Motion Capture and the Digital Dance Aesthetic: Using inertial sensor motion tracking for devising and producing contemporary dance performance.

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In July 2018 our interdisciplinary group of collaborators presented a live digital-dance performance 'Malta Calls' for Valletta 2018 European Capital of Culture, using the inertial sensor Rokoko Smartsuit Pro motion capture system in an embedded way throughout development and production. In doing this, we explored the impact of this real-time, camera-less and wireless motion capture technology on the way contemporary dance works could be devised and produced to enhance the expressive possibilities of digital dance. This article explains and explores the successes and limitations of this project, contextualised and informed by a philosophy of digital media that interrogates the potential of such technologies in their uses in both disciplinary and creative modes. While many have seen motion capture technology primarily as a functional and efficient tool for the documentation, cataloguing and archiving of generic dance movement, I suggest that through the use of motion capture data the movement of the body can be altered and extended into pure virtual qualities of movement. When digitally visualised on screens, or in immersive VR and AR, this digital expression of bodily motion has aesthetic significance for both choreographic creatives and for dance audiences. I suggest that the technology can be used to capture dance movement in a way that should suggest itself to aesthetic, phenomenological, affective, and even therapeutic realms of engagement and creative practice.

Keywords**:** inertial sensor motion capture, digital choreography, real-time generative performance.

Introduction

Since 2016 we have seen the emergence of a new generation of relatively accessible and affordable motion capture systems such as *Rokoko Smartsuit Pro, Perception Neuron, Holosuit* and *Xsens*.[1] Their arrival heralds a distinctive new realm of possibility in terms of accessible, flexible and yet accurate motion capture, and for the digital and virtual expression of bodily movement in real-time, generative and interactive modes. The relatively affordable systems function with no studio, no camera, and largely wirelessly, meaning they can be used in any indoor or outdoor location with only a local wifi network. This prompts the makers of the Rokoko suit to define their product as 'democratizing motion capture' with 'an entire motion capture studio in one markerless suit' (rokoko.com).

[FIGURE 1 HERE]

Figure 1: The Rokoko Smartsuit Pro in action (rokoko.com).

One of the interesting applications of this technology is in the documentation, archiving and databasing of a fixed library of motions in established genres of dance; for conservation and posterity, for learning and teaching, and for precise technical analysis. However, another approach to the complexity of dance movement can also be explored here; by using these motion-capture technologies to explore sensations and expressions of form, force and movement, that move beyond generic and familiar bodily motion, and towards generating altered and emergent kinaesthetic and proprioceptive perceptions. Here, dance motion can become simply a line, an arc, a shape, or an expression of elemental force or energy – first captured as data, and then visualised in various aesthetic, experimental and abstract modes.

This latter approach extends the uses of the technology into less figurative territories of creative expression, and goes even further than this into emotional, phenomenological, empathetic, transformative and potentially therapeutic realms of

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[1] Most of these motion capture systems come in at around €2000-€3000 with the exception of the higher costing *Xsens*.

engagement and practice. Rather than analysing dance movement as a discrete 'thing' to be captured and catalogued, we can instead imagine a set of virtualised phenomenal experiences of dancing with oneself (in real time), with a different body than our own (or an abstract body of colour and shape), and in virtual and changing spaces. Besides purely aesthetic applications (e.g. in dance performance) these experiences could have other practical functions, conditioning new ways of thinking about corporeal motion, and generating new possibilities for the creation and experience of dance movement.

The creative uses of the new motion capture technology place it in the middle of a hybrid and relatively new field where performance and new media come together – an area of practice in which there is widespread interest and a recent proliferation of collaborative projects (especially since 2010 and the release of the Microsoft Kinect motion sensing device). However, there is arguably a need for a solid theoretical and conceptual framing for these collaborations between the dance and tech worlds. They are practices which are often under-theorised in terms of meaningful insight from the humanities, and this lack of insight into philosophical, cultural or historical concepts can lead to work that is technologically gimmicky, superficial, and uncomfortably 'tagged-on' to existing practices. Dance-digital collaborative works also often prove difficult to produce because of incongruities in the underlying principles, methodologies and languages of each separate practice, and for many choreographers, motion capture still seems either not interesting or welcome as a tool for creating new work (Nesta, *Digital Culture Dance Factsheet*, 2019). As such, there is a need for a deeper understanding of dance digital performance and installation work as a 'new medium' for choreography, with key structuring concepts that appeal equally to dancer and digital artist, and with a functional vocabulary for inter-disciplinary communication and dialogue. Only then will artists be able to embrace and explore the creative possibilities of the new technologies, and the collaborative practices that go with them.

To this end, this article reflects on lessons learnt in the development of a specific digital dance performance 'Malta Calls', produced in collaboration with London-based digital visual artists Prickimage and Studio Aszyk, with ŻfinMalta Dance Ensemble and internationally recognised choreographer Mavin Khoo, and with students from UCL and

Goldsmiths' Computing and Design departments.[2] The performance took place in an outdoor location in Valletta, Malta for their European Capital of Culture 2018 programme, and was the subject of a Goldsmiths-based research project to explore collaborative and interdisciplinary creative processes through the use of the motion capture in conjunction with the games engine *Unity*.[3]

Real-time motion capture and augmented realities.

In discussing a new 'virtual' technology of the capture of dance motion, we can understand an essential shift from the very corporeal and material expressions of dance both on stage and in the mirror (for the practicing dancer in the studio), to *virtual* screen images as various reflections, refractions and abstractions of dance. Even if we become lost in the intense moment of spectatorial engagement with dance, it seems common sense that there is a decisive phenomenological distinction to be made between actual direct and immediate physical presence with another body in motion, and simply looking at that same motion represented on a screen, however embodied, immersive and interactive the spectators' relation to the image might seem. As Marc Boucher describes:

> '… If we consider that dance is a performing art, requiring embodied presence, virtual dance (in the technological sense of the word) does not qualify as dance… Virtual dance has no weight, no breath, no spontaneity.' (2011, Section 9)

I would suggest that contemporary motion capture however, in its fully generative and interactive capacities and alongside its potential application in VR and AR, has the potential to perhaps finally bridge this gap between embodied presence and virtual image by being able to place a fully articulated avatar of our own body in real-time immersive and interactive virtual environments. Of course, there is still no weight, no

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[2] For Rokoko's own case study based on this project, rokoko.com/en/explore/blog/shaun-of-prickimage (accessed 22nd Nov 2019)

[3] One of our student collaborators, Luyang Zhou, made this video of the production vimeo.com/349286503

breath perhaps, but perhaps there is something else of equal value to the dancer and audience alike. As researchers Kim Vincs and John McCormick state, dance as an exploratory, often abstract form (more than gaming or sport, for instance), is particular useful for pushing at the boundaries of possibility for action and agency in virtual spaces.

> 'Dance might provide a means of exploring ways of reinserting the complexity of whole-bodied agency – the nuance of physical sensation and action – within virtualized digital interfaces' (Vincs and McCormick, 2010, p. 360)

Over the last few 10 years we have seen digital forms of immersion and interaction blossom in mainstream media, not only in gaming environments, but also cinematically through digital 3D (since 2009 and the impact of the release of *Avatar* in 3D – and for dance in the Wim Wenders 2010 3D film *Pina; Dance, dance otherwise we are lost*), and in digital slow-motion using incredibly high-speed cameras (in, for instance David Michalek's piece *Slow* Dancing). These media technologies yield a set of affects of uncanny realism, which both challenge perception and also open-up realms of rich and textured immanent detail which can be intense and beautiful in a truly sublime sense.

Digital media forms, inclusive of the recent motion capture systems, fit within a wider paradigm shift in image production towards what film theorist Thomas Elsaesser calls 'operational images' – images which are not there to be simply gazed upon as a spectator, but rather demand to be touched and interacted with (Elsaesser, 2013). In new media theory, an operational image is a call to action, and its full meaning manifests or is only completely revealed in the interaction with a spectator/user (Hansen, 2006). However, as Elsaesser points out, the operational image in entertainment media such as gaming simulation, VR or AR, simply cannot be considered without some attention to its heritage and origin in both military and surveillance applications (a genealogy and legacy that is described in Lenoir and Caldwell's concept of the 'military entertainment complex' [2018]).

We can thus consider that motion capture technology arrives in the dance world, as with other 'operational' simulation technologies, with a dual potential; the first – a

tendency to fix and measure discrete forms of movement as a form of discipline (understood as both the *discipline* of dance, but also in the Foucauldian sense of a system of regulation of bodies), the second – to creatively extend and expand both actual and virtual interactions of body and space. While it may seem a stretch to say that the former tendency should be considered in any way similar to military surveillance, it does clearly fit into a conception of bio-political technologies, described by philosopher Eugene Thacker as modes of mapping, controlling and disciplining bodies.

> 'The increasing use of charts, stamps of the body upon which notes could be made, and filing systems of patient records produces a Foucaultian monitoring and regulation – except that what is regulated is the bodies of bio data (specified along sexual, racial, economic, psychological, and physiological lines – See Foucault 1973) as much as the physical bodies that data refers to.' (Thacker, 1998, p. 4)

For Thacker there is a genealogical thread of the scientific application of bodily coding, from early practices of anatomical drawing through modern technoculture and infomedicine's penetrative body scanning devices (X-ray, EEG, MRI etc.) that is pseudo-scientific but which is essentially discursive and cultural. He portrays the contemporary human body of science and medicine as rendered docile, fixed in code – a streamed, networked and hypertexted body:

> 'The relation between discourse-language and the body-materiality is one of docility, a "technology" of bodily production. Change the code, and you change (render docile) the body hardwired as that code.' (ibid, p. 6)

In this way, we can see that the capture and documentation of motion from the dancer's body could be seen as a technology of the docile body, with a pseudo-scientific focus on efficiency and perfectibility whilst exerting a form of biopolitical control. While these uses in dance are ostensibly in the service of learning, teaching and making, there can often be a sense in the language used that it amounts a fixing, dissecting and arranging of movements in a disciplinary or regulatory mode. A clear concern here is that this might render genres of dance as standardised practices, constructed of elemental components which can assembled and disassembled in technological and impersonal modes. This is problematic for dance conceived of as an art form, as

creative flow and emotional connection become side-lined, and dance knowledge and *know-how* become conceived of as purely technical.

It can, however, be said that a model of technical, efficient motion capture is not *necessarily* reductive, and addressing this concern, an interesting insight comes from Vincs and Barbour in their article 'Snapshots of complexity: using motion capture and principal component analysis to reconceptualise dance' (2014). Here, a methodology of statistical analysis of quantitative dance data yielded by new motion capture processes is designed to '*challenge* accepted culturo-physical 'grammars' of dance creation' - rather than to fix and regulate them. They first note, using seemingly technical language:

> 'Motion capture, by virtue of its ability to record movement trajectories in precise detail— down to the millimetre and in 3-D—offers dance artists the possibility of recording, mapping and analysing dance movement in unprecedented detail' (2014, p. 62).

However, Vincs and Barbour move to offer a critical theoretical position: that dance movement and expression is culturally contained, interpreted and moderated by discursive models in disciplinary modes. These discursive modes, or cultural narratives, actually obscure or at least make opaque, certain 'actualities' about dance technique. They describe how dance discourse tends to categorise and describe dance practices as relatively difficult or technical – for instance perceiving ballet to be the height of form and control, and with contemporary dance as relatively loose – but as their statistical analysis reveals, these givens 'may not be as thoroughly grounded in the materiality of the dancing body as we would like to think' (ibid: 75). Thus the new 'precision' technologies as deployed here thus do not extend modes of control, standardisation and regulation, but instead actually undermine received cultural and disciplinary knowledge.

> 'Statistical techniques such as principal component analysis (PCA), because they are 'blind' to the artistic and semantic value of different kinds of movement, offer the possibility of providing fresh perspectives on dance analysis that are not predetermined by historical and cultural discourses surrounding dance practice' (ibid, p. 63).

They go on to elaborate the theoretical critique behind the research:

'Drawing on a Deleuzian philosophical perspective, we suggest that the power of a technique like this lies not so much in the specific information gained about individual movements or dance performances, but in the ability to reveal hidden stories in the movement data that can provoke artistic, aesthetic and conceptual questions about what dance movement creation is and could be.' (ibid, p. 64)

This approach shows that though motion capture's use in this 'quantitative' mode seems to primarily focus on a narrow or reductive definition of technical specificity tending towards standardisation and repetition, it can actually reveal an immanence of bodily motion that overturns disciplinary and regulatory practices.

The 'infinitely malleable' body versus the 'highly technical' body

Following a similar trajectory, Wood et al. (2017) describe seem to describe an almost unexpected turn in their WhoLoDancE research project, when a seemingly dissective approach of documenting and isolating dance movement in five discrete genres gave birth to a much more phenomenological and creative use of the tech. The primary stated purpose of using motion capture tools in this project (here using a Vicon multi-camera optical motion capture system) was to create a 'repository of dance motions allowing for similarity searches among different compositions' (ibid, p. 504). Visualisations of the motion capture data as a 3D digital avatar were then shown to the performer using a Microsoft Hololens AR device, and were modified in varying modes ranging from the 'figurative' (as a recognisable human form) to the 'qualitative' (more abstract).

In their findings Wood et al. note that: 'the more figurative avatars encourage the dancer to critically examine her movement *accuracy* whilst the qualitative avatar encourages the dancer to engage more with her feeling state or mood' (ibid, p. 507). They thus essentially reiterate the dualism noted above; that the expression of bodies as data in a detailed precision mode tends to becomes a (self-) disciplinary technology whereby the dancer sought for accuracy and perfectibility, while more qualitative and abstract expressions of that same data extend and opened up the dancer to more creative and poetic modes of engagement and reflection. Wood et al. describe the dancers feeling an 'ontological shift in their sensory awareness, a kinaesthetically empathic

connection with the avatar and felt compelled to move with it and invited to participate in the dance' (ibid, p. 509). One participant in the WhoLoDancE project notes 'I'm a small shaped dancer, so seeing myself as a bulky avatar with big volume, was an interesting experience and triggered me to move in new ways'. Another states:

> 'Seeing myself dancing as a female avatar was an interesting and strange feeling. It was amazing! I like the fact that most of the avatars were gender neutral. I was mostly intrigued by some avatars where the human shape was distorted; I would like to play more with this aspect.' (2017, p. 510)

We can see a position emerging in which the uses of motion capture in a dance context is perhaps not so conflicted as it could first appear. While one strategy of capture seems to fix and reduce emotional, fluid and corporeally affective practices to discrete technical components, one can also see that by breaking down movement in this way new insights, new perspective and indeed new affects are revealed. By disassembling and disembodying the dancer's received knowledge of bodily expression – which is in a way already an abstraction – and then by being able to move around, into and through these forms though various 3D and interactive platforms, an immanence within generic motion may be revealed.

As Vincs and Barbour note, the open and abstracted, fluid and emotional body, and the highly technical, controlled and disciplined body, already combine in the work of dancer in unique ways before the technology even arrives to capture their labour.

> '… though the 'infinitely malleable' body and the 'highly technical' body might be thought of as conceptual opposites, they are not necessarily mutually exclusive in the embodied, material praxis of a dancer dancing. It would be feasible to argue that these two ideas of the body may co-exist in complex and dynamic interplays within most, if not all, choreographic practices, and within the artistic processes of most dancers. (2014, p. 63)

Seen in this way, dance easily merges with new 'virtualising' technologies as these marry with both the impulse of the dancer/choreographer to create and express symbolic forms and to evoke force, and also with the impulse of the spectator to perceive, mirror and mentally simulate the dancer's corporeal agency. The technology

permits an expression of the dancer's interior qualia in exterior and extensive space, albeit virtually.

> '…to embed the nuance of personal action, which in dance translates to the qualities of movement, within an externalizing technological system that also displays the brush strokes of trajectory – of actions that are not gestures as such, but gestural in their deliberate spatiality' (Vincs and McCormick 2010, p. 366)

Malta, July 2018

In the performance 'Malta Calls' I wanted to explore the use of motion capture within this qualitative, phenomenological mode and as creative tool in the choreographic process. I wished to experimentally use the technology as a means of engaging with the fluid and emotional body, so that we might be able to visually externalise the dancer's interiority into the space around them.

Using the Rokoko Smartsuit Pro and its own custom software, we worked with the choreographer and artistic director Mavin Khoo to improvise movement based on a loose narrative about the way that bodies and minds are increasingly digitised in both productive and destructive ways. The choreographic process evolved organically since we had no clear precedent for devising in this way, and thus the research design was always directed toward more fully discovering and embracing the potential of the mo-cap suit both technically and narratively.

[FIGURE 2 HERE]

Figure 2: Studio capture with Mavin Khoo in Valletta, Malta (image Prickimage).

[FIGURE 3 HERE]

Figure 3: Exterior capture session at Golden Bay, Malta (photo Niels Plotard for Zfin Malta).

In our first capture session we were in the dance studio in Malta, and Khoo improvised movement with the musical score, familiarising himself with the Rokoko suit (figure 2). This was filmed and documented with an iPhone camera, and we then watched the video playback alongside the motion capture visualisation on a laptop

screen. In the second capture, we decided to use the possibility of doing an outdoor capture to explore the idea that Khoo could improvise movement in response to the Maltese landscape. We did this at sunset at Golden Bay in the west of Malta, and though Khoo here had no direct visual feedback on his own performance, a small audience quickly gathered to observe (figure 3). The third capture session took place in a darkened studio in the UK, in Margate, with a large-scale screen projection of the capture visualisation given in real time (figure 4).

[FIGURE 4 HERE]

Figure 4: Studio Capture with a full size projected avatar of the dancer (photo author's own).

Khoo at this point was for the first time able to watch the image of his own dance movement in real-time whilst he improvised. At one moment, we almost accidentally realised that we could actually do a second capture whilst replaying a first. This essentially meant that Khoo could devise a duet with himself, in real-time, whilst watching himself as he did it.

All of this motion capture was of course for two clear purposes; the first as a choreographic process of devising movement towards choreographing a 45-minute piece for the ZfinMalta Dance Ensemble, the second to capture data for the visualisation of the dance movement (in games engine Unity) to be projected on the screen in the live performance. On the first purpose Khoo notes:

> 'Being made to creatively work differently is always a good thing. As a choreographer, one is always concerned about generating movement vocabulary first. For me, it has always been a more internal space that I have had to engage with to articulate my body organically. In this instance, I am reliant on observation. As a maker, there is a huge benefit in being able to negotiate aspects of the body in real-time as a kind of shadowing partner. It allows for a kind of objectivity to take hold in choices you make, particularly in relation to the body in time and space. 3D capture of my own movement impacted the creative process both through the instant playback of my movement, and potentially with motion capture in real landscapes influencing choreography and conceptualization (Khoo, 2019).

For the second purpose, multiple takes of the motion capture data were given to digital artist Studio Aszyk, who, working with students Hugh Kennedy (MA Gaming, Goldsmiths) and Luyang Zhou (MA Design for Performance and Interaction, UCL), generated digital avatars and particle effects to be projected during the performance. Finally, the images were stitched together in Premiere into a full 45-minute timeline for the final performance.

[FIGURE 5 HERE]

Figure 5: Particle effects generated in games engine Unity (image Studio Aszyk)

However, due to the scale of the performance space (on a 30m stage – figure 7) the dance ensemble could scarcely manage to rehearse with the full scale projection as it would finally appear. We had to design the visual elements in a modular fashion, with seven separate screens/modules. By doing this the choreographer and dancers could start to understand how images would move between screens, and how they might move with the images. At great extra cost an extra-large (16 metre) space then had to be hired for full cast rehearsals, along with three projectors and a show system to play out the graphic elements that we had (figure 6).

[FIGURE 6 HERE]

Figure 6: First rehearsal with the dancers together with the projected image (photo Matteo Carratoni for Zfin Malta)

A full dress-rehearsal and run through of the entire performance could only actually be achieved one day before the final performance due to the exterior stage space and lighting/projection still being built and rigged. This added a certain level of anxiety, with last minute technical adjustment being made, and the need to re-render images right up until the evening of performance.

[FIGURE 7 HERE]

Figure 7: The exterior stage space during rigging (photo author's own)

Reflecting on the final performance, our team of collaborators fully appreciated the scale and technical achievement of what we had delivered. Aesthetically, it was undeniably powerful, with strong metaphoric connections and synergistic resonances between the movement of the live dance performance and the virtualised projected images, tied together by a powerful musical score.

Of particular strength was a section which narratively portrayed the breakdown of both identity and bodily materiality in a digital ether. This was portrayed through dance sequences which played against different abstracted and fragmented expressions of bodily motion projected behind the dancers. Here, the wildly creative virtualisation of dance motion in kinetic and colourful abstract shapes and forms, combined with the force and energy of the live dancer's performance to create a potent dynamism in terms of both figure/space and affect/emotion. We noted a kind of flickering of attention between the dancer and the image, and yet this did not detract from the live dancer's performance – indeed it augmented and extended its aesthetic power.

[FIGURE 8 HERE]

Figure 8: Zfin Malta dancers with the projected image during performance (photo author's own)

Lesson learned

While the new generation of consumer accessible motion capture is still developing, it is clear that they will become taken up in the dance and performance industry more widely, as well as in gaming, sports science and biomechanics. Many excellent studies, projects and research have been conducted with either the older Xbox Kinect camera system and its noted problems with movement-tracking and occlusion, or instead with prohibitively expensive professional multi-camera studio set-ups (for instance Wood et al. 2017; Vincs & Barbour 2014; Vincs and McCormick 2010). Some of the potentials of more recently emerging motion-capture systems are therefore largely already understood in these other technological contexts, though many more will now be

experimenting with them, and engaging in the same trial and error process as we have.[4] However, there are some theoretical and even philosophical principles that do need to be further considered in the current deployment of these new practices. Digital dance researcher Sarah Rubidge was particularly prescient, back in 2002, in discussing some of the issues in working with this technology.

> 'Interactive digital media only begins to make a significant contribution to choreography as an art when its underlying principles are taken on board, and become central to the choreographing thinking which underpins any work using interactive media.' (Rubidge, 2002, p. 4)

The concern for the choreographer is exactly that the technological aspect with pull away from the poetic one, and overwhelm it even. Khoo reflected on this challenge to his 'emotive ownership' of the work:

> 'As a choreographer, I am usually drawn to the 'intuitive outcomes' of improvisation in the studio. My work in itself is usually heavily driven by a narrative thread and so, those intuitive outcomes are framed by task-based sessions linked to clear emotional strands. I was genuinely concerned that the presence of motion capture in my process would be problematic in generating a kind of emotive human ownership to the work. That it would be replaced by a technological imprint and that this would be deliver a sensationalist element to the work instead of a poetic one. I was excited when I started to discover the opposite' (Khoo, 2019)

Through our lengthy collaborative process, Khoo thus found that while working with the avatar was challenging, there was a positive creative outcome that allowed him to think narratively and poetically, and to shift his choreographic thinking into a new realm.

> 'It's an entirely new way of working for me and that has really been exciting, to use a kind of alternative avatar that constructs, deconstructs and constructs again within the

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[4] See for instance the work of choreographer Alexander Whitley

work. It has been creatively challenging in the most positive sense, pushing those buttons to think differently and to create different movement' (Khoo, 2019)

[FIGURE 9 HERE]

Figure 9: A rendering of the avatar for 'Malta Calls' (image Studio Aszyk)

Acknowledging that there will be an inevitable challenge to the choreographer and their art that results in the possible sense of loss of 'human ownership', Rubidge notes the enduring role of the author within the new environments of creation and makes certain recommendations that certainly ring true with our own project experience.

'[If] the choreographer allows performers to become familiar with the rules underlying the installation, to 'rehearse' with it, and devise their own choreographic response to the installation, they relinquish much more of their authorial control… However, I would argue that even then the originating artists remain inextricably implicated in the work. It is the authors' materials, their themes, their ideas, which provide the frame within which the interactions take place, and which subtly guide the responses of even the uninitiated interactors. This is the authored work.' (2002, p.12)

In a pragmatic sense this mode of creation equates with the performers and choreographer creating and rehearsing with the technology (and thus the technician and digital artist) at all stages, such that we see: 'the dancer gaining a sense of her three-dimensionality as a (virtual) body moving through and inhabiting (virtual) space' (Wood et al. 2017, p. 510). Instead of bringing in the technology only to capture, document and augment existing practices in a technical and *supplementary* mode, this should be a process of playing to the strengths of the technology in a revealing and expansive mode by which new perceptions are made, and new practices emerge. In a simple sense this is a playful and experimental mode of interactive creation in which the limits of the technology, and of both the dancer's technical practice and self-perception, are toyed with. Of course this take time, and strong collaborative relationships that develop through time. This is why the increased accessibility and affordability of the new inertial sensor motion capture systems is significant. Dance companies will need to

hone their technological sensibility through simple tools used regularly, and only then will these make a real contribution to the art.

References

Boucher, M. (2004) Kinetic Synaesthesia: Experiencing Dance in Multimedia Scenographies, *Contemporary Aesthetics*, 2. Retrieved from: https://contempaesthetics.org/newvolume/pages/article.php?articleID=235

Boucher, M. (2011) Virtual Dance and Motion-Capture. *Contemporary Aesthetics.* 9. Retrieved from http://hdl.handle.net/2027/spo.7523862.0009.011

Elsaesser, T (2013) The Return of 3-D: On Some of the Logics and Genealogies of the Image in the 21st Century, *Critical Inquiry,* 39: 217-246.

Hansen, M. (2006). *New Philosophy for New Media*, Cambridge MA: MIT Press.

Lenoir, T. & Caldwell, L. (2018), *The Military-entertainment Complex* (London: Harvard University Press)

Nesta & Arts Council England, (2020) 'Dance Factsheet, *Digital Culture 2019.* Retrieved from: https://www.nesta.org.uk/report/digital-culture-2019/

Rubidge, S, (2002) Digital Technology in Choreography: Issues and Implications, Given at the 17th Annual Symposium of the Dance Society of Korea, Seoul, Korea, November 6th 2002. Retrieved from https://www.sensedigital.co.uk/writing/DigChorIss02.pdf

Strutt, D (2019) *The Digital Image and Reality: Affect, Metaphysics, Post-Cinema,* (Amsterdam, Amsterdam University Press)

Thacker, E. (1998) .../visible_human.html/digital anatomy and the hypertexted body', on *CTheory.* Retrieved from: http://ctheory.net/ctheory_wp/visible_human-htmldigital-anatomy-and-the-hyper-texted-body

Vincs, K. & Barbour, K. (2014) Snapshots of Complexity: using motion capture and principal component analysis to reconceptualise dance, *Digital Creativity*, 25:1, 62-78, https://doi.org/10.1080/14626268.2013.786732

Vincs, K. & McCormick, J. (2010) Touching Space: Using Motion Capture and Stereo Projection to Create a 'Virtual Haptics' of Dance, *Leonardo,* 43:4, 359-366.

Wood, K; Cisneros, R.E. & Whatley, S., (2017) Motion Capturing Emotions, *Open Cultural Studies* 2017:1, 504–513. https://doi.org/10.1515/culture-2017-0047