

Digital Dance

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Digital Dance

Introduction

Digital dance presents a wide and varied field of practice. The term can refer to staged dance with technologies, dance captured through recordings, and the intersection between dance and digital technologies to research and discover more about the dance in question. In digital environments, the fleshy body becomes an open and fluid system that receives a variety of inputs and explores tactile spaces between the 'live' and the 'virtual', questioning the way materiality and corporeality is experienced. At the same time, bodily knowledge and embodied memory offer challenges to digital structures and processes that reveal new ways of thinking for both digital media and dance.

Digital dance can refer to the work of artists who have incorporated digital technologies in the creation and performance of dance on stage, and some reference will be made to artists who have made an important contribution in this field since the closing decades of the twentieth century. Moreover, whilst the discussion will focus on digital *dance*, some of the references point to the crossover of dance and performance, or other art practices. Evolving since the 1980s and responding to technological change means that practitioners describe their work in myriad ways, reflecting the idiosyncratic nature of the working process and work itself. Critical engagement with technological processes is developed in parallel with the practice. This demands some cautioning against the way in which technology can divorce the viewer/dancer from the body and the source of movement, which can "alienate us from our own connection with the neurophysical and intellectual source of movement, allowing the machine to think the movement and to control it for us" (Salazar Sutil 2015: 50). However, our primary focus here will be on the way in which digital technologies have been brought into interplay with dance to

enhance the experience of viewing, learning and making dance, to explore the potential for dance data to have an impact on other subject domains, or to reveal hidden dimensions of dance.

The chapter begins by providing a brief overview of contemporary developments in the digital dance field, dwelling on some significant moments that have influenced digital dance and some of the artists and theories that have informed the way in which scholars have discussed this body of work. This opening discussion of early developments in digital dance will lay the foundation for a close reading of two digital processes that continue to elicit questions about the relationship between dance as a live, embodied art form, and the digital environment; motion capture and choreographic software. In different ways, both participate in debates about the body, ontology, ethics, immersion and about how digital technologies reveal ‘hidden’ dance knowledge. These debates are addressed through an in-depth examination of two contemporary projects as case study examples; projects that are concerned with the potential for digital technologies to enhance understanding of dance. The first is *Becoming* (2013), a digital installation, or ‘body’, created by digital artists Marc Downie and Nick Rothwell, in collaboration with researchers Scott deLahunta, James Leach and British choreographer Wayne McGregor, along with his company Random Dance (now called Company Wayne McGregor).¹ *Becoming* was intended as a generative tool for McGregor and was used during the development of his work *Atomos* (2013) as a stimulus to create new movement material. It was also displayed in the exhibition *Thinking Through the Body: Mind and Movement in the Work of Wayne McGregor / Random Dance* (Wellcome Collection 2013). The second is WhoLoDance (January 2016 - December 2018) a three-year multidisciplinary project that is built upon motion capture technology to create a series of tools for dance makers, teachers and learners to explore how the ‘volume’ of the dancer’s space can be reconstructed in the digital environment. The project

explores smart learning environments through multi-modal/multi-sensory interaction technologies and advanced immersive real-time training interfaces using motion capture, virtual avatars and the potential for holographic projections. These projects have been selected for their contrasting approaches to integrating digital technologies for experimental purposes but where there is a shared commitment to contributing to understanding about choreographic creativity, which has implications for artistic and educational processes. Both projects bring together teams from across different disciplines to investigate fundamental questions about dance transmission. As members of these development teams, we also bring an insider perspective to the projects. Together, the case studies and the broader discussion will aim to point to the evolving condition of digital dance discourses, and will propose some thoughts about future directions.

Early Digital Dance: Some Antecedents

There have been rapid developments in the relationship between performance and technology, particularly since the millennium. Digital technologies that have been brought into performance practice are diverse in nature, and include for example motion tracking,² robotics,³ virtual and augmented reality,⁴ animation,⁵ wearable technologies⁶ and interactive interfacing.⁷ Bringing technologies and bodies together also led to exploring different environments for performance, beyond the stage and/or the screen, and blurring the boundaries between performers and audiences.

Several scholars have offered close readings and analyses of the impact of the digital on performance practice (Birringer 1998) and the emerging themes in digital performance, such as interactivity and the alchemical affect of the 'double' in the melding of the live and virtual (Dixon, 2007), theories of 'liveness' and how what counts as a live experience changes over time

in relation to technological change (Auslander 1999, 2012) and ‘remediation’ (Bolter and Grusin 1999). Many look to identify the common features in this diverse playground and in various ways argue for the centrality of the body and the engendering of ‘an altered corporeal experience’ (Broadhurst and Machon 2006:xvii) through technology. As performance scholar Johannes Birringer argues, digital performance is ‘characterized by an interface structure and can be said to include all performance work in which computational processes are integral for the composition and content, the aesthetic techniques, interactive configurations and delivery forms’ (2009: 10). At the same time, performance scholars are looking to other discourses and theoretical frameworks to examine how digital technologies introduce new kinds of human experience in arts practice, touching on subjects as diverse as consciousness, cognition and perception, modalities of the senses, and physical science (Ascott 2000).

Experiments with cyber-theatre first entered the performance environment in the 1990s, with digital artist Paul Sermon’s telematics in which theatre audiences interacted directly with professional performers. One of his most significant works, *Telematic Dreaming* (1992) in collaboration with dance artist Susan Kozel is a virtual reality performance installation in which Kozel ‘performs’ with her projected image, as audiences who are in a different room interact with this projection of Kozel. At the same time, Kozel is able to watch and respond to her own projection in duet with the audience member on a screen. Kozel describes how her embodied experience is altered by working with computer systems in performance, noting how working with a responsive computer system requires her to insert herself bodily into the environment: she observes, ‘[w]hen working across bodies and digital technologies not only is the concept of knowledge restructured but, of necessity, our modes of perception and notions of materiality also shift’ (Kozel 2011: 204). *Telematic Dreaming* posed an important question about the role of

touch in dance; does the physical sensation of touch that is often fundamental to the dancer's experience fade or become more vivid in the technological world? Other projects followed that probed this question further, including, for example, Sita Popat's *TouchDown* (2000) (in collaboration with Jeffrey Gray Miller), which explored touch in a relationship that exists in the realtime meeting of the hands of two live but remote telematic bodies. The novelty of these distributed performances heightened attention on the sensorial properties of dance and informed other processes such as motion capture. They also fueled an emerging discourse that drew from several other theoretical fields, including philosophy, psychology and aesthetics, to find ways to account for these new body-technology encounters. These new performance experiences in digital dance also prompted new scholarly thinking. For example, in 1999, writer and performance practitioner Susan Broadhurst introduced the concept of the 'liminal' space as a description of how, according to Broadhurst, digital works were 'located in the 'threshold' of the physical and virtual the space between the physical and virtual' (2006: 137). Similarly, artists and scholars were referencing Freud's notion of the 'uncanny' or *unheimlich* (Freud 2003), which referred to the dark self or 'other'; something that is both familiar but also strange and uncomfortable. The uncanny typified how artists were confronting the ghostly, doubling experience introduced by new technologies, whereby they felt separated or 'abstracted' from the physical activity whilst simultaneously connected more closely to their own or another's body through various synaesthetic technological processes (Boucher, 2004).

Motion Tracking/Motion Capture and Choreographic Software

One of the most popularly used technologies that has entered the dancer's tool kit and which has extended the experience of, and related discussion about, the 'doubling' of the dancing body in

the digital environment is motion capture. Motion capture is a digital technique whereby a dancer's movement is captured by means of having reflective or magnetic markers attached to various body parts. The captures produce digital data of the dancing body. There are many systems available and more accessible and affordable kits⁸ are evolving, which has led to many more and different kinds of artist experiments. Technologies might include gyroscopes, accelerometers as well as simpler tools such as Kinect. Traditional systems are dependent on specialist 'labs' and, importantly, experienced technicians who can set up the system and process the data. At least twelve cameras are positioned 360 degrees to make the captures of the optical markers positioned on the dancer's body. Many dancers have used motion capture as have those involved in sport, health, the military and entertainment. In dance, it has been a valuable tool for those interested in biomechanical analysis of movement where close attention is required to investigate the load on muscles and joints (Charbonnier et al. 2011; Shippen and May 2010).

In dance making and performance practice more widely, motion capture introduces questions about the process of movement generation and the dancer as 'agent' within the creative output. A common characteristic of motion capture is *extracting* movement from a body, and the subsequent *abstraction* of the body from the physical site of the dance (although performances may involve the dancer moving in reaction to, or in collaboration with, real-time motion capture). The disconnection between the live dancer and her data, which can be used in various ways and at different times, can enable the dancer to examine her movement from outside the experience of dancing, and others to also analyse the data sets for myriad purposes. The extraction of data, and data that once processed and turned into a digital avatar that usually appears to carry a clear signature of the dancer and her gestures in the dots, lines and trajectories, can be unsettling or induce an uncanny experience for the dancer. The animation or 'digital

portrait' (Dils 2002: 94) that emerges is not a mirror image, nor is it necessarily a representation of the dancer so the dancer's sense of self can be disrupted, particularly if glitches enter the animation process.

So-called 'identity-markers', such as gender, skin colour, physicality, and age are usually not visible though motion capture renderings and the images are skeletal, rather than weighty. The removal of identity markers that are often the root of judgment and prejudice might be viewed as a form of liberation. However, we need to approach with caution the idea that digital technology can offer a de-politicized or neutral space. The contexts for technological production are as deeply embedded within the political world as any other. Whilst data rendering might produce otherworldly or ghostly images, they are very much a part and product of the human world we inhabit. Technologies and their products are deeply and firmly situated within particular socio-economic, institutional and political contexts.

What characterized many of these early experiments in extending or virtualizing the dancing body in performance was the recognition that the work unfixes stable categories of identity, indicating a dancing body that is 'transitory, indeterminate and hybridized' (Broadhurst 2006: 140). This is not to say that the live dancing body is abandoned in these contexts, but rather it participates in what might invite a reconfiguring of the human body or more particularly, provide access to new information about the human body that is otherwise inaccessible. These concerns have continued to intrigue artists as technology advances and new instruments and software become available, which open up new kinds of immersive and interactive experiences,⁹ generating new perceptual processes for both performers and audiences. Properties of dance in the physical environment, such as the pull of gravity, spatial orientation and the role of internal processes such as breath, are recalibrated in the virtual, digital space, where the material,

corporeal dancing body is absent but not ignored. Such digital dance projects continue to prompt questions about how dance knowledge is transmitted and encourage new approaches to analysis that draw from related fields such as corporeal computation.

Corporeal computation is not new within choreographic processes even if it is relatively recent in dance scholarship. The potential for computer programming in dance can be traced back to the mid 1980s when Merce Cunningham (1919 - 2009) was one of the first choreographers to experiment with choreographic software, developing a system called *LifeForms*, which allowed him to generate movement on digital avatars, which was then learned by the dancers in his company (Schiphorst 1993).

Multimedia performance company Troika Ranch similarly developed their own software for dancers, *Isadora*, to play with and manipulate live and prerecorded captures of dancers in performance. With reference to one of Troika Ranch's digital intervention projects, *loopdiver* (2009), Mark Coniglio (one of the leaders of Troika Ranch) describes the importance of presenting the dancers with 'impossible instructions' (2015: 281) for creating new kinds of digital performance experiences. Coniglio has since reflected on the relationship between live performance and technology, arguing that technology is yet to be sufficiently sensitive to human gesture and the qualities of human movement (2015: 281). He speaks about looking forward to sensing machines that will be able to reflect and intervene in performance, and do 'the impossible'; 'to *cheat*' (2015: 284), to break the rules and thereby inspire new ways of composing and performing.

Another project that calls up an earlier artificial-intelligence interaction is the Choreographic Language Agent (and the subsequent *Becoming* digital installation, discussed later), created by Mark Downie with McGregor. Downie, working with his partner in the

OpenEndedGroup, Paul Kaiser, collaborated with choreographer Trisha Brown for her stage work *how long does the subject linger on the edge of the volume* (2006) to build a software agent that appears to act autonomously, generating a series of dance diagrams that are projected live on a transparent screen at the front of the stage. Extending this work, the Choreographic Language Agent (CLA) was developed in collaboration with Nick Rothwell and McGregor in response to the choreographer's wish to disrupt his movement habits, and those of his dancers (Leach and deLahunta 2015). Each of these projects probe questions about dance ontology, about the relationship between computers and bodies, and the multiple cognitive and physical processes involved in dance creation.

Dance Transmission/revealing hidden knowledge

Many individual artists and groups in addition to those mentioned earlier have had an important impact on the choreographic imagination through the development of digital objects that visualize features of movement that are otherwise imperceptible, such as pathways, structures and movement trajectories. For example, William Forsythe's 1999 CD Rom, *Improvisation Technologies*, has had an important and lasting impact on the development of multiple dance projects that have developed new insights, through the incorporation and development of digital technologies. By drawing virtual lines over video of the dancer in action, the 'invisible' trajectories of movement are revealed as digital enunciations of Forsythe's idiosyncratic movement language. Subsequent projects by Forsythe, including *Synchronous Objects* (2009) and *Motion Bank* (2013), have continued to explore methods for representing corporeal and choreographic systems at play in his work. For example, Motion Bank¹⁰ has developed a range of computer-aided visualizations of dance, and the structures that underpin dance works, for arts

education and interdisciplinary research. The project brought together researchers, leading dance choreographers, designers, educators and computer scientists. The aim was to ‘explore how digital technology can be uniquely applied to the challenge of documenting, analysing, notating/annotating and presenting dance’ (Forsythe and deLahunta 2011: 12) by archiving a number of choreographers’ conceptual approaches along with video recordings and three-dimensional data documenting the performances and the depictions created by the designers. Incorporating different motion analysis tools including Kinect and Motionbuilder to visualize different aspects of the choreographer’s work, a number of digital scores have been created as a result of this interdisciplinary design process.

Forsythe’s projects are part of a collection of related enquiries and objects, developed since the late 1990s, which seek to capture and make visible aspects of choreographic processes and structures. Behind these projects is a claim for ‘choreographic thinking’ (Forsythe: 2009; deLahunta, Clarke and Barnard: 2012). Twelve of these projects¹¹ are examined in the book *Transmission in Motion* (Bleeker 2016). Bleeker and deLahunta suggest that ‘each in their own way engage with something that might be called dance knowledge’ (2016: 3). Whilst each of the projects engage quite differently with what this knowledge might be, and how to capture or transmit it, they do share some overlapping features, including a focus on how drawing different disciplinary approaches might help interrogate and articulate the process of making choreography and enacting it in performance. Each of the projects use technology to make visible or reveal aspects of movement that might otherwise be hidden or difficult to see, such as cues, spatial pathways and relationships between body parts. As well as those mentioned previously in relation to *Motion Bank*, this group of projects uses a range of techniques, including audio narration, visual video annotation, motion capture and animation. The premise that there are

aspects of dance that cannot be seen, or are not easy to see in analogue form demonstrates the centrality of technology to this field of research. As Bleeker and deLahunta point out, ‘the ways in which [the projects] took shape are intertwined with the emergence of new technological possibilities they could draw on’ (2016: 6). The revealing of hidden or less visible aspects of human experience, such as spatial trajectories, is thus behind many of these and other digital dance projects. As such, the interest in revealing what was concealed, seems to chime with philosopher Martin Heidegger’s notion of *Techne*, which he describes as a bringing-forth, or *poiesis* (1977: 13). Technologies that facilitate the visualization and contemplation of non-material structures can be said to bring forth knowledge about dance that remains otherwise unseen, which is why Heidegger is frequently cited in relation to the nature of knowing in this context. Heidegger also makes a distinction between technology and *Techne*, although argues that technology is a form of bringing-forth, so both are connected, through a process of enframing (in which technology is a mode of revealing). The attraction to creating and sharing digital dance data is partly because of the new knowledge that emerges through the act of digitizing dance content but also because the circulation of dance data can provide more longevity to dance.

Data

Whether through recording, motion capture, animation, or holograms, whenever dance is captured and rendered through technology, it is transformed into data. Whilst most research and scholarship in the field of digital dance is concerned with the re-analogue¹² form of this data, such as films, some thinking is emerging (deLahunta 2012; Digital Echoes 2017) that considers the ethics, ontology, and affordances of dance data itself. Of particular pertinence seems to be

questions about the ways that dance data is shared and circulated. However, when dance becomes data, a question emerges about who owns this data.

As technologies are increasingly used by governments and businesses for surveillance and biometric identity recognition, questions about the ownership and ethics of bodily movement data are of concern beyond the field of dance. For example, the field of ‘behavioural biometrics’ is also asking questions about the ethics and ownership of data produced by the movement of the body. The term ‘behavioural biometrics’ refers to data that measures our physical behaviours, and can therefore be used for identification. Pre-digital examples include signatures and polygraphs. Advances in technology have multiplied the ways in which our movements can be captured, including through gait analysis and biometric scanners. Scholars of computing and human behaviours, Ben Schouten, Albert Salah and Rob van Kranenburg write,

With increased availability of cheap and innovative sensors, it has become possible to derive correlations from many sensors and construct prototypical patterns of behaviour, which can be employed to authenticate a person, as well as to derive a host of associations and inferences about a person. We will call this *behavioural biometrics*.
(2012: 197)

Using this form of data for recognitions rests upon the idea that the way we move is unique to each individual, and that this uniqueness can be maintained as movement becomes data. Furthermore, using this form of data raises ethical questions about the individual’s relationship to the data produced through their movement. These questions have been explored in dance research in relation to motion capture’s ‘digital portrait’ (Dils 2002, 94), mentioned earlier, with

some scholars (Boucher 2011; Kozel 2007) suggesting that people can be identified through their motion capture images due to the distinctive way they move.

In general, dance artists and companies tend to adopt fairly relaxed attitudes towards the sharing of their work in both analogue and recorded form. Whilst full-length works might not be available freely online, most will share extracts, and possibly footage, from the creative process. This sharing mentality has been discussed by Ramsay Burt (2016) and Harmony Bench (2016), both of whom suggest that dance communities have generated a form of ‘commons’, into which movement ideas are contributed, circulated and developed. However, questions about the implications of open sharing for dance data are still to be fully interrogated. Researcher in social security, Günter Schumacher (2012) suggests that the level of understanding around issues of privacy is lower in behavioural biometrics than in other forms of biometric data gathering, thus we can see how current and future thinking around digital dance might usefully extend into other domains.

As the previous discussions have demonstrated, the vibrancy of thinking around the questions posed by digital dance suggests that research in this area has the potential to shed light on questions of corporeality and technology beyond the disciplines of dance and performance. As Kozel suggests, ‘the dance or performance studio is a hothouse for understanding wider social engagements with technologies’ (2007: xiv). The centrality of the body in our critical examination of dance means that this thinking extends into multiple areas of human life. Bleeker and deLahunta acknowledge this potential when they suggest that the projects they discuss share a motivation to reach new contexts ‘beyond dance’ (2016: 6).

Becoming

Our first case study, *Becoming* (2013) was the result of a long research trajectory focused on the development of digital choreographic agents for the augmentation of McGregor's choreographic process. Commencing in 2000, the choreographer undertook a number of projects in collaboration with researchers from multiple different fields, including the cognitive and social sciences, which focused on understanding more about the nature of McGregor's choreographic process and developing tools to support the making of new works (*Thinking with the Body* 2013).

Leach and deLahunta articulate McGregor's desire to introduce 'elements designed to disrupt the habitual movement and process of himself and his dancers' (2015: 3). Between 2007 and 2011 the team developed the Choreographic Language Agent (CLA). Contributing to the field of choreographic software mentioned previously, the CLA allowed McGregor and his dancers to generate abstract animated structures by inputting instructions into a computer. These structures were then used as stimuli for generating movement.

Research conducted by Leach and deLahunta as a follow up to the CLA project suggested that something was missing from the tool. They felt it needed 'a body' in order for McGregor to find it more engaging to work with in the studio. Thus, it was decided that the CLA should be further developed, and that the new version should have or be a body, posing the questions: what is a body; what do bodies do; and (how) can a body be generated through digital media?

To develop *Becoming* three key bodily features were specified by the research group. First, the interface should be human scale; secondly it needed to have dimensionality in order to come off the screen; and thirdly it must be compelling. The first consideration led to the installation being presented on a screen of 'human scale' (Leach and deLahunta 2015: 9). In both the studio and exhibition contexts the work was installed on a rectangular, vertical screen,

allowing for those standing in front of the screen to be positioned in a familiar body-to-body relationality. The second consideration was met through the use of 3D technologies, which allowed *Becoming* to animate beyond the flat surface of the screen. The third criteria, however, is more complex than the first two. The potential of the digital body to elicit responses in other bodies became central to the development of the programme. Leach and deLahunta describe how when ‘investigating “the body”, McGregor, and several dancers (independently) asserted that bodies are things one has a response to’ (2015: 6). They go on to suggest that there is a certain quality to a body that cultivates a form of relationality with other bodies (Leach and deLahunta 2015: 6).

The motivation to construct an entity that would be compelling in the same, or similar enough, way as a human body to generate relationality can be examined through a range of different perspectives. Research in dance has often considered the potentials of bodies to affect one another. Alongside recent discourses concerning ‘affect’ (Apostolou-Hölscher 2014; Massumi 2002; Thrift 2008), a large body of research examines the kinaesthetic and cognitive impact of dance movement on spectators. Beatriz Calvo–Merino et al. (2005), Matthew Reason and Dee Reynolds (2012), and Susan Foster (2011) have all made observations regarding the physical perception of movement. This area of enquiry dates back to 1933, and dance critic John Martin’s (1983) account of ‘metakinesis’. Kinaesthetic empathy and related research on mirror neurons often suggests that when spectators observe a body moving, they recognize, to a greater or lesser degree, the movement that is being performed. It has been suggested that recognition triggers both cognitive and empathetic kinaesthetic responses in the observer (Calvo-Merino, 2005, Reason and Reynolds 2012). There are, of course, important considerations about how these ideas might apply to bodies interacting via mediated, digital contexts. However, one thing

that ties together these various discourses is viewers' recognition of the body and its movements, and many examples of digital bodies are re-analogue'd as recognizably human forms, meaning the applicability of these discourses to digital representation might not be too hard to conceptualize.

However, *Becoming* does not look like a human body. Once the body is abstracted, how do we begin to understand and conceptualize its potential to illicit 'affect' or 'empathy'? *Becoming* is an abstract form. It generates coloured lines that change, grow, expand and dissolve. It does not perform recognizable or codified dance movements. Describing an encounter with *Becoming*, dance scholar Stephanie Jordan suggests 'A skeleton of lines like bones intersecting with joints appears out of nowhere, and appended to it are what look like light webs, hairs, as well as arrows and geometrical structures. Wearing 3-D glasses, you notice how it can rotate and trace luscious arcs. Thus, it elicits a kinaesthetic response, as if alive' (2013: 2). Yet the relationality produced by *Becoming* is arguably different to those experiences described and explored in research on kinaesthetic empathy, which often focus on the recognizability of the body. Whilst *Becoming*'s form and actions are not entirely unfamiliar, and appear living, as Jordan points out, they cannot be immediately recognized as a dancing body, meaning that the behaviour and movement of *Becoming* is complex to acknowledge, understand and articulate.

The animation moves randomly. Its behaviours are generated through the computational interpretation of filmed stimuli. Downie and Rothwell used creative coding methodologies to generate an object that responded autonomously to source data from the film *Bladerunner* (1982) (Jordan 2013: 2). Numerical data was transformed into an artistic, self-generating form. Although there is movement in the film, dance and the body are not the primary focus, therefore *Becoming*'s data is not produced by a human body.

[INSERT FIGURE 1 HERE]

***Becoming*. Credit: Marc Downie and Nick Rothwell**

Rothwell suggests that *Becoming* works within a world that possesses both gravity and friction, describing how ‘it has follicles, bones, edges, it has nodes, it has muscles and it responds to gravity, so it will under certain circumstances tend to fall down because gravity pulls it down’ (Rothwell in *Thinking with the Body* 2013). A relationship to gravity is seemingly integral to *Becoming*’s bodiliness, in particular in the context of contemporary dance. One of the critiques of motion capture in relation to dance involves its inability to record weight and the body’s relationship to gravity (Dils in Boucher 2011: 7). As Kim Vincs suggests, ‘The central project of contemporary dance has been to create a corporeal poetics of the body based on its relationship to gravity’ (2016: 263). She goes on to suggest that technologies, in particular those used in virtual reality enable a ‘radical deconstruction’ of the conventional dancing body (2016: 263). Nevertheless, for *Becoming* to become a body, a relationship to gravity was deemed important. This was generated through the use of sketched lines to indicate a floor, and shadows (see Figure 1). The implied connection to the floor not only portrays a relationship to the ground, it also situates *Becoming* on the same plane as those observing or working with the installation. The agent’s self-generating nature is also important in *Becoming*’s bodily status. The entity’s autonomy means that it moves beyond the representation of particular movement principles, which was the focus of earlier interactions between dance and technology. Rather, it is a ‘thinking’, moving being, which has bodily features and affordances. Through the analysis of the principles underlying *Becoming* we are able to learn more about what bodies are and what they

do. In particular, the importance of its self-generating nature highlights the autonomy and ‘thinking’ that the body is capable of.

As mentioned previously, the excavation and emphasis of the intelligence or ‘knowledge’ of the body has been a key project in digital dance research. Technology has offered a variety of ways in which to analyse, share and visualize the unique form of bodily intelligence generated and utilized through dance making, training and performance. As Vincs suggests, ‘Twenty years of dance technology works have reconceptualized movement as information (data) rather than representation (articulation)’ (2016: 264). *Becoming* demonstrates this reconceptualization due to the way that the interrogation of bodily features, or information about the way that the body comes into relationship with the world, were transmitted into data, rather than representing particular movements or behaviours. Digital technology has cultivated many forms of human, digital, symbolic and metaphorical bodies. As we have already considered, recordings, motion capture and graphic visualizations offer numerous ways to deconstruct, represent and encode human movement. Motion capture and holographics, for example, are generated through dance data. As mentioned previously, movement is extracted and abstracted, but nevertheless, the physical dancing body is the root of the visualisation. Its capture, transformation and re-analogization can therefore be thought of as an extension of the body (Manning 2009: 63). In much the same way that a photograph or film extend our identities into virtual space, our movement data becomes part of an expansive circulation of self-hood. However, *Becoming* is not representational or analytic. It is constructed. A body built through code, and taught to self-generate. Whilst the images produced through dance data, and this alternative form of creative coding might appear similar, their different roots fundamentally impacts on their ontology.

If we are to concede that bodies can be generated through code, the ground upon which we understand what it means to be human is significantly altered. Furthermore, the question is posed: what kind of body is *Becoming*? And what is at stake in labelling an abstract, constructed entity a ‘body’? Bodies *constructed* in code appear ontologically distinct from renderings generated and re-analogue through dance data. The distinctly bodily nature of dance is often-cited as affording it a particularly unique ontology. As Schiphorst suggests, ‘Conceiving dance is “of the body”, and therefore has a large non-verbal creative component which can be made manifest only through the ephemeral physicality of the body’ (1993: 6). Whilst the ease and accessibility of recording technology and the internet has impacted significantly on various areas of dance practice, the actions of the corporeal body in space remain central to the form. Through the previous discussion about the intersections of dance and technology, it is clear that technology is being used as a way to stimulate, extend, and examine the bodily practice of moving in space, rather than replace it. To think through this extension of the body, many scholars concerned with the relationship between the body-based practices of dance or performance and digital technology have found the concept of ‘posthumanism’ generative (Causey 2001; Dixon 2007; Remshardt 2010). N. Katherine Hayles’ book *How We Became Posthuman* (1992) is perhaps the most frequently cited source for thinking through the extension of, and interaction with, bodies in digital form. Hayles articulates four central tenets of a posthuman perspective; first, it privileges ‘informational pattern over material instantiation’ (1999: 2); second, it considers consciousness as a ‘minor sideshow’, thus challenging Western thinking’s historical privileging of the phenomenon; third, it views the body as ‘the original prosthesis’, thus allowing for it to be extended or replaced with other prosthesis; lastly, and according to Hayles, most importantly, posthumanism views the human being as capable of

being ‘seamlessly articulated with intelligent machines’ (1999: 2-3). She writes, ‘In the posthuman, there are no essential differences or absolute demarcations between bodily existence and computer simulation, cybernetic mechanism and biological organism, robot teleology and human goals’ (1999: 2-3). Her discussion foregrounds the way in which existing epistemologies of the body, and what it means to be ‘human’ have been significantly reconfigured during the rapid increase of digital and online technologies that has occurred during the past two decades. In relation to dance, a posthumanist framework might suggest that the actual and the digital are not in a binary relationship, but co-exist in a way that is enmeshed to the point where there is no absolute distinction to be drawn between them.

Stamatia Portanova’s book *Moving without a Body: Digital Philosophy and Choreographic Thought* (2013) considers questions about the transformation of movement into numerical code. She suggests that the key issue for dance’s relationship with technology is no longer how it can accurately render movement, but rather, ‘the numerification of movement requires a broader thinking, or perhaps a rethinking, of what movement itself is (or what it can become)’ (2013: 3). *Becoming* offers a compelling example of this claim, as movement is generated through numerical code, which is activated as an abstract body extends the potential of digital movement beyond a focus on accurate depiction. Perhaps controversially, Portanova maintains a dualist perception regarding the relationship between the mind and body, suggesting that, ‘choreographic thought will also be distinguished from performance, or the physical execution of dance by one or more bodies. A body performs a movement, and a mind thinks or choreographs a dance’ (2013: 5). While much dance scholarship, particularly perspectives arising in the fields of somatics and phenomenology (Fraleigh 1987; Rouhiainen 2008; Sheets-Johnstone 2010) have challenged, and in some cases entirely done away with, the idea that the

mind and body are distinct, it seems that engagements with digital technologies invoke yet another rethinking of the relationship between cognition and corporeality.

Portanova presents a perspective that is detached from the lived, kinaesthetic experience of the body and technology. She describes this perspective in relation to the concept of ‘abstraction’, which, as she suggests, ‘presents itself as diametrically opposed to phenomenological observation’ (2013: 11). Kozel’s phenomenological reflections, on the other hand, offer a different consideration of the interactions between bodies and technologies. Kozel suggests that attention to the lived experience of technologies allows her to respect the sensations, inner voices, ideas, thoughts and images that ‘emerge directly from the experience of being in computational systems’ (2007: xvi). She adopts what she describes as an ‘immaterialist’ approach, describing the apparent dualities of bodies and machines as ‘enfoldings or entwinements’ (2007: xvii). Pointing to the ‘tangled array’ of questions around ethics, corporeality, and ontology that emerge through the process of motion capture (2007: 214), Kozel suggests that ethical questions are shaped by the relationship between the actual and digital self, rejecting the view that we can be considered self-contained subjects, or that ‘the other is outside of me’ (2007: 214), which she describes as the ‘self-other divide’ (2007: 215). Kozel (2007) argues that relations with ourselves and others shift through our interactions with technologies.

Becoming proposes a stimulating provocation in response to Kozel’s framework. What or who is the ‘other’ in relation to whom our sensibilities are extended, and singular selves reconfigured? If we agree to rebuke the self-other divide, and enter into ‘enfoldings’ and ‘entwinements’ with technologies, how significant is it that this interaction occurs between two (or more) ‘bodies’, as opposed to other forms of digital rendering, agent, or images? The motivations underpinning *Becoming*, and the discussions presented by Portanova and Kozel

suggest that for dance there is something pivotal about considering the concept of bodily-ness to make sense of how the form might be extended by, enmeshed within, and revealed through technology. In the non-digital realm, bodily-ness is rooted in lived, physical experiences, which digital bodies are, to a greater, or lesser extent removed from. Re-analogue versions of motion capture data vary in terms of how faithfully they represent a human form, and abstract images are perhaps more difficult to read as belonging to, or arising from, particular individuals. In such cases, the framing and an understanding of how the images were generated seems important in terms of the viewer's ability to see the images in relation to the body, if indeed this is the aim. The way that *Becoming* was generated through non-dance data presents a unique set of complexities when compared to motion capture images. As previously explained, the form does not arise from, capture, or replicate any particular person's movement. In order to see and experience this as a body, a particular perspective is required. The dancers who work with *Becoming* in the studio are asked to respond to the entity as a body, imbuing the interaction with a particular set of qualities and conditions. Dancers and gallery visitors were provided with 3D glasses to observe *Becoming*, which was accompanied by a short video which explained the progression from the *CLA*: 'The latest version, *Becoming*, has been reimagined, less as an object or tool, and more as a body – as another dancer provoking new movement creation in the studio' (Thinking with the Body 2013). This framing was important in how *Becoming* was perceived and the responses it invoked.¹³

Furthermore, the notion of the 'body' is culturally situated, and we should be cautious of assuming any over-arching understanding of what a body might be or do. Conceptualizing *Becoming* as a body allowed it to serve a particular function in McGregor's process. *Becoming's* bodily-ness was constructed in relation to characteristics identified through ethnographic research

with the dance company, meaning that it arose from their (culturally embedded) conceptions of the body, and was therefore context specific. Furthermore, as *Becoming*'s bodiliness was focused on the body's relationality, Leach and deLahunta explain that, 'what is being termed 'the body' here, [is] far less of an individual entity restricted to the skin, and much more an extension of feeling, knowing, and sensing into the world *with, and of, other bodies*' (2015:6). The suggestion that this sense of feeling and knowing with and of other bodies can extend into the relationship between fleshy and digital bodies implies a posthumanist paradigm through the muddling of distinctions between humans and machines.

WhoLoDance

The second case study, WhoLoDance has motion analysis at the core of the project¹⁴ and is generating large datasets of dance movement. Using machine intelligence tools and methodologies, the aim of WhoLoDance is to apply sequence similarity and clustering methods for analysis of motion captured dance data in order to allow for multiple novel applications in the area of dance analysis and education. Four dance genres are the principal focus for the project because each is based on a dance vocabulary that is in general use in the context of its practice and teaching. Each genre is thus built around a lexicon of movement actions and sequences that form a basis for the genre's pedagogy: Flamenco, classical ballet, Greek folk dance and contemporary dance. The aim is to extend the exploration towards the capture of more somatically-informed improvisational dance practices, to test out the premise on which the project is based that the projection of the dancer in relation to the live dancer produces a novel sense of embodiment and a different kind of relationality.

The data that is being generated in WhoLoDance is analysed in a number of ways to

identify the movement principles and connections between different dance practices, and to support the learning principles that have evolved through the many years of dance teaching within each of the genres. The aim is not to provide a virtual proxy for the teacher but rather to enable the dancer, teacher and choreographer to discover the hidden properties of the dance genre. The motion capture production is taken through various stages and two pipelines of development. The first, covering both high-end and low-end capture devices has created a blendable motion capture repository and 3D position reconstruction for the modelling of the avatar. The second pipeline is concerned with creating the interactive visualization of the virtual bodies that will be used in the installation (polygonal 3D avatars, or real-time visualizations of force fields, vectors of movement and particle point-clouds) that identifies when a physical body is intersecting with a virtual body and feeds back sensory signals to the user. The aim is to provide different modalities of feedback (for example, audio, visual, audio-visual, and verbal).

The main ambition of the project is to create an immersive environment to innovate dance teaching and to encourage a greater sense of three-dimensionality by developing a life-size volumetric display, incorporating hololens technology¹⁵ that will enable a dancer to literally ‘step inside’ the dance teacher’s body. Whilst other motion training projects have used motion capture to create a virtual dance teaching tool (Chan et al. 2011) and have gone some way to collect enough data for evaluating the difference between the learner and teacher, none have yet combined motion capture with virtual reality and hologram technologies to support the teaching of dance with a focus on the qualities of movement and, in particular, the imagery that generates metaphors of motion for the dance learner and teacher. The concept is that, by inhabiting a virtual avatar/projection space/holographic projection, the tools will elicit for the dancer a particular experience of being ‘in’ the body, the dancer’s own body and the body of another that will be

informative, and provide new ways to learn movement and perceive movement from the outside and inside simultaneously. The current state of the technology means that the dancer needs to dance with the hololens, which is the main challenge for the project. Much like McGregor's dancers wearing 3D glasses to engage with *Becoming*, the dancer needs to adjust to dancing with equipment, moving towards a close relationship that evokes Hayles's (1999) call for the fleshy and digital to co-exist in a way that is enmeshed to the point where there is no absolute distinction to be drawn between them.

[INSERT FIGURE 2 HERE]

WhoLoDance

Early feedback has revealed some interesting insights. First, the environment offers a chance for the dancer to think about her own sense of control in the digital environment. On one hand the holographic projection may appear to be the 'master' version for the dancer to emulate, to fully inhabit, and with which to be identical. When the projection is 'an other' then the desire to emulate is stronger. It seems to be the case that the nature of the avatar itself plays a strong role in how the dancer experiences her relationship to the hologram. If the avatar is a recognizable projection of the dancer herself, she is drawn towards noticing errors and a desire to self-correct in her own 'live' performance. If the avatar is less figurative and less resembling a human dancing form (such as the lines and dots of the traditional motion capture avatar) then the dancer feels freer to dance 'with' the holographic avatar, experiencing the avatar as a dancing partner rather than a dancing 'master'.

Each dance genre has raised different questions. For example, Greek folk dance forms

have a long tradition of being taught body to body through generations of dancers, much like an oral tradition. There are 'rules' that pertain to the form, gender roles within the practice and distinct regional variations with traditional dancers. Most Greek dances are also group dances so the teaching and learning of the dances require understanding of how the group functions, of relationships between the ensemble and of the spatial pathways taken by the dances, as most are circle dances or partner facing dances. Moreover, as with all folkloric dance, it is seeped in local traditions, costumes, music and customs. Indeed all dances are situated within a particular context, whether that is a staged theatrical setting or a site-specific location. When dances are taken out of their environment and rendered through a motion capture process, important contextual matters can be lost. For Greek folk dancers who perform in large ensembles, often in various rural or civic contexts, the transposition from a communal environment to the computerized motion capture 'lab' can be destabilizing. On the other hand, the visualizations created by the motion capture data can reveal hitherto 'hidden' aspects of the dance that may enrich the dancer's experience of learning and performing the dance. A Greek dance teacher commented on how 'the accuracy of the recorded motion of each bone of the skeleton, full of information, is valuable, and will complete the existing recordings of the past, for further study' and how 'the fragmented sequences, for blending, with the possibility of assembling them, according to the dance, will be useful for teaching/learning purposes and why not for other proposed purposes'.¹⁶ The digitalization of the dance is thus not so much distancing the dance from the machine but is showing to us how the intangible aspects of the dance, hence important aspects of our intangible cultural heritage, surface through the hologramic volume. Not only are the dance 'forms' therefore available for sharing more widely, but the forms are also enriched by the knowledge that is able to emerge. However, each dance genre is a complex movement system

and the necessary segmentation of the practice, for capturing and analysis purposes, makes clear that the dance can disappear through its atomization and categorization. Whilst motion capture is not a new technology, some of the ongoing challenges persist when attempting to record the dance in its fullness (capturing multiple bodies, stillness, touch, floorwork because of occlusion due to placement of markers on bodies). Another potential challenge resides in how the motion capture process sets up a situation where the dancers are closely watched by the eyes of the many cameras, as well as those operating the motion capture system, and therefore injects a performance element to the process.

Noticing and acknowledging the technological apparatus that is brought to bear on dancing bodies also means being aware of the different intelligences that come into play, including the intelligence of the corporeal body. By creating a volume for the dancer and an avatar that becomes a different kind of dancing partner, the dancer can tune into different senses, downplaying the visual sense by tapping in to proprioception to sense the whole body in relation to others and the environment. Thus far, however, tracking proprioception remains largely elusive in digital dance projects that explore the convergence of human and machine knowledge. Moreover, the WhoLo dancers are largely new to working in the volume of the motion capture studio (as well as working with the hololens) so are discovering more about their own dancing, their relationship with the digital ‘other’ as well as their specific dance practice. Their experiences point again to Kozel’s ‘tangled array’ of questions around ethics, corporeality, and ontology that emerge through the process of motion capture (2007: 214). Overall, as noted earlier, the experiences so far have been illuminating and supportive of the dancers’ practice, and emphasize in particular the potential for play and expanding improvisational and compositional possibilities.

Digital Dancing Futures

The field of digital dance is shaped by multiplicity and interdisciplinarity and many of the projects discussed throughout this chapter have generated new insights and ways of knowing that extend into areas as diverse as cognitive science, anthropology, animation, mathematics, computer science, and biometrics. The rapid and expanding development of new technologies means that practice and research in the field is continually evolving. Dance and technology have developed a synergetic relationship, with each field of practice informing the development of the other. However, whilst digital technologies are ubiquitous, technology can be sometimes expensive and beyond the reach of many artists. Moreover, when it is more readily available, platforms, computer programmes and operating systems can become quickly obsolete, or crash, and disappear as quickly as the dance itself. Consequently, many of the early digital dance projects we outlined earlier cannot be experienced today. Notwithstanding the rapid turnover of digital technologies, dancers and choreographers are quick to explore new tools for making, capturing, documenting and rendering movement and projects emerge through encounters between dance makers and researchers from different domains, including designers and coders as well other discipline experts. Underpinning many of these enquiries is a desire to unearth more of the 'hidden' aspects of dance, such as the dynamic, relational and co-creative aspects of dance creation, acknowledging that dance is a heterogeneous art form incorporating many styles and techniques. As Vincs and Barbour observe, the 'semiotic variability of dance' means that there is 'no single "grammar" of the body [that] can be relied upon to carry the communicative valence of any particular dance movement or practice' (2014: 65).

As we have discussed, many digital dance projects invoke questions about the relationship between humans and machines. Stiegler (2007), for example, suggests that we have sacrificed some of our humanity to machines, and Popat and Salazar Sutil remark, ‘Digital movement – opens up a political contestation that sees two agencies meet from opposite directions: we control the machine, but the machine can control us back’ (2015: 7). The immediacy of the lived dancing body and the complexity of technologies could bring us closer to the machine or perhaps takes us further away. This relationship is a concern for performance artist and scholar Chris Salter (2009) who questions how the material body comes into being through bodily expressions in myriad technological environments describing how technology may be treated merely as a tool for humans (therefore seen only in terms of their utility) or is regarded as a threat to us and therefore to nature itself. Kozel also calls for a productive relationship without losing the ‘basic human qualities such as touch, trust, vulnerability, pain and embodiment . . . when people engage with each other through technologies’ (2007: 88). The discourse that is growing up within these conjoined disciplinary fields, which seeks to articulate the particular nature of the human/technology interface in digital performance and is curious about what new knowledge emerges through the practice, has developed alongside the making of digital dance works, including those we discuss here.

Our two case-studies explored different ways in which choreographers, performers, technology experts and researchers are drawing from practical and intellectual enquiries into the materiality and immateriality of the dancing body as a source for making new dance work and dance tools, and thereby contribute to a new poetics of digital dance. As an interactive digital software tool, or ‘virtual dancer’, *Becoming* grows and evolves in response to emulated mechanical constraints and to a database of film material (Leach and deLahunta 2015). By

contrast, WhoLoDance is building a ‘toolbox’ of digital applications that will inspire new blendings of motion captured movement and experiments with three-dimensional holographic projections to build an immersive real and virtual dance environment. When dancing bodies are extended into and constructed from data they generate new ontologies for dance and reveal features of the form. The discussions of *Becoming* and WhoLoDance highlight how the relationality between bodies is an integral feature of dance spectatorship, making and teaching, and how this corporeal synthesis might extend into digital contexts. The growing interest in the value of dance data to promote the application of embodied knowledge in other subject domains, together with the ongoing developments in mixed reality technology that is opening up new creative opportunities, indicates that digital dance will continue to be a rich site for dance makers, performers, researchers and audiences.

¹ *Becoming* is one of the outcomes of the Enhancing Choreographic Objects (EChO) project, funded by the UK’s Arts and Humanities Research Council and run by Leach and deLahunta.

² *Ghostcatching* (Jones 1999), *Biped* (Cunningham 1999), *Capturing Stillness* (Gibson Martelli 2010).

³ *Human Interface* (Freundlich 2012), *The Umbrella Project* (Pilobolus and MIT 2013)

⁴ *In Search of Abandoned* (Gibson Martelli 2013) and *Stuck in the Middle with You* (Bate and Sydney Dance Company 2016).

⁵ *Using the Sky* (Motion Bank 2013), *LifeForms* (Cunningham 1989)

⁶ Notably the work of Birringer and Danjoux, and *Dissolving Self* (Ghaderi 2013), and the work of Teoma Naccarato and John MacCullum.

⁷ *Double Skin/Double Mind* (Emio Greco | PC and Ziegler 2007)

⁸ Some of these Motion Capture kits include Xsens, OptiTrack and Perception Neuron.

⁹ For example, Ruth Gibson and Bruno Martelli (Gibson/Martelli, previously Igloo) have utilized motion capture technologies in numerous ways over many years, creating interactive immersive installations that combine dance and game engine technology (Whatley 2015). Recent works have also experimented with virtual environments for CAVE and for Oculus Rift headsets to explore large scale projected realtime 3D and mixed reality environments.

¹⁰ See Motion Bank website: <http://motionbank.org/> (accessed 16 October 2017).

¹¹ *Loops* (Cunningham, Downie, Eshkar, Kaiser 2001-11), *Material for the Spine* (Paxton and Contredanse 2008), *Improvisation Technologies: A Tool for the Analytical Dance Eye* (Forsythe and Kuchelmeister 2008), *A Choreographer's Score* (Cvejić and deKeersmaecker 2012-14), *Siobhan Davies RePlay* (Davies and Whatley 2009), *Digital Dance Archives* (Fensham and Whatley 2011), *Dance-Tech.Net* (Barrios Solano 2007), *Double Skin/Double Mind* (Emio Greco | PC and Ziegler 2007), *Synchronous Objects for One Flat Thing, reproduced* (Forsythe, Palazzi and Zuniga Shaw 2009), *Choreographic Language Agent* (McGregor, deLahunta, Rothwell and Downie 2011), *Whatever Dance Toolbox* (BadCo and Turing 2011), *Motion Bank* (Forsythe, deLahunta et al 2013).

¹² This term is borrowed from deLahunta (2017). See also Marchini (2015) for a related discussion.

¹³ See Blades (2014) for a discussion of audience responses to the installation during the exhibition at The Wellcome Collection.

¹⁴ WhoLoDance is a Research and Innovation Action funded under the European Union's Horizon 2020 Programme. The project's aim is to develop and apply breakthrough technologies for dance learning; this is aimed at practitioners, researchers, professionals, dance students and

the general public. The consortium includes technology experts, dance researchers, professional dance companies and dance teachers. See <http://www.wholodance.eu/> (accessed 16 October 2017).

¹⁵ The Hololens is manufactured by Microsoft. The lens produces a mixed reality experience in which people, places, and objects from the user's physical and virtual worlds combine in a blended environment.

¹⁶ Comments were made during an interview with Greek folk dance expert Amalia Markatzi.