to generate random, performable dance sequences" at the University of Pittsburgh. This is believed to be the earliest known use of computers in the creation of choreography. They achieved this output by giving the computer "[twenty] different time variations, [twenty] different spatial directions, and [twenty] different types of movements". The computer then outputted "[seventy] dances in verbal form, in a period of four minutes" (Schiphorst 21). Another early exploration was done by John Lansdown, and architect, in 1978. He attempted to use Benesh notation, but eventually decided to have a "visually immediate and direct representation of the human figure" because of the large quality and scope of vocabulary used by choreographers (Schiphorst 22). This type of visualization is now very common in AI projects associated with dance and human movement.

The common challenge encountered during these types of projects was that each choreographer has their own process to "physically creating and structuring movement" (Maderer). This process can be a combination of "notes, sketches, and floor plans", or video recordings (Maderer). The final piece of choreography is determined by "all [the] creative disciplines [...], [with] error[s] and mistake[s] often play[ing] a crucial role in the creative process" (Maderer). The "synthesis of physical dance knowledge with logical analytical computer science knowledge" is imperative to tying these fields together. In order to perform this synthesis "an interdisciplinary approach that recognizes systems design theory, computer

graphics theory, computer user-interface design concepts and, perhaps most importantly, choreographic and compositional knowledge" is required (Schiphorst 10). In order for technology to continue to become entwined with dance is important to understand aspects of both fields proficiently.

In recent years, there has been a large growth in the use of artificial intelligence in the dance choreography process. Three examples that are relevant are the Merce Cunningham's use of *Lifeforms* program, collaboration between Wayne McGregor and the Google Arts and Culture Lab, and the *LuminAI* project at Georgia Institute of Technology. The first recent example is the use of the *Lifeforms* program by renowned choreographer Merce Cunningham in a piece named *Tracker*. In 1986, the Computer Graphics Research Lab at Simon Fraser University, under the direction of Dr. Thomas W. Calvert, developed a computer program called *Lifeforms*. This program is "a computer compositional tool for the creation of dance", which "provides an interactive, graphical interface that enables a choreographer to sketch out movement ideas in space and time" (Schiphorst 28-29). The program has three interconnected windows: "sequence editor" window, "spatial" window, and "timeline" window. The "sequence editor" window is where the user can create "movement sequence[s] for a single dancer". The "spatial" window allows the user to arrange the dancers in space, and the "timeline" window allows the user to arrange the dancer's movement sequences in time. The purpose of this interface is to support "the hierarchical nature of composition by allowing movement between [the] conceptual levels of abstraction" (Schiphorst 36). Through the creative process of building the AI, the programmers worked with Merce Cunningham. In March 1991, Cunningham premiered a dance piece entitled *Trackers*, in which "one third of the movement was created with LifeForms" (Schiphorst 44). Cunningham was a huge advocate for the integration of technology with dance,

and he was quoted saying, “I think this technology can, in this case, particularly.... open out a way of looking at dance and movement in a way that would be stimulating and invigorating to the whole dance field eventually” (Schiphorst 45). Through this collaboration, they learned that “computer technology is as much affected by the articulation of dance knowledge as dance and choreography is affected by the articulation of technological knowledge” (Schiphorst 29). The nature of dance involves “a wide range of movement possibilities, and often requires great physical virtuosity that extends the limits of a human body’s physical ability and training”. Ultimately, through the use of computer programming within dance, the methods “can be generalized for other forms of human motion planning” (Schiphorst 30).

The second recent example is the collaboration between Wayne McGregor, and the Google Arts and Culture Lab. Damien Henry, Google Arts and Culture Lab technical program manager, has created an “AI-driven tool [which] can generate its own independent choreography based on hundreds of hours of video footage it has been fed – both from the choreographer’s archives, and from the ten dancers in [McGregor’s] company” (Leprince-Ringuet). They were inspired by another AI project in which a neural network was used “to predict the form of the next letter” a person would write “based on [the] handwriting in the previous letter” (Leprince-Ringuet). Henry created “a similar algorithm” which was “capable of making predictions for a given movement” (Leprince-Ringuet). The program captured the movements of the dancers through video, then based on the dancer’s pose, it would come “up with several options for the most likely choreographic sequence to follow, and [would display] them on screen in real-time” (Leprince-Ringuet). The program extracts “the ‘skeleton’ of a dance making a particular pose, by drawing points between their different body parts”, and then it “runs this input through three different algorithms to guess what the next pose” (Leprince-Ringuet). The program “takes into

account the individual style of that particular dancer", but it can also mix different styles and individuals (Leprince-Ringuet). Ultimately, the tool "produces a total of 30 potential choreography sequences […] using a similar 'skeleton' visual" (Leprince-Ringuet). Henry believes that this tool "is not meant to invent moves that have never been seen before", but rather as a predictive tool (Leprince-Ringuet). He said that the purpose of the tool is "to create options in a very efficient and fast way, so that the creative process never stops" (Leprince-Ringuet).

The third recent example is a project created at the Georgia Institute of Technology. The project, titled *LuminAI*, involves a "computer-controlled dancer" who "'watches' the [dancer] and improvises its own moves based on prior experiences" (Maderer). Then, when "the human responds, the computerized figure […] reacts again, creating an impromptu dance couple based on artificial intelligence" (Maderer). This project is "housed inside a 15-foot-tall geodesic dome […] lined with custom-made projection panels for dome projection mapping", which was "designed and constructed by Georgia Tech digital media master's student Jessica Anderson" (Maderer). The program works through the use of "Kinect devices" which are used to "capture the person's movement" (Maderer). Next, the "computer analyzes the dance moves being performed and leans on its memory to choose its next move" (Maderer). The program is the most successful, the "more moves it sees" because this allows for the computer to a have a deeper vocabulary of dance movement. The computer can then use this data "as a basis for future improvisation" (Maderer). The project's team believes that the improvisation of the dancers "is one of the most important parts" of the program because the digital "avatar recognizes patterns, but doesn't always react the same way every time" (Maderer). Due to this, the dancers must improvise the entire time too, which is believed to lead to "greater creativity all around" (Maderer). These three recent projects represent a few methods that programmers have

implemented into the field of dance. They illustrate the many uses for technology in dance, and they also show the many ways of attacking the problem that is teaching an AI to choreograph.

There are many mixed feelings about the use of artificial intelligence to create art. First, let's examine the more polarizing views. Duke University's director of the dance program and choreographer, Michael Klien, was a very proficient user of "The ChoreoGraph" program, which is "a sequencing tool that let[s] the choreographer set up digital variations on a timeline" and acts "as a cue-sheet for dancers during performance" (Leprince-Ringuet). He decided to discontinue using "The ChoreoGraph" because he preferred to work with the dancers directly (Leprince-Ringuet). He said: "We kept including more algorithms in the system to make it more intelligent. […] But I realised it is not the strength of dance to be developed by AI". He believes that the human assumptions made when creating AI would spell the "tragic limit of our imagination" (Leprince-Ringuet). On the other hand, there are many individuals that believe AI can help increase creativity Damien Henry, Google Arts and Culture Lab technical program manager, believes that the creativity comes "from the use that [the choreographer] will make" of the technology based on the options given to [them] by the computer program (Leprince-Ringuet). Wayne McGregor believes that "the most fascinating aspects of the technology is that it can learn and recreate the particular style of a dancer" (Leprince-Ringuet). Andy Serkis, an actor and film director, has described motion capture "as the 'bottling up' of performance", which "can go [...] toward[s] capturing their creative identity (Leprince-Ringuet). Mikhail Jacob, the lead developer of the *LuminAI* technology, believes that since *LuminAI* "gives autonomy back to the computer", it forces a person to create something new — potentially something better" because the dancers have to take their virtual "partner's actions into consideration" (Maderer).

The most commonly held feeling is that the AI will "not to replace the choreographer", but rather act as a tool for the choreographer to make the choreographing process easier and more streamlined (Leprince-Ringuet). Some choreographers believe that there is a distinction between the initial creative ideas of a dance and composition of it. Murray Louis, a choreographer, once said that until he had "taught Composition [he] had always equated good choreography with creativity. [He] know[s] now that this is not the case. Creativity is the source.... composition is a skill, a craft that can be taught and learned, the means and method to structure creativity" (Schiphorst 8-9). He is one of many choreographers and researches that believe that the design of computer systems is "to provide an extension, to open out possibilities, to supply a working tool that provides a visual idea generator, and to support the iterative and interactive nature of the choreographic process, on many levels" (Schiphorst 11-12). It is then the challenge of the choreographer "to find a physical reason or intent to produce what is suggested by the chance or random operations" (Schiphorst 21). Today, "AI mostly relies on instructions fed to it by humans", which therefore makes it impossible to program the computer with every possible instruction. Brain Magerko, Georgia's Tech digital media associate professor and leader of the *LuminaAI* project, believes that this impossibility is due to the unpredictability of humans (Maderer). The computer programs are most successful when they "can learn from [both] people and prior experiences" (Maderer). Despite the many mixed opinions, the continuation of discussions about ethics is important to the future of how technology will be programmed.

Artificial intelligence and machine learning have increasingly been used to aid choreographers and dancers. The three recent projects explored illustrate the broad range of applications of artificial intelligence in the field of dance. They also highlight the trajectory of

AI towards automated systems for choreography. The ethical ramifications questioned by programmers and choreographers are all valid. However, based on the current trend of technology becoming more pervasive in our society, it is not productive to claim no technology should be used in the arts and humanities. Brain Magerko says it best when he says "As computers become more ubiquitous, we must understand how they can co-exist with humans. Part of that is creating things together." (Maderer). Technology has always been used as a tool to make life easier for humans, so it is most productive to continue to see it as a helpful tool rather than a necessary evil. One point that is often left out from discussions about ethics is the creativity and work that goes into creating the artificial intelligence that perform the tasks to create art. Artificial intelligence is still dependent on how it is programmed and who has programmed it, and there is a prevailing lack of appreciation for the programmers of AI. There is a common perception is that the sciences are cold, logical, and uncreative. This is a blatantly false claim: creativity is built into the scientific method, and discovery and invention could not exist without it. Integration between technology and the arts will continue to lead to interesting discoveries in both fields. Overall, the prevalence of discussions about ethics is promising because we as humans still have some say in the future of technology, and these discussions help us to understand our relationship with technology as it becomes more omnipresent in our society.

References

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