Laura Karreman The Motion Capture Imaginary > Digital Renderings of Dance Knowledge

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Opening new horizons

GHENT UNIVERSITY

This dissertation is submitted to Ghent University in partial fulfilment of the requirements for the degree of Doctor of Art Studies

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Artists Gibson/Martelli re-imagine 'dazzle' camouflage as tribal markings for invisible performers, activated by a special App. The (free) MAN A Virtual Reality App for Apple & Android devices can be downloaded via http://gibsonmartelli.com/MANA/. How to use the app: Point your device at the patterns to reveal the movements of the hidden characters.

This research project was funded by Ghent University & Research Foundation — Flanders (FWO)

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The Motion Capture Imaginary

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Faculty of Arts and Philosophy
Ghent University

2017

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FACULTY OF ARTS AND PHILOSOPHY

To my parents,

Adelheid and Wim Karreman,

for showing me what love and curiosity can look like.

Contents

Acknowledgments

I feel very fortunate to have been inspired, supported and cheered on by so many great people during this PhD project. I sincerely hope that this is just the beginning, and that the people I mention here will continue to be part of the journey onwards.

First of all I want to express my gratitude to the Research Foundation — Flanders (FWO) for funding the four-year research project from which this dissertation evolved. The support of FWO made it possible for me to work on this project with great devotion and allowed me to seize many opportunities along the way to discuss and share my research in progress at international conferences.

I have been blessed to have Christel Stalpaert as my main advisor. As my research project progressed, more and more researchers joined our vibrant research center S:PAM (Studies of Performing Arts and Media). This did not affect the generous amount of time and attention Christel invested in our meetings. It was a great pleasure to have Christel as both a research partner and an expert witness of my process. Christel skillfully combines insight, strategy and intuition, which enabled her to point out missing pieces of the puzzle to me at crucial moments. After our dialogues I always left her office revived and eager to continue.

I want to thank my co-advisor Marc Leman for his advice and support for this project, which was the first collaborative research project of Theatre Studies and Musicology at Ghent University. I found the IPEM - Institute for Psychoacoustics and Electronic Music to be an inspiring experimental playground for research into embodied music cognition. The possibility to invite dancers into IPEM's motion capture lab was vital for acquiring a better sense of what occurs in such a setting.

I am grateful to my co-advisor Katharina Pewny, who provided me with inspiring advice in the course of this project. Her feedback and critical comments on drafts of this dissertation were a great help.

I want to thank my long-time mentor Maaike Bleeker, who was also a member of my advising committee. It is now more than twelve years ago that Maaike opened my eyes to new ways of seeing in the MA seminar *Vision and Visuality in the Theatre,* which she taught just after having defended her PhD on this topic. This thesis is a tangible proof of the profound impact that her research and teaching have had on my work. Since that initial encounter, we have always managed to find ways of working together — with a little bit of luck. I cherish the thought that the most exciting chapters of our collaboration may still be ahead of us.

A great support in the trial-and-error stage of this project was Michiel Demey, a physicist who worked as a postdoctoral researcher at IPEM. Michiel showed me how to operate software and hardware in the motion capture lab and was always generous with his time and advice. The help of IPEM technician Ivan Schepers was also invaluable, especially in the preparation and the support of the performance *Emergence* by John McCormick and Steph Hutchison, which combined motion capture-based imagery and stereoscopic projection and was presented at the *Does it Matter?* conference.

The financial support of the Andrew W. Mellon Foundation made it possible for me to make two research trips to the United States to participate in two Mellon Dance Studies Summer Seminars, which took place at Stanford University (2014) and Brown University (2016). The Mellon seminars were the site of a deeply inspirational exchange with emerging and senior scholars in the field of dance studies. I want to thank all my fellow participants at the Mellon gatherings, as well as the fabulous staff that hosted these sessions: Susan Manning, Janice Ross, Rebecca Schneider, Susan Foster, Tommy DeFrantz, Sherrill Dodds and Carrie Noland. Although my research interests have never been limited to dance studies alone, these gatherings have inspired much enthusiasm for the issues that are alive in this field and the researchers who engage with them. I look forward to continuing our collaboration on new scenarios for the futures of dance studies.

Throughout my work on this project I have benefitted greatly from being a close witness to the collaborative research project *Inside Movement Knowledge* (2008-2010). Although this thesis is not an official result from this research project, the impact it has had on my thoughts on this topic is significant. *Inside Movement Knowledge* involved a great and diverse group of researchers and I would like to thank all of them. A special thanks to Bertha Bermudez, Scott deLahunta and Chris Ziegler.

I would like to thank Anne van Aerschot of the Rosas dance company and Steven de Belder of P.A.R.T.S. for their support. I am grateful to the Rosas dancers whom I interviewed: Linda Blomqvist, Fumiyo Ikeda, Cynthia Loemij, Elizaveta Penkova, Samantha van Wissen, Sue-Yeon Youn. I want to thank three other experts on the work of Rosas for sharing their thoughts: Renate Bräuninger, Bojana Cvejić and Rudi Laermans.

The journal articles I worked on during my research project helped me to develop and articulate my ideas. I want to thank the editors of these journals for their challenging feedback and valuable comments: Eirini Kartsaki, Theron Schmidt, Sarah Whatley, Kim Vincs, Scott deLahunta, Jerome Fletcher and Ric Allsopp.

I was lucky to encounter the wonderful people at the Centre of Dance Research (C-DARE) at Coventry University at an early stage of my project. This is also where I met Ruth Gibson and Bruno Martelli, whose work I write about in this thesis and is also featured on the cover. I almost felt adopted by the research community at C-DARE. What was most important in my interaction with C-DARE was the Coventry Reading Group, in which I participated over Skype. For more than two years, David Bennett, Hetty Blades and I functioned as the three core members of this group. At times we were joined by other sharp-witted researchers: Emma Meehan, Paula Kramer and Rebecca Stancliffe. Our conversations always were a healthily balanced mix of thinking out loud and laughing out loud. David and Hetty, thanks so much for your intelligent remarks, your support and your friendship. And a big thanks to Sarah Whatley, the inspiring leading thinker at C-DARE.

Many thanks to the organizers of inspiring conferences, including Néill O'Dwyer, Elisabeth van Dam, Nicolás Salazar Sutil, Diane Elshout, Adam Alston. I would like to thank Iñaki Azpillaga, Anouk Llaurens and others that made my involvement in the Teaching The Teachers initiative and the IDOCDE symposium in Vienna so memorable.

On the first day I entered my office at Ghent University, my colleagues jumped up from their seats to take me out for a coffee and on a tour of the university. In those early days, a warm welcome was also provided by Mario Floryn, the librarian of the performing arts section of the Ghent University library. In the past years the S:PAM research center has continued to grow and shape-shift, with PhD and postdoc researchers coming and going, from Belgium and across the globe — every single one of them endowed with a bright mind and a kind heart: Jeroen Coppens, Evelyn Jonckheere, David Depestel, Sofie Verdoodt, Charlotte Gruber, Kristof van Baarle, Pieter Vermeulen, Aneta Stojnic, Goran Petrovic, Frederik Le Roy, Jelena Juresa, Adriana la Selva, Ana Cuzovic, Marina Albertyn, Gerko Egert, Hasan Işikli,

Annelies van Assche, Tan Tan, Antonio Gazquez, Sofie de Smet, Marieke Breyne, Leonie Persyn and Jasper Delbecke. I am grateful to all of you.

I am indebted to Marieke Krijnen (a.k.a. Marieke Kraak) for organizing the *Shut-up-and-write* meetings for Ghent-based PhD students and other writers of different feathers in Le Jardin Bohémien on Thursday mornings. Had she not done so, I would have never met spirited and smart people such as linguist Esther Le Mair, to whom I am very grateful for proofreading this dissertation. Marieke and I found noble procastinatory relief during the end stage of our projects by engaging in some feminist activism, which — I am happy to report — generated interesting results.

In the past three years I have been fortunate to be a student of Mareike Tross and Karel Hajek, who are the driving force of a small, but vibrant international yoga community in Ghent. Apart from keeping my stubborn, laptop-bent spine flexible and healthy, and making me laugh at the end of tough days, their profound lessons on the relationship between breath and movement influenced my thoughts and ideas on this topic, and eventually found their way into this thesis.

In Amsterdam and Utrecht there were regular gatherings of a group of PhD researchers in theatre and dance studies in the Netherlands. These peer-feedback sessions provided many valuable insights on work in progress. A warm thanks to all contributors to these sessions including Jeroen Fabius, João da Silva, Ruben De Roo, Jordi Ribot, Lisa Skwirblies and Evelyn Wan.

It is a great pleasure to have joined the Department of Media and Culture Studies at Utrecht University this year. I want to express my thanks for the support and understanding of my new colleagues in the past months during which finalizing my thesis and starting a new job overlapped. A special, heartfelt thanks to the following people who created the conditions for me to make it to the finish line in one piece: Liesbeth Groot Nibbelink, Sigrid Merx, Konstantina Georgelou and Isis Germano.

Throughout my PhD project, there have been two close friends that kept cheering me on from the West Coast, all the way from the city by the bay. Thank you Christine Germain, for combining dancing, healing and travelling in ways that never cease to amaze me. Thank you Scott Simmons, for your wisdom, your music, and for teaching me some important lessons on creative awareness. Thanks also to my wonderful friends in the Netherlands that somehow remained my friends even though I missed many of their birthday parties during the past four years: Judith Fraune, Anne Wouterlood, Tesse van Camerijk, Lennie van Schep-

pingen and Rachel Kloek. Maaike Bergstra deserves a special mention here for our wonderful monthly Ghent-Amsterdam Skype conversations that typically went on for hours.

Intellectual mountains can be tricky to climb. In the past years I have found lots of joy and relaxation by climbing actual mountains together with Stuart Idell and Elly Baltus. Our jumping into the occasional freezing-cold mountain lake helped me to get some perspective and clear up my head.

The opportunity to work on a research project for four years has also allowed me to reflect on the conditions I need to be able to research and study, to think and write. Rather than being glued to one and the same desk, it turned out that these conditions were quite nomadic. To overcome intellectual obstacles, it often helped to physically move to another location. Moving between Ghent and Amsterdam formed an essential part of this dynamic. Additional writing retreats have brought me to an eclectic list of locations over the past years. Significant parts of this thesis were written in Ghent, Amsterdam, Montefollonico, Incisa, Almen, Haarlem, Cadzand, Bergen, St Erme Outre et Ramecourt (PAF), La Herradura, Boston and Swampscott. I want to thank my hosts at these locations.

For many, many hours of writing, on several of the above-mentioned locations, I teamed up with fellow PhD researcher Marijn de Langen, who became a very close friend in the process. The presence of Marijn in my 'writing bubble' was the best company I could have ever wished for in the final stage of the project. Together, we developed a solid method of co-working and peer feedback that worked wonders. Marijn's coaching couples wisdom with humor, her endurance is an example, her singing a delight. We made a habit of quoting Etienne Decroux: 'One doesn't notice the sky changing, one notices the sky has changed.' Inevitably, we also created our own set of proverbs along the way: 'Sometimes you gotta drop the pizza… and run.' Wake me up in the middle of the night, Marijn, and I will follow you to Montefollonico — and beyond.

I want to thank my family for their love and support: my parents Wim and Adelheid, my brother Wouter and his partner Tracy, my sister Matthia and her partner Victor, and last but not least the small Vincent and Emma for bringing so much joy to all of us. I also want to thank Karim's family, both the Huisinghs and the Benammari, for their warm support.

There are exactly 222 kilometers between Amsterdam and Ghent. It is not a huge distance. But sometimes it seemed very far, especially when it meant missing my partner Karim Benammar. 'I happened to notice your absence,' we would joke on the phone, to avoid the sentiment of the phrase 'I miss you.' Despite the distance, Karim made sure I felt his unflinch-

ing, loving support every step of the way. As my not-so-secret shadow co-advisor, Dr. Benammar proofread the early drafts of my whole thesis, even when — *especially* when — I objected that they were not ready yet. He made me say 'I'm right on track' at moments when I was about to lose faith. It is such an immense joy to share ideas and to travel together.

More adventure awaits.

Introduction

0.1 The space of the page

In *Thumbelina: The Culture and Technology of Millennials* (2014), French philosopher Michel Serres recalls his surprise when two towers were built on the campus of Stanford University. These new buildings were financed by billionaires from nearby Silicon Valley and were meant to accommodate the Department of Computer Science. Serres was struck by the similarity between the towers and the surrounding buildings at Stanford's Main Quad. The new structures were almost identical to the old brick buildings, which by then had accommodated a century of teaching in mechanical engineering and medieval history. The architecture of these buildings — their cubical rooms and windowless hallways — continued to be designed based on the age-old format of the *page.* The page is a rectangular format that can be recognized in billboards, road signs, campus libraries, powerpoint lectures, and city plans. It can be traced back to the *pagus* of our ancestors: a small swath of farmland, neatly demarcated by furrows. Serres argues that in the Western world, the page still constitutes *the* spatial unit in perception and action, thinking and planning. The page is as dominant a format as the hexagon is for honeybees. However, Serres expects that the digital age will inevitably challenge this format, and eventually leave it behind. His bewilderment about Stanford University's new computer science buildings, then, can be explained by his conviction that the digital age should have a radical impact on our ideas on what constitutes knowledge, on how it is shared, and on how we design environments for learning. All of these, after all, were originally designed by the book and for the book. Whereas the professor's stand in the lecture hall used to be the source of knowledge and the center of gravity — the literal *power point* of the university's force field —, today the processes of sharing knowledge increasingly resist such a defined center. Instead, these processes are now starting to take up space in a myriad of ways that were difficult to imagine not so very long ago. And yet, the old lecture halls are not only still there, they continue to be built anew.

Serres' book demonstrates that even if emerging technologies allow for different ways of knowing and engaging with the environment, people's understanding and application of these technologies is necessarily structured by ways of thinking that are decades or even centuries old. The environments in which people live, work, play and think are necessarily filled, quite physically so, with these enduring ideas. They manifest themselves in old and new technologies alike, creating a heterogeneous landscape in which 'innovation' never takes on the absolute meaning that the term suggests: to make changes in something established. Serres aptly code-names the millenials, who were born in the digital age, Thumbelina ('petite poucette') and Tom Thumb because of the ease with which they access the world through smartphones. Marc Prensky first called them Digital Natives (2001). However, even these younger generations still continue to acquire the habit of focusing their gaze on the professor's lectern.

Technological innovation happens as a result of complex processes rather than a singular event. When it comes to contemporary developments in this area, these processes tend to be significantly shaped by a limited amount of hotspots that combine the highest levels of expertise with adequate funding, such as Silicon Valley, as well as technical universities such as Massachusetts Institute of Technology in Boston and Delft University of Technology. As science fiction writer William Gibson has remarked: 'The future is already here. It's just not very evenly distributed' (in Hui Kyong Chun 2011, 9). Even though these centers of technology play a key role in enabling and structuring the new affordances of emerging technologies, the widespread impact of technologies only becomes truly apparent through cultural practices that engage with these technologies in different ways and with different purposes.

0.2 Knowing dance through motion capture

In this dissertation I focus on a very specific example of such practices: the use of motion capture technologies to create digital renderings of dance knowledge. Optical motion capture technology is used to track the three-dimensional trajectories of moving bodies in submillimeter detail. A motion capture setting usually consists of a suspended grid to which multiple infrared cameras are attached. The infrared light is reflected by a set of optical markers, which are lightweight, marble sized and have a reflective surface. These markers are attached — with velcro, tape or glue — to designated spots on a tight-fitting motion capture suit, or directly onto the skin. The size of the camera grid and the amount of cameras that is used co-

determines the size of the 'motion capture volume', which is the space in which the performer in the motion capture setting can move without compromising the data stream. In the film and game industry, optical motion capture is principally used to animate characters in a virtual realm. In the dance field, the application of this technology stands out by the variety of purposes for which it is currently employed, including artistic and creative applications, dance notational purposes, motion-based recognition of dance qualities, archival aims and pedagogical purposes.

Although some features of these practices have been partially explored in relation to performance capture in film, they have not yet been subjected to a systematic, critical evaluation from the perspective of dance studies. As a first step in this direction, this study explores a set of key concepts and lines of inquiry in order to evaluate contemporary practices of digital dance capture. What are the implications of such practices? How do they introduce new ways of seeing and understanding dance? I undertake a discourse analysis of such practices by taking examples from research areas such as dance practice, dance studies, performance studies, philosophy, film studies and computer science. This allows me to observe that ideas of how the mind works and about how the body is experienced shape the way in which media are employed in meaning-making practices. More specifically, I discuss ways in which emerging applications of digital motion capture technologies are used for the transmission of dance knowledge in order to support creative and analytic processes. I approach dance as a phenomenon that we can know in two important ways: as *choreography* and as *performance.* The conjoined questions I address in this thesis are: How is dance conceived of as a type of knowledge that can be transmitted? And: How does motion capture invite us to know dance differently? The answers to these questions vary depending on the perspective from which they are approached in the field of knowledge, including the perspectives of dance and performance scholars, coders, choreographers and dancers. I introduce the notion of 'the motion capture imaginary' as a conceptual framework. This framework interconnects the various characteristics associated with ways of seeing and knowing dance through motion capture. These characteristics are presented and discussed throughout this thesis.

0.3 How technology transforms performance

A prominent feature of today's performance practice and research is the search for ways in which to communicate knowledge about dance in digitally enabled formats. Such inquiries test a wide range of technologies, such as motion capture, gyroscopes, accelerometers, GPS,

Kinect and physiological sensors, for their ability to compute performance features. Together with the emergence of these technologies, experiments with corporeal computation have become a topic of inquiry for artistic praxis in 'digital performance' (Dixon and Smith 2007). As Chris Salter puts it in the subtitle of his comprehensive study *Entangled* (2010), the dance field has proven to be a primary locus for inquiries into the question of how 'technology transforms performance.'

Ideas about the role that computers could potentially play in dance practice and research emerged for instance at Bell Labs in New Jersey in the 1960s, a case I describe in Chapter 2. For the first time, it was argued that if a way was found to transfer dance movements to digital data, this data could subsequently be manipulated and visualized in many different ways, offering new opportunities for the analysis, creation and transmission of dance. Merce Cunningham, undoubtedly one of the most important dance pioneers in this area, set an agenda for the field at that time : 'It seems clear that electronic technology has given us a new way to look. Dances can be made on computers, pictures can be punched out on them, why not a notation for dance that is immediately visual?' (Cunningham 1968, n.p.). During his lifetime, Cunningham contributed greatly to the endeavor he had articulated by seeking ways in which the 'visual notation' he proposed could materialize. On a different level, the aesthetics of his work can also be regarded as a prime example of a dance form that follows the logic of computer innovations, for example by mapping a pre-determined movement vocabulary on dancers through chance procedures.

Cunningham's endeavor took another leap when motion capture technologies became more sophisticated and affordable at the beginning of the 1990s. Cunningham collaborated with the pioneering digital art collective OpenEndedGroup to create the performance *BIPED* (1999), in which motion capture data of dancers were beautifully rendered in large, colorful renderings, which resembled charcoal drawings come to life. The juxtaposition with the dancers on stage created a magical effect. This was just one example of the rich variety of experiments that characterized the creative outburst in the field of dance and digital technology in the 1990s. The rich variety of experiments in this area had creative, analytical and documental aims. Choreographer William Forsythe's *Improvisation Technologies: A Tool for the Analytical Dance Eye* (CD-ROM 1999) combined all of these aims. It stood out because of its sophisticated design: it featured graphic layers superimposed on dance videos. By showing how elegantly dance knowledge could be conveyed by means of a digitally-enabled tool, *Improvisation Technologies* set the tone for the years to come.

However, long before the digital revolution, experiments with photography and film had already paved the way for a visual paradigm of capturing movement. Recent revaluations of the work of pioneers such as Eadweard Muybridge and Etienne-Jules Marey (Solnit 2003; Manning 2009; Salazar Sutil 2015) point in this direction. Despite the scholarly attention for these pioneers, which is continuing in step with the growing affordability and sophistication of digital capturing technologies, few studies exist that engage with the implications of the paradigm of these 'old' media for motion capture practices. Nicolás Salazar Sutil identifies this knowledge gap when he writes that: 'a major critical and theoretical body of work has yet to emerge that responds critically to the interactions between notation, animation, and motion capture, and (…) no such body of work has yet revealed an understanding of the almost inevitable transmedia relations beween these technologies' (Salazar Sutil 2015, 5). Brian Rotman has also addressed this lack, stating that: '[Motion capture] constitutes a gesturo-haptic medium of vast, unrealized, and as yet untheorized or critically narrativized potential' (Rotman 2008: 47). The current study presents a novel contribution to this larger endeavor.

0.4 A media taxonomy

My methodological approach is inspired by the notion of *media taxonomy*, as it is defined by W.J.T. Mitchell in *What do Pictures Want?* (2005, 261). Mitchell uses this term to describe a method that pays attention to the entanglement of the different senses that media address and the complexity of possible meanings media convey. This method does not classify media based on incontestable features inherent in these media, but instead on a closer examination of the practices in which media are used. Mitchell does not expand on his use of the term 'taxonomy', but it is worth doing so, since it is a rather specific term. Taxonomy is not a term that is traditionally part of the vocabulary of media studies. The term taxonomy is chiefly used in biology to indicate the branch of science concerned with classification, especially that of organisms. In a more general sense, taxonomy means 'a scheme of classification'. The 'tax' in taxonomy stems from the Latin verb 'taxare', which means 'to estimate; to tax; to establish the value of something' (Pinkster 1998, 1064). The combination of the two terms 'media taxonomy' is attractive, because 'taxonomy' invites us to consider media as *organic* phenomena — phenomena that have a certain *aliveness* to them. Such a view contrasts with the essentialist, historical notion of medium specificity, which tends to be rooted in a view of media that emphasizes their basis in technological hardware. An organic view of media does not

focus on media's inanimate properties, but rather draws attention to their ability to appeal to our senses through *animation*, through the re-creation of life-like movement. The advantage of such a view is that it stresses that media do not exist in a technological realm separate from social and cultural practices, but that they are in fact deeply entangled in these practices, and grow and develop in tandem with them. Although this thesis does not aim to provide conclusive statements on the subject, it does deliver the first building blocks of a media taxonomy of motion capture in relation to dance practice.

0.5 Prototypes for sharing dance knowledge

William Forsythe has played a leading role in giving impetus to a re-examination of dance as a practice that involves thinking as well as the creation and transmission of knowledge. He has initiated projects such as the CD-ROM *Improvisation Technologies* (CD-ROM, 2000), the website *Synchronous Objects* (2009), and the research project Motion Bank (2013), the last one resulting in several digital scores, presented online. These initiatives have spurred on a range of activities, projects and publications with similar objectives. Forsythe's projects have been described as 'intended to serve as a prototype for shareable principles of visualizing information and facilitating understanding of time-based arts' (Forsythe and deLahunta 2011, 10). With these projects, Forsythe has inspired others in the dance field, such as Belgian choreographer Anne Teresa De Keersmaeker, to share their knowledge. De Keersmaeker created the multimodal publication series *A Choreographer's Score* on the work of the Rosas dance company, which I discuss in Chapter 1.

Forsythe has termed the results of the above-mentioned projects 'choreographic objects', describing a choreographic object as an 'an alternative site for the understanding' of choreographic principles (2011, 92). His research in this area was instigated by the question: 'What else, besides the body, could physical thinking look like?' (Forsythe 2011, 91). Choreographic objects transpose choreographic ideas into a different 'mode' that allows for a closer examination of choreographic ideas because of their abstraction from the ephemeral, bodily based event that the dance performance constitutes. The explicit aim of choreographic objects is to address audiences in other disciplines than dance, without a preconceived idea of the type of response that may result from this. Social anthropologist James Leach suggests that

> these choreographic objects are prototype exchange objects, prototypes that are experimenting with and looking for feedback on the form of relationships they bring into being, their effects on future practice, and perhaps most of all, on the visibility and presence of contemporary dance in other spheres (disciplines, sectors and audiences). (Leach 2013, 13)

Leach identifies the way in which these choreographic objects 'look for feedback' in 'other spheres' as their defining characteristic. He therefore defines these digital creations as 'prototype socio-technical essays', proposing that they are 'prototypes of new relational forms: experiments in building new groups, new constituencies and new audiences' (2013, 3).

The work of Forsythe exemplifies how abilities and opportunities of digitization to mediate dance knowledge are being explored through iterative design processes, processes in which continuous adjustments are made through successive trials in order to reach an adequate result. Here, choreographic principles are transposed into formats that allow for a sustained reading and study of dance. The emergence of prototypes for sharing dance knowledge in the wider realm of the contemporary performing arts is also increasingly motivated by a political concern. This concern is constituted by the urge to relate to audiences through alternative channels and modes of representation. The underlying motivation here is to extend the legitimization of an artistic practice beyond the fleeting encounter in a theater setting.

At the heart of the strategy of these 'choreographic objects' (Forsythe 2011) or 'prototype socio-technical essays' (Leach 2013), is a re-examination of core ideas about the live transmission of dance in the studio and of the key principles that are connected to a specific choreographer or dance performance. The shift towards bringing choreographic ideas beyond the studio walls through the development of digital applications and environments has triggered many questions. One of these questions relates to the complex process of designing access to dance knowledge in digital formats: How to make motion data speak?

0.6 The emergence of 'dance knowledge'

Digital capturing technologies have often been employed in the creation of prototypes for sharing dance knowledge because of the specific opportunities they offer. The mapping of dance movements onto motion data not both offers the possibility of dance recordings that can be navigated three-dimensionally, and also opens the door to endless possibilities of visualizations, manipulations and calculations based on this motion data — including the abili-

ty to map the data onto other 'bodies', both real and virtual. However, despite the many opportunities they offer, these technologies are also perceived to produce specific constraints when it comes to the representation of the dancing body. In a nutshell, motion capture cannot but fixate an image of the dancing body, and thus radically reduces the complexity of its phenomenological wholeness.

There is a heated debate on whether or not it makes sense to use motion capture to 'capture dance'. In this debate, supporters of motion capture praise the new analytic and artistic opportunities motion capture opens up. Opponents maintain that the transposition of the dancing body into digital data is a quantification of dance, obliterating the depth and complexity of the embodied reality of the dancer. This debate serves as a pointer for a more fundamental question, which addresses the reasons for bringing dance into the motion capture volume in the first place. Why is motion capture taken on as a legitimate tool to achieve analytical and creative aims?

Despite the critique on the 'quantification of dance' that occurs in motion capture, movement data lying at the basis of highly complex calculations may well generate new insights into the dancing body (Vincs 2013) or expand habits of seeing and knowing. Motion capture is predominantly used for phenomenological re-creations. However, this may be setting these media up for an unfavorable comparison with the power of expression of live performance or video. Such comparisons encourage resistance and skepticism towards the use of motion capture, because of its inevitable reduction of the complexity and phenomenological 'indivisible wholeness' of a dance performance.[1]

This brings up the question of what the 'dance knowledge' that is mediated through these representations consists of. I argue that an inquiry into the recent emergence of notions of 'dance knowledge' is vital for understanding the encounter between dance and motion capture technology. What habits of seeing and knowing are embedded in contemporary practices of movement capture? What are the consequences of relying on these technologies to produce new bodies of dance knowledge? What dance features are highlighted and what features escape our notice as a result of these mediations? I observe that motion capture technologies and other 'gesturo-haptic media' (Rotman 2008) open up new avenues of thought and vision with regard to dance and the dancing body, because gesturo-haptic media take the performer's body as their main point of reference. This also means that the prac-

[1] In *The Phenomenology of Dance* (1979) Maxine Sheets-Johnstone uses the term 'indivisible wholeness' to describe the complex experience of a dancing body.

tices in which these technologies are used are characterized by ongoing efforts to articulate less-explored dimensions of the embodied knowledge of the dancer. This is a central area of tension that is outlined in this thesis.

The application of digital technologies such as motion capture to support transmission practices in the dance field should be considered as an experimental phenomenon. These applications are currently not an established part of transmission practices in dance companies. However, this does not mean that the digital age does not have a considerable impact on the dance field. This impact manifests itself in different ways. Marc Downie (2004) introduced the term 'computational sensibility' to describe the 'algorithmic concern' that can be observed in various dance forms during the past 50 years and 'the common ground between recent choreographic practice and computer graphics' (Downie 2004, 5). In accordance with Downie's observation, I argue that this computational sensibility also has had a concrete impact on current ways of seeing and thinking about practices of transmission in the dance field. A related view on how dance may reflect societal change is articulated by Gabriele Klein:

> More than any other medium, [dance] was always also the physical expression of a society's experience of an era: you might say the body 'knew what it was doing' when it acted out the exhilarating experience of speed and transcending distance made possible by the construction of railways in the 19th century in the walz (…) when ravers dancing to techno in the 1990s attempted to transcend their physical limit, or when break-dancers played previously unthinkable games with their bodies' axes and centres of gravity, in a physical expression of the fragmented and flexible nature of the citizens of post-industrial society. (Klein 2007, 27)

Klein's observations draw attention to the incorporation of technological and cultural developments in dance's corporealities. This suggests that the event of the dancer's entrance into the motion capture volume can never fully allow for capturing the dance *as it is,* but also always alters *what it looks like* — in and beyond the motion capture volume. In accordance with this line of thought, I observe that a computational sensibility is indeed reflected in the aesthetics of contemporary dance practices.

0.7 The imaginary

The main title of this thesis - *The Motion Capture Imaginary* - features a specific use of the word 'imaginary'. Whereas 'imaginary' is commonly used as an adjective, here it is used as a noun. In recent studies in the area of cultural analysis the term 'the imaginary' is often used without further explanation of its origins. Since the term is significant for my research, here, I briefly trace a selection of its origins.

In the 20th century, this use of 'the imaginary' occurs as a concept in the toolbox of various prominent French thinkers. In the work of Jacques Lacan, the imaginary (*L'imaginaire*) denotes one of the three orders he distinguishes in his psychoanalytic theory, the other two of this triptych being the symbolic and the real. Lacan relates the category of the Imaginary to the mirror stage in the development of the child - *le stade du miroir* - , in which the child learns to identify with the image that it perceives outside of itself, in the reflection of the mirror, which is a crucial step in the formation of its ego. Lacan argues that this need for identification with an external image is prompted by an experience of the body as *fragmented*, the experience of a *body in pieces*. As Jacques-Alain Miller puts it, 'the body in pieces finds its unity in the image of the other ... [or] its own specular image' (1988, 54). The use of 'the imaginary' in psychoanalytic theory is thus imbued with a sense of fragmentation and alienation.

Taken to an everyday setting, this may be exemplified by a person's attempt to identify with an external representation of themselves. Does their reflection in the mirror perform what they believe to be them? Even though they may grow used to the daily exposure to their *frontal* reflection in the mirror, alienating encounters with external representations that are in conflict with their body image continuously catch them unaware. For example, imagine a person being confronted with a *profile* view of their body, produced by the angled-mirror setup in a fitting room of a clothes shop.

What happens when a dancer enters a motion capture setting can be viewed as a transformative performance of this situation in a fitting room. Projections of motion capture data of a dance performance may take on a shape that is quite close to that of a mirror image. But not only can these data be viewed from any perspective, they can also be rendered in ways that make it all but impossible to identify the dancer who was the source of these data. Nevertheless, these renderings may very well perform some key features of a specific dance. Thus, through a fragmentation and manipulation of a *body* image, a *dance* image emerges.

A second example of the use of the imaginary as a concept appears in Jean-Paul Sartre's book *The Imaginary* ([1940] 2015).[2] This work contains Sartre's early views on art. *The Imaginary* 'offers a phenomenological account of the imaginative experience' and thus represents one of the earliest volumes on imagination by a French phenomenologist (Mori 2012, 11). Notably, it predates Maurice Merleau-Ponty's work on phenomenology and Roland Barthes' work on aesthetics.[3] In *The Imaginary,* Sartre makes a distinction between perception and imagination. When an object is perceived, it is observed from a specific perspective, for instance, only one side of a chair is visible from a given viewpoint. Whereas when an object is *imagined*, this limitation is lifted, the chair can be imagined from all sides. Moreover, Sartre states that the imaginary process relies on intentionality. This means that intentions, the way in which one engages with the world, have an impact on one's imagination of the objects encountered. Translated to a familiar scene in the motion capture setting, this explains why one does not merely see a collection of glowing dots when confronted with the three-dimensional 'point cloud' of motion capture data on a screen. In the mind, the moving dots take on the sense of a dance performance. The dots are perceived. The embodied reality of the dancer is imagined.

The imaginary has yet another conceptual root, beside those in psychoanalytical theory and phenomenology. Its use has also been influenced by socio-political philosopher Cornelius Castoriadis's notion of 'the social imaginary' ([1975] 1998). Castoriadis argues that societies can only function because of a shared belief system that informs and legitimizes institutional and legal structures. One central shift that Castoriadis identifies is the shift from imaginaries that are based on myth and religion to a capitalist-based social imaginary. New imaginaries are thus the result of complex historical processes and belief systems. The media taxonomy of motion capture practices presented in this thesis also reveals an impact of such long-term processes and the effect of established belief systems.

Recent studies in cultural analysis frequently make use of 'the imaginary' as a conceptual term that is used to denote typical representations, vocabularies, metaphors, images and fantasies that are associated with specific cultural discourses or (sub)cultures. In a more general sense, the imaginary here points to ways in which modes of representation that are

[2] The original French publication carried the title: *L'Imaginaire: Psychologie phénoménologique de l'imagination* (1940).

[3] Note that Barthes wrote *Camera Lucida* in homage to Sartre's *L'Imaginaire* (see Barthes [1980] 2000, page preceding "Contents").

typical for these discourses have an impact on the way we see and understand our being in the world. For instance, in her essay "Meta(l)morphoses", Rosi Braidotti introduces the notion of a 'cybernetic imaginary' to discuss how new technologies affect human corporeal behavior. She describes the cybernetic imaginary as a 'machine friendly and evolution minded' imaginary that fits the contemporary context in which the 'merger of the human with the technological, or the machinic, not unlike the symbiotic relationship between the animal and its habitat, results in a new compound, a new kind of ecosophical unity' (2011, 56). There exists a mutual influence between cultural phenomena and imaginaries, as is apparent in the study *Cultural Ecstasies* (2013), in which Ilana Mountian notes that 'Imaginary, in a broad sense, refers to images, fantasies, illusions and so forth that are seen as relevant to the constitution of subjectivity. These elements both constitute and are constituted by society' (Mountian 2013, 11).

Other recent studies in the field of cultural analysis suggest that discourse analysis is an appropriate method to investigate what specific meanings are performed and produced by a specific imaginary. This is exemplified by Donna McCormack, who explores 'the transplant imaginary', a notion that was first introduced by Lesley Sharp (2014), noting that McCormack's approach of 'the *imaginary* is less about what will or may come (…) and more about a significant and existing cultural phenomenon made manifest in literary and visual texts' (McCormack 2016, 137). Discourse analysis is not limited to the study of such 'literary and visual texts' but includes, as Ian Parker writes, 'texts that are delimited tissues of meaning reproduced in *any* form that can be given an interpretative gloss' (Parker, 1992: 6). Discourse analysis, then, offers support in the analysis of cultural imaginaries, which seem difficult to grasp in any other way. As McCormack remarks: 'The transplant imaginary gives space and time to that which cannot and may never materialize, demanding we sense that which is there even when it is an immaterial presence, an invisible materiality or a haunting absence' (McCormack 2015, 150).

In this thesis, then, I conduct a discourse analysis in the fields of dance practice, dance studies, performance studies philosophy, film studies and computer science. I discuss ways in which emerging applications of digital motion capture technologies are used for the transmission of dance knowledge in order to support creative and analytic processes. I introduce the notion of the motion capture imaginary as a conceptual instrument to discuss how these practices can be read as part of a broader cultural phenomenon. I evaluate these practices by pointing to specific features that characterize this imaginary. All these features high-

light different aspects of how the body in performance is seen and understood in accordance with the motion capture imaginary.

0.8 Interdisciplinary dialogues

There are different actors involved in the encounter between dance and motion capture. The entrance of the dancer into the motion capture setting involves a continuous translation between different ways of knowing and seeing. This thesis is situated in the context of several large interdisciplinary research projects across the globe that have investigated similar questions. These projects include but are not limited to: *Inside Movement Knowledge*,[4] *Motion Bank*,[5] *Capturing Dance*[6] and *Moving Stories*.[7] The researchers involved in these projects come from different areas of expertise and include dancers, choreographers, coders, digital artists, performance scholars, computer scientists and dance and movement notation experts. Such research environments are the site of an encounter of different vocabularies, different notions of what knowledge is and how it can be gained, and what the best way of transferring this knowledge is. Exchanges between members of these mixed teams are therefore brimming with potential, but also marked by risk and misunderstanding. Indeed, a problem of interdisciplinary research environments is that they often provoke the old conflict between the supradisciplines of the humanities and the sciences, which is caused by a mutual lack of recognition of differing views on how research is done and reported on. The art of in-

[4] The precursor of *Inside Movement Knowledge* (The Netherlands, 2008-2010) was *The Notation Research Project* (2004-2007). The results of *Inside Movement Knowledge* were discussed in *Capturing Intention* (2007). Another publication that resulted from this project is *Transmission in Motion: The Technologization of Dance* (2017), edited by Maaike Bleeker. This volume includes detailed project descriptions and contributions that delve deeper into the implications of the developments that are reflected by these projects.

[5] *Motion Bank* (Germany, 2010-2013) was an experimental project conceived by William Forsythe in which three digital scores were developed in collaboration with Deborah Hay, Jonathan Burrows and Matteo Fargion, Thomas Hauert and Bebe Miller. The scores are available online (Motion Bank 2013).

[6] *Capturing Dance* (Australia) was conducted at Deakin Motion.Lab at Deakin University, Melbourne. *Capturing Dance* was a three-year collaborative research project of choreographer and dance scholar Kim Vincs, mathematician Vicky Mak-Hau and biomechanist Richard Smith and was supported by the Australian Research Council Discovery program, it brought together a team of artists and scientists to explore quantitative analysis of dance style using motion capture.

[7] The *Moving Stories* Research Partnership, for which Simon Fraser University acts as a host institution, is an example of ongoing collaborative research in which renowned Laban Movement Analysts and experts in the area of HCI design from the US and Canada have joined to research bridges between movement experience and digital technology design ("Moving Stories: Digital Tools for Movement, Meaning and Interaction" 2012).

terdisciplinary research is to make such tensions productive. Research findings in one discipline may well be an inspiring lead for research in another field, and vice versa. This perspective removes the need to give prominence to the merits of their independent positions. In this context, musicologist Richard Parncutt writes: 'Many believe, or take for granted, that the sciences are somehow intrinsically more important than the humanities. But convincing evidence for this belief is lacking' (2007, 24).

To make an interdisciplinary collaboration work, a mutual interest and willingness to exchange ideas and perspectives are crucial. The following personal anecdote illustrates that this is not necessarily easy to achieve: I will never forget the panicked look I once got from an engineer working in a motion capture lab when I proposed to go and see a dance performance together. Interdisciplinary anxieties such as these are unlikely to go away. Each collaborator needs to risk stepping into a lesser-known or wholly unfamiliar territory. Indeed, Parncutt suggests that '[i]nterdisciplinarity is best achieved by personal interaction between individual researchers from the two traditions' (Parncutt 2007, 3). Successful interdisciplinary research teams do not focus on the lack in the software and technology that is available, but instead look for added value in the dialogue between experts from different domains. In one way or another, such dialogues always require each dialogue partner to articulate what may well be self-evident to themselves, but entirely new for others. Empathetic listening is therefore a key feature of such dialogues. The question that I use to start such a dialogue is an open question: What can you tell me about your practice? ('How are you *doing*?'). As a follow-up, I then ask: What can you tell me about how you reflect on your practice? ('How do you *know* how you are doing?').

0.9 The identity of the dramaturg-researcher

Motion capture processes involve many deliberate elements of staging. Parallels can be drawn between a setup for a motion capture experiment and the staging of a performance. The analogy is that all parties involved in an experiment come to an agreement that the outcome of the setup — whether this is raw motion data, imagery, or a type of animation — is in accordance with a pre-conceived idea of what a legitimate result would be. Such settings trigger questions that have a dramaturgical dimension. What common ground is created when these different actors meet? What is accepted as a viable result? How is the idea of dance knowledge legitimized in this encounter? The ongoing discussion of such questions is also of vital importance for dance research processes in which motion capture is used. Based

on my observations in the past years, I believe that such research environments benefit from making more explicit who will take on the responsibilities for the dramaturgical aspects of these complex collaborative processes.

In dance and performance practice, the dramaturg usually functions as an observer — sometimes called the 'outside eye' —, whose primary role is to *imagine* what meaning is conveyed by a specific performance, based on the artistic choices that have been made. Dramaturgs communicate their findings to directors and choreographers, with whom they often work in close collaboration. As a researcher, I use an approach that is closely related to dramaturgy. I recognize this special dramaturgical identity more broadly in the area of performance research. I propose to call this the *dramaturg-researcher*. Dramaturg-researchers can be identified by the responsibility they take on for the following seven activities: positioning, interpretation, mediation, translation, support, ambassadorship and research:

1. Positioning: To describe a specific performance practice by establishing a critical cartography of its where, what, how, who and why.
2. Interpretation: To explain what meaning a specific performance practice conveys.
3. Mediation: To establish a common ground where different actors involved in a creative process can come to a shared understanding of the effects of their collaboration.
4. Translation: To support an exchange between various types of actors who may be unable to articulate their expertise in other professional vocabularies than their own.
5. Support: To support performance practitioners by taking responsibility for the activities listed here, which may be out of reach for practitioners themselves for various reasons, including lack of funding, lack of time, and/or lack of expertise.
6. Ambassadorship: To actively promote performance practice by articulating its importance in discursive texts in the public domain outside of the realm of performance practice itself. This includes, but is not limited to, the following areas: academic research, art education, journalism and art policy.
7. Research: To articulate the insights gained from the study of performance practice. To develop terminology and conceptual tools in order to provide opportunities for others to access and share this knowledge.

To summarize, the dramaturg-researcher takes on the responsibility to analyze and communicate how meaning is produced in dance as performance practice, and thus supports the larger endeavor of explaining the importance of such practices. The above-mentioned traits of the dramaturg-researcher surface as a common concern of the current generation of

emerging performance scholars, as can be seen in recent dissertations in dance and performance studies in Belgium and the Netherlands.[8]

0.10 Chapter overview

This thesis is structured in accordance with the approach of the dramaturg-researcher, in the sense that it puts the practice first. Chapter 1 examines the culture of transmission of the choreography *Rosas danst Rosas* (1983) by the Belgian dance company Rosas. *Rosas danst Rosas* is approached through different sources that shed light on the transmission practice of the work, including in-depth interviews I conducted with dancers, recordings of the performance, the film version of the performance by Thierry de Mey, and various literatures. Specific attention is paid to the multimodal publication *A Choreographer's Score* (2012) authored by Anne Teresa De Keersmaeker and musicologist and performance scholar Bojana Cvejić. I discuss the question of how each of these sources 'performs' this choreography, building on Philip Auslander's notion of 'the performativity of performance documents' (2006; 2014). This discussion provides insight into the various practices of dance transmission of a specific work in a long-established dance company. I contextualize this specific culture of knowledge transmission by referring to two large contemporary projects which aim to foster dance heritage: The Legacy Plan of the Cunningham Dance Foundation and The Pina Bausch Archives.

Again, the choice to reflect on a specific culture of knowledge transmission in Chapter 1 is a deliberate gesture of *putting the practice first.* This approach presupposes that it is of great importance to examine strategies of dance transmission that are *already* in place in dance practices, in order to evaluate experimental practices of motion capture-based dance transmission. What is the deeper meaning when dancers speak of 'the body as archive'? Why is the documentation of a choreography in an already existing, symbol-based dance notation system often considered to be at odds with the idiosyncrasy of a specific dance practice? It is for these issues that the Rosas company's culture of dance transmission offers a rich set of perspectives. This first chapter thus provides insight in key issues that play out in dance transmission practices, and thereby informs the discussion in subsequent chapters, in which related issues resurface when dance transmission is transposed to a computational mode.

[8] These PhD dissertations include, but are not limited to: Konstantina Georgelou (2011), Frederik Le Roy (2012), Zeynep Gündüz (2012), Liesbeth Groot Nibbelink (2015), Jeroen Coppens (2016), Timmy de Laet (2016), Charlotte Gruber (2016) and João da Silva (2016).

In Chapter 2 I position the encounter between motion capture and dance in the current discourse around 'dance knowledge', which is a recurring notion in recent dance documentation projects. Contemporary dance practice is increasingly recognized as a 'knowledge-producing endeavor' (Leach 2013). An examination of William Forsythe's notion and application of 'choreographic objects' helps to understand this trend. A discussion of the pioneering digital tools for dance documentation that were proposed by A. Michael Noll in the 1960s demonstrates that these endeavors are not new, but have a longer history. The emergence of dance knowledge is connected to the so-called 'practice turn' in theory and philosophy, which recognizes embodied technique as a vital area of ongoing exploration.[9] I trace back the roots of this development to the work of Michael Polanyi, who introduced the notion of the 'tacit dimension', the unarticulated dimension of intelligence that shapes our speech, writing and also our approach to science. I connect the notion of tacit knowledge to dance practice by going back to observations of Rosas dancers in Chapter 1. Finally, I evaluate the recent study *What a Body Can Do* (Spatz 2015), which proposes several ideas of how to approach an epistemology of performance based on practice and technique.

Chapter 3 presents an overview of existing practices that employ motion capture in various strands of dance research and practice. It also maps the main issues and concerns in the debate on motion capture and dance. I contextualize these practices in a larger cultural-historical development in which capturing apparatuses are used to 'picture the invisible' (Joel Snyder in Mitchell 2005, 260), revisiting Eadweard Muybridge's first experiments with 'instantaneous photography' (Prodger 2003) of racehorses at the end of the 19th century. I discern two characteristics of the use of motion capture as apparatus in these practices: its remediation of video and its indexical referentiality. The chapter closes with an analysis of the digital tool *Noh Composer* (Oshita et al. 2013) and *TWO* (Hauert, Miller and Motion Bank 2013), a digital score of the improvisation strategies of Thomas Hauert/ ZOO company. These analyses further illustrate important consequences of corporeal computation in dance practice.

Chapter 4 shows how the experiences with performance capture in the film and game industries can be made productive in the analysis of contemporary practices of dance capture. This chapter presents a comparative analysis of actors and dancers in the motion capture volume. I point to similarities, such as the explicit strategies of staging, as well as con-

[9] The practice turn in the dance field can be exemplified by new inquiries into dance technique, such as Ingo Diehl and Friederike Lampert's *Tanztechniken 2010: Tanzplan Deutschland*, which starts with the question 'Was wissen wir, wenn wir tanzen?' [What do we know, when we dance?].

spicuous differences, such as the absence of facial capture in digital dance practices. A closer examination of this setting reveals that distributed cognition is inherent in the relationship between the dancer and the capturing apparatus. The new movements that are generated in this process are thus the result of a force that is essentially co-creative. This also has an effect on how the bearer of the memory of such a process is identified. Rather than being a sensorimotor sediment in the dancer's mind-body, the bearer of such knowledge becomes multiple. It stretches beyond the dancer's body into the materiality of technological hardware and the virtual realm of code that structures the software. Drawing on the motion capture-based performance *Emergence* (2014), I discuss how Artificial Neural Networks are used in this setting. Artificial Neural Networks are biologically computational models that seek to emulate the neural structure of biological organisms. The chapter closes with an analysis of the solo dance performance *meta* (2014), which is a reflection on a dancer's experience of performing *with* motion capture.

Graphic, linear traces are a common way to visualize motion data of dance. Chapter 5 investigates the origins of this convention in data visualization. I argue that these digital renderings of dance data are not accidental, but are firmly rooted in the history of Western choreographic practices, and enabled by a basic embodied experience. This imagery invites the viewer to imagine the dancing body as an instrument that draws lines while moving. I approach this as a conceptual metaphor (Lakoff and Johnson 1980; 2003), which I call the *dancing-drawing body*. This chapter shows that digital renderings of motion data may function as a *score* in the sense that they index a spatial trajectory of dance. I analyze works by Lesia Trubat, Nancy Stark Smith, Motion Bank and Deborah Hay, OpenEndedGroup and Gibson/Martelli. Each of these examples provides a different perspective on how knowledge about the bodily basis of cognition finds its way into digital renderings of dance knowledge. The chapter closes with a discussion of Nelson Goodman's notion of 'rightness of rendering' (1978) to address the experimental, iterative processes that are involved in getting this *right*, that is, to create renderings of dance motion data that achieve a specific effect or outcome. This is distinguished as a principal aim of media design in the experimental area of corporeal computation.

In Chapter 6, the closing chapter of this thesis, I propose that the study of breath in performance offers new opportunities in the contemporary pursuit to 'make motion data speak'. I go back to the work of Rosas when I discuss the performance *My Breathing Is My Dancing* (2015). This duet between a dancer (De Keersmaeker) and a flutist (Dimitriou) puts

the role of breath in dance performance center stage. It illustrates the ‘respirational empathy’ that I recognize at the heart of dance practice. I then examine various case studies that deliberately incorporate breath as movement to affect specific body states. Inspired by Luce Irigaray’s philosophy of breath, I argue that breath is a rewarding lead in the continuing endeavor to design intuitive ways to transmit dance knowledge in the expanding realm of corporeal computation.

Chapter 1

Dance Transmission in Practice: Repeating *Rosas danst Rosas*

> Let's start on an even more basic level, the very act of dancing, making movements in space and time and showing those to others, inviting them to look at them. That's what I'm interested in, especially when I consider how one carries the world inside one's body . . . When you dance, you make space and time decisions within an energy field.
> — Anne Teresa De Keersmaeker in "Sharing Experience" (Laermans 2012, 87).

> Words like duration, rhythm and texture suggest a cold, calculated relationship. But, while it is true that Rosas dancers spend a lot of time counting, the result of this precise and delicate encounter between movement and music is a passionate celebration. There is, in the work of [Anne Teresa De Keersmaeker], a quiet trust that the truthfulness of the encounter of both is bound to generate beauty, emotion and meaning. Structure is never just rational; emotion is not limited to meaning. That, of course, has also to do with the core material of choreography: the human body with all its idiosyncrasies, emotional charge and energy.
> — Mark Deputter, "Lust for Life" (2012)

Based in Brussels, the dance company Rosas and the dance school P.A.R.T.S. stand out in the international dance field because of the emphasis they place on dance practice as worthy of rigorous research. It is clear that the transmission of dance knowledge has become a central topic of inquiry of the of Anne Teresa De Keersmaeker's creative ambitions. She performs these in her multiple professional capacities as choreographer, director of a dance school *and* as a dancer. De Keersmaeker's efforts at finding ways to articulate this knowledge serve as an inspiring example of what a communication of dance expertise could look like beyond its disciplinary boundaries. I believe that this movement is full of potential for further interdisciplinary inquiries.

Rosas has created an impressive oeuvre during its 34-year existence (and counting). Many of Rosas' works have become part of a living repertory, which is successfully presented at stages worldwide. It has earned De Keersmaeker important awards and distinctions in Belgium and abroad. But the impact of Rosas extends beyond the creation and staging of performances. In recent years, De Keersmaeker has distinguished herself by seeking ways to share her reflection on her choreographic craftsmanship and her oeuvre to date. These efforts have materialized in the multimodal triptych *A Choreographer's Score* (2012; 2013; 2014), which was researched and co-authored by performance scholar and musicologist Bojana Cvejić.

The current chapter provides an insight into the culture of dance transmission as it exists within De Keersmaeker's dance company Rosas. What is the result of a deliberate effort to convey a dance to future generations in order to share and sustain the legacy of the company that created it? There are different practices involved in dance transmission: Training in dance technique, scoring practices, video recording, and rehearsal practices. All of these are examples of different modes that these practices take on, and each of these incorporates different technologies and brings its own different emphases and omissions of a dance and its specific features: its structure, its movement vocabulary, its qualities and intensities. Together, these practices constitute what I propose to call the *culture of transmission* of a company.

Using the multimodal publication *A Choreographer's Score*[10] as an analytical framework, I propose to combine De Keersmaeker's inside knowledge with a series of in-depth interviews that I conducted with different generations of Rosas dancers. In these interviews, I considered the dancers' experience with the performance and transmission of the choreography *Rosas danst Rosas*. I propose an expansion of the notational endeavor of *A Choreographer's Score* by adding testimonies of the dancers' corporeal 'enunciation'. As such, this chapter is a further investigation of aspects of 'performance-style', which Cvejić distinguishes as one of the main thematic parameters that runs through the four scores of Rosas' 'Early Works' (Cvejić 2017, 59). It connects the repetitions within De Keersmaeker's work with the question of how these practices themselves can be repeated by dancers in their long-term engagement with the company's repertory.

[10] The series *A Choreographer's Score* consists of three volumes that were co-authored by Anne Teresa De Keersmaeker and Bojana Cvejić: *Fase*, *Rosas Danst Rosas*, *Elena's Aria*, *Bartók* (2012); *En Atendant & Cesena* (2013); and *Drumming & Rain* (2014).

These considerations also tie into the present debate in dance studies on how dance knowledge could be shared beyond the boundaries of its own discipline. Indeed, Cvejić positions the initiative for *A Choreographer's Score* in developments of the last decade, which 'has also been characterized by the "educational turn" in the arts (Rogoff 2008), a keen interest in developing modes of documenting, archiving and transmitting contemporary dance emerged in Europe and North America in concert with new digital technologies' (2017, 53).[11]

Taking the choreography *Rosas danst Rosas* as my main case study, I first of all analyze how this iconic work is 'performed' by *A Choreographer's Score*. I describe the company's practice of transmission of the choreography and I look at dancers' experience with teaching and performing the work. I pay specific attention to the function of breath in these processes. By showing how dancers breathe life into the complex choreographic architecture of the choreography, dancers provide a deeper understanding of the information that is made available in *A Choreographer's Score*. The relationship between breathing strategies and expression is also a feature that is made palpable by the direction of the *Rosas danst Rosas* film by Thierry De Mey. This film was based on the choreography, as a highly dynamic representation of the choreography that emphasizes movement qualities and bodily intensities.

On a different level, through a discussion of the role of embodied, performative knowledge, I contribute to the present debate on what is and what is not validated as 'dance knowledge' (see Chapter 2). I claim that this question should be a cental topic of dance research, connected to the ongoing concern with topics such as dance legacy and the legitimization of dance expertise both within and beyond the limits of the field's disciplinary boundaries.

In this chapter I explore how the analysis of these key sources — the score, the film, dancer's experiences — of the performance *Rosas danst Rosas* connect performative knowledge to the detailed account of choreographic poetics in *A Choreographer's Score.* What type of ideas about the performance are articulated in each of these sources? How do the different modes of these sources highlight different types of dance knowledge? I argue that an integrative approach to choreographic and performative dance knowledge may lead to a new scholarly appreciation of embodied dance techniques, such as breathing. Breathing techniques constitute a key to intentions and intensities that are at the core of the dancer's expression. In the following chapters, I explore how this type of performance analysis can in-

[11] Cvejić (2017, 53) names three projects that were referential for the creation of *A Choreographer's Score*: William Forsythe's *Improvisation Technologies* (CD ROM, 1999), Emio Greco|PC's *Inside Movement Knowledge* (2008), and *Synchronous Objects* (2009).

form thinking about corporeal computation and digital modes to transmit dance. In Chapter 6, the final chapter of this thesis, I explain how such a shift in attention ties into contemporary questions with regard to emerging modes of human-computer interaction.

1.1 *Rosas danst Rosas*: From controversy to canon

The founding performance of the Rosas dance company, and in many ways an iconic example of its oeuvre, *Rosas danst Rosas* was created in 1983 during an intensive, four-month rehearsal process during which De Keersmaeker — 22 years old at the time — collaborated with dancers Michèle Anne De Mey, Adriana Borriello and Fumiyo Ikeda (fig. 1 and 2). At the time of its premiere, the audience was both impressed and provoked by the rigor of De Keersmaeker's choices. Most audiences in Belgium and other places in Western Europe where the performance initially toured were not yet familiar with American postmodern and minimalist dance (Verstockt and Dierckx 2009). Many of De Keersmaeker's choices were ground-breaking: her use of everyday movements as a basis for her choreography, the demanding contrapuntal structures, the exhausting repetitive movements, the seductive confidence that the young dancers expressed, and the demanding start of the performance during which the performers danced on the floor, in silence, for approximately 40 minutes. All

Figure 1. *Rosas danst Rosas* by Anne Teresa De Keersmaeker in 1983. Third movement. Dancers: Adriana Borriello, Anne Teresa De Keersmaeker, Michèle Anne De Mey, Fumiyo Ikeda. Photo: Jean-Luc Tanghe.

these elements were unprecedented in contemporary dance in Belgium and it instantly turned the Rosas company into one of the key representatives of the 'Flemish dance wave' (Laermans 2010). Following the success of *Fase: Four Movements to the music of Steve Reich* (1982), *Rosas danst Rosas* established the international reputation of the young dance company.

Since its initial success, the history of *Rosas danst Rosas* has also been one of repetition and revival. It was the first of her early works that De Keersmaeker was able to revive when she became resident choreographer at the Brussels opera house La Monnaie in 1992. The choreography has been taught as part of the curriculum of the Brussels-based dance school P.A.R.T.S. from the beginning of its establishment, to introduce students to De Keersmaeker's choreographic ideas and dance techniques.

Since its establishment in 1995, the dance school P.A.R.T.S. (Performing Arts Research and Training Studios) has been located in the same building as the Rosas company. The establishment of P.A.R.T.S. marked a structural institutionalization of the Belgian dance field (Laermans 2010, 407) and was a 'decisive element in the hybrid network of ingredients that consolidated the renown of Brussels as a dance capital' (Laermans 2015, 286). The curriculum of P.A.R.T.S. students consists of training in a broad range of dance techniques and includes theory classes that cover a broad range of subjects such as musicology, sociology and philosophy. The school thus offers ample opportunity to gain practical skills as a dancer and/or choreographer, but it also provides students with reflection tools that support the development of critical views on their own individual paths. The ongoing attention to research and reflection at P.A.R.T.S. is exemplified by a recently launched trajectory called *Research Studios*, a research program for choreographers and dramaturgs that provides an environment for reflection and experiment, in order to further develop their choreographic language. The shared location of P.A.R.T.S. and Rosas and the double identity of De Keersmaeker — who functions as the school director *and* the director of the company — serve as two important conditions for the organic exchange between these two entities, in which Rosas dancers and P.A.R.T.S. students learn from each other. P.A.R.T.S. also functions as a natural breeding ground for future company members, even though this is not propagated as a common scenario for graduates by either the school or the company.

In addition to being an ongoing part of the curriculum of P.A.R.T.S., *Rosas danst Rosas* has also played an important role as part of the recent revival project of the *Early Works* (2010), during which it was presented together with three other key choreographies: *Fase*

Figure 2. *Rosas danst Rosas* by Anne Teresa De Keersmaeker in 1983. Third movement. Dancers: Adriana Borriello, Anne Teresa De Keersmaeker, Michèle Anne De Mey, Fumiyo Ikeda. Photo: Jean-Luc Tanghe.

(1982), *Elena's Aria* (1984) and *Bartók/Aantekeningen* (Bartók/Annotations) (1986). The tour was followed by the publication of the first volume of *A Choreographer's Score* (2012).

A project that also can be considered to be part of the revisiting of Rosas' *Early Works* is *Re:Rosas!* (2013). *Re:Rosas!* was an online project that invited viewers to interpret and perform a short sequence of *Rosas danst Rosas*. On the project's website, an instruction video explained the basic choreography of the second movement of *Rosas danst Rosas*. Colloquially known as "the dance with the chairs", this is the most famous part of the performance: It is one of the most iconic choreographic sequences in Rosas' oeuvre. The video was annotated with letters that referred to the movement cells that the choreography consists of. Visitors of the website were invited to interpret the choreography based on these instructions, and to subsequently record and submit their own take on the choreography. The film clips that were created were then made available on the website. The collection grew steadily and soon included dozens of examples. Some of these were an attempt to follow the instructions as closely as possible. Others took a different, more liberal approach, in which the choreography was re-enacted in ways that often gave a considerable twist to the original scheme. The flexibility of video also led to a wide variety of performance spaces. Results included a

performance of a group of four adolescent girls in their student apartment, but also a solo performance by a man who positioned a wooden chair in the middle of a deserted, unpaved road in a French rural landscape (Von Washimmel 2013). The project thus made use of the popularity of contemporary DIY (do it yourself) practices on YouTube to introduce a (young) audience, the majority of whom were not professional dancers, to the broad range of issues and choices that present themselves in the process of learning and staging a choreography. The project was launched in 2013, one and a half year after Beyoncé plagiarized sequences from *Rosas danst Rosas* and *Achterland* (1990) in the videoclip *Countdown.*[12] The *Re:Rosas!* project can in this regard also be seen as a creative counter-gesture to this blunt appropriation. New movies are still being submitted to the project. As of 1 July 2016, the website contained 357 contributions.

Since its premiere in 1983, *Rosas danst Rosas* has been danced by several generations of dancers. Even though the cast tends to be relatively stable, in case of injury or other circumstances, interpreters from earlier generations occasionally return to performing the work, including De Keersmaeker herself (fig. 3). The choreography has a special status within the company, and being given the opportunity to perform the work is considered to be a rewarding challenge. The rigor and stamina that the performance demands certainly contribute to this intense experience. With its total duration of almost two hours, De Keersmaeker describes *Rosas danst Rosas* as a 'paroxysm of dancing, dancing, dancing without counting, over and over again, a kind of *dépense'*, referring to Georges Bataille's notion of 'expenditure' (2012, 82). Cvejić further explains: 'In the case of *Rosas danst Rosas*, Bataille's *dépense* could be understood as relentless repetition and endurance which engenders an excessive expenditure of erotically charged energy' (2012, 82).

The endurance that the performance requires contributes to the special status of *Rosas danst Rosas* in the company's repertoire. 'With other performances I manage to pace myself to avoid injuries, but with this performance I can't resist, I always want to give 100%. I feel that the audience would not feel ecstatic if I give less than 100%' (Loemij 2014). In addition to the intense physical dimension of the dance, dancers remain challenged and inspired by their ongoing, detailed exploration of the rich movement material of the choreography, even

[12] The position of Rosas that was communicated to Sony was that videoclip *Countdown* by Beyoncé could not be shown without prior approval of the authors (i.e. Anne Teresa De Keersmaeker and Thierry De Mey). De Keersmaeker issued a dismissive personal statement on the affair (October 10, 2011). In November 2011, Beyoncé brought out a new video of the song in which the Rosas material had been removed. For a discussion of the copyright implications of this affair, see Yeoh (2013).

Figure 3. *Rosas danst Rosas* by Anne Teresa De Keersmaeker in 2009. First movement. Dancers: Anne Teresa De Keersmaeker, Cynthia Loemij, Sara Ludi, Samantha van Wissen. Photo: Herman Sorgeloos.

after as many as 100 performances. 'This show is physically difficult and so challenging because there is so much space to keep on looking for movement, for quality. It is a never-ending search, not for the right way, but for how else it can be' (Penkova 2013). Its rich culture of transmission makes *Rosas danst Rosas* an ideal case to gain more insight in what dance transmission in practice can look like.

1.2 *A Choreographer's Score*: How De Keersmaeker writes with movement

'My main field is writing with movement. But how do you make a dance and give it to younger generations?' (2014a). This was the main question that motivated De Keersmaeker to start creating the publication series *A Choreographer's Score*, in which a selection of Rosas' work is notated in multimodal 'scores' that offer detailed insights into the choreographic craftsmanship of these dances. The project allowed for an articulation of specific categories of De Keersmaeker's choreographic knowledge, which were translated to appropriate presentational modes. The notion of 'score' in this particular project, then, is primarily conceived of as an analytical framework that opens up the choreography for further research and interpretation.

Elaborating on Jacques Derrida's notion that 'the archivization produces as much as it records the event' (Derrida 1995, 17), Philip Auslander has pointed to the 'performativity of performance documents' (Auslander 2006; 2014). Using J.L. Austin's account of the performative (1962), Auslander suggests that

> performance documents are not analogous to constatives, but to performatives: in other words, the act of documenting an event as a performance is what constitutes it as such. Documentation does not simply generate images/statements that describe an autonomous performance and state that it occurred: it produces an event as a performance. (Auslander 2006, 5)

In the following section, I take on Auslander's notion to explore how *A Choreographer's Score* 'performs' *Rosas danst Rosas*.

De Keersmaeker has said that William Forsythe was an important inspiration for creating *A Choreographer's Score*: 'Remarkably few texts on the craftsmanship and on the compositional tools of dance exist. Forsythe taught me you should share this knowledge, even though it is rather normal for choreographers to keep it to themselves' (2014a). Indeed, taking into consideration the mistrust in interpretative discourses of the generation of choreographers De Keersmaeker belongs to, Cvejić states that '[De Keersmaeker's] wish and readiness now to formulate all she could remember and convey about the creation and choreography of her performances, attests to a mature awareness of the importance of disseminating knowledge about dance beyond its hermetic specialism' (Cvejić 2017, 54).

De Keersmaeker's handwritten scores play a prominent role in the book. They foreground the complex contrapuntal structures and geometrical patterns which function as the basis of her choreography. In her dance writing, she uses letters to refer to movement cells, accents to indicate movement qualities and geometric figures and arrows to point out movement trajectories across the stage. De Keersmaeker's scores are printed in juxtaposition with text in which her choreographic ideas are articulated. Because of the first-person perspective that is maintained throughout the textual layer of the score, the text is in danger of being misinterpreted as a close transcription of the interviews on the accompanying DVDs. A closer comparison reveals that the text is edited to fit the requirement of the detailed written score the authors envisioned. Cvejić explains:

> This is why the text, still sourced from the video, diverges to some extent from the video; the discrepancy between *la parole* and *l'écriture* is also conditioned by

> the two different media. The written word compensates for a precision that the spoken word sometimes lacks; the video demonstrates the movement that can't be described enough, but has to be performed. The choreographer's *parole* fleshes out the account with affective tones of storytelling that the text is numb to. (Cvejić 2012, 12)

The choice to maintain the first-person perspective in the text produces an oral quality that creates a common ground between the printed score and the interviews and thus ties them together.

On the DVDs, in response to Cvejić' queries, De Keersmaeker draws choreographic structures on a blackboard, provides voice-over comments to recordings of performances and occasionally demonstrates short excerpts from the dance. This presentational mode, which allows De Keersmaeker to simultaneously describe *and* show movement material, also provides the viewer with some impressions of the actual transmission process in the studio. For example, De Keersmaeker lays down on the floor to demonstrate movement cells from the first movement, first laying down on her belly, then pushing herself up from the ground by her elbows, and then gently shifting her head to the side, while she explains how she associates these movements with sleeping and with 'talking to your lover who is lying next to you'.

To return to the question, then, how does *A Choreographer's Score* perform *Rosas danst Rosas*? The publication provides valuable inside knowledge into how De Keersmaeker 'writes with movement'. Indeed, as Cvejić comments: 'The painstaking explanation of detail [in the score] serves to make choreography's poetics and *episteme* accessible outside the hermetic boundaries of self-referential disciplinary knowledge (of dance) and within other disciplines' (18). The explanations on how the choreography 'works', both in a structural and in a dramatic sense, are expressive and clear. Even though at this time it is too early to accurately map different ways in which readers in and beyond the dance field will actually engage with this score, the publication invites further analyses of these performances and may also inspire new notational endeavors or dance creations.

1.3 The allure of the archive

The primary goal of *A Choreographer's Score* differs from that of recent projects in the dance field that aim to create a documentation of dance works by offering concrete tools for reconstruction or reinterpretation. Notably, it excludes references to other documents that could

have specific value in future reconstructions, such as the existing Labanotation of the first movement of *Rosas danst Rosas* (De Keersmaeker and Hardillier 2000). Rather than creating exhaustive documents of the work that would facilitate revivals, however, Cvejić strived for 'the articulation of De Keersmaeker's methods and intuitions into a *poietics*, a more or less coherent set of ideas, concepts and methodological parameters' (Cvejić 2017, 56).[13] In this respect, the project's intentions are different from the recent Legacy Plan by the Cunningham Dance Foundation, which includes the digital preservation of eighty-six dances by Merce Cunningham in so-called *Dance Capsules* that 'provide an array of assets essential to the study and reconstruction of Cunningham's choreographic work' (Merce Cunningham Trust 2012, 46). If reinterpretation or reconstruction would be of interest to the reader, Cvejić emphasizes the importance of consulting performance recordings and the dancers' knowledge, which is 'indispensable to any transmission of their roles' (18).

As I discuss in greater detail in Chapter 2, William Forsythe is well known for several projects that engage with the question of how the continuing development of digital technologies impact our understanding of dance literacy. The influence of Forsythe on these projects, which all are rooted in a digital environment, the analogue character of *A Choreographer's Score* is notable. This is also remarked upon by Renate Bräuninger, a musicologist who has conducted research on Rosas' work and *A Choreographer's Score* in particular. Remarking on the gap between *A Choreographer's Score* and projects such as *Siobhan Davies Replay*, *Oral Site*, and Forsythe's projects, Bräuninger asks: 'Hence, one wonders why De Keersmaeker and Cvejić have chosen such a simple format for these DVDs. In other words, why was greater use of the available digital technology not made?' (2014, 381). Bräuninger speculates on different plausible reasons such as lack of funding and other resources.

Even though such factors have undoubtedly played a role, the choices for the format of *A Choreographer's Score* nevertheless seem quite deliberate. Cvejić writes that the approach of the publication to gather and juxtapose a selection of archival materials was inspired by Yvonne Rainer's *Work 1961-1973* (1974). 'In particular', Cvejić notes, her principle of radically juxtaposing heterogeneous elements: '"categories of things" that "have varying degrees of emotional load"' (Cvejić 2017, 55). The publication evokes associations with photocopying

[13] Cvejić further explains her use of the term poietics as follows: 'By choreographic poietics I mean the art of making dance performances in analogy with the poietics of composers in twentieth-century modern music, as in the canonical examples of Igor Stravinsky (*Poétique musicale*, 1942) or Arnold Schoenberg (*Fundamentals of Musical Composition*, 1967 and *Style and Idea*, 1975). There are, exceptionally, only a few specimens of this genre in dance literature, such as Rainer's aforementioned *Work*, that could be compared with composer's writings on poietics' (Cvejić 2017, 56).

strategies in the 1970s and 1980s, in which the regular method to combine images and texts was to tape or glue cut-outs of images onto a space purposefully left blank on a page with text (written, at that time, with an analogue typewriter). The image-text document thus compiled was subsequently photocopied, a reproduction method also referred to by the term 'stenciling'.[14]

Because of its format and design, the contents of the score do not surrender themselves easily to readers. In the past two decades, the boom in digitized resources and methods such as OCR-scanning has opened up a wealth of documents for text-based analysis. The great advantage of this development is that researchers can search these documents by using self-chosen terms and keywords. The text of the score is not amenable to such a digital search method. The absence of an index is another example of what makes the score difficult to search through.

The archival documents that are included in *A Choreographer's Score* — photos of performances, cut-outs of reviews, notes by the choreographer, publication material — sometimes function as an illustration of what is mentioned in the text, but are at other times presented without additional commentary. It is at times difficult to access these sources, which is not helped by the fact that they are written in a variety of languages (including Dutch, French and Italian) and are printed without translation, as has also been noted by Bräuninger (2014, 378). It seems that instead of providing a new way of opening up the archive to readers, the score rather provides a sneak peek into the company's documents, partly leaving intact the resistance that characterizes the archive.

On a different level, by its selection of documents that are so typical for performance archives, *A Choreographer's Score* does to a certain extent succumb to what historian Helen Freshwater has termed the 'allure of the archive' (2003). Freshwater argues that 'the archive's seductive charms often serve to conceal its flaws. This archive's undeniable allure obscures the contingency of its construction, its destructive powers, and the way in which its contents remain vulnerable to interpretative violence' (2003, 729). In other words, archives always trigger questions about how a collection of materials was motivated and how these choices inevitably stimulate certain ways of researching and otherwise engaging with the past events these materials are linked to. As Freshwater puts it:

[14] Also note that the font that is used in *A Choreographer's Score* resembles that of an analogue typewriter.

> This duality of random inclusion and considered exclusion marks the construction of every archive. (…) The original decisions as to which materials are to be preserved and which are to be discarded, prior to public access, are often unavailable to the researcher. But the archive's very existence indicates an a priori value judgment concerning the worth of the documents or artifacts it contains. (…) While these records are undoubtedly of great value, we must address their contradictory nature, their paradoxical enactment of destruction and preservation. (Freshwater 2003, 740-741)

Another recent example of a performance archiving initiative that seeks alternative ways to archive performances are The Pina Bausch Archives that are currently being set up by the Pina Bausch Foundation (Wagenbach and Pina Bausch Foundation 2014).[15] One of the formats that was tested was the oral history project called *7x7x7*. This format was first tried out when the piece *Two Cigarettes in the Dark* was restaged. Seven audience members interviewed seven members of Tanztheater Wuppertal, each interview lasting seven minutes. The evening's interviews resulted in 49 videoed dialogues, which were transcribed and evaluated. The project is to be repeated in a similar form with other pieces (Pina Bausch Foundation 2013). Although oral history is by no means a new interpretative method, this is an important way of bypassing the allure of the archive, in fact a *crucial* method to document the recent past of performing arts when the persons concerned are still alive.

Indeed, the component of oral history is what *A Choreographer's Score* does best: offering De Keersmaeker a space to narrate her work and the methods and principles lying at its basis. Again, though, a transcription of the DVD interviews with De Keersmaeker would have made it easier to study the *Score*. Even when Cvejić motivates the difference in text between the interviews and the written text of the book by distinguishing between the particular expressive force of *la parole* and *l'écriture*, the many differences between the content of these two media are often puzzling for a critical reader and frequently trigger additional questions

[15] This is the mission statement of The Pina Bausch Archives: 'The Pina Bausch Archives serves as the repository for the historical records of Pina Bausch including the records of the Tanztheater Wuppertal Pina Bausch and the performers and other collections related to Pina Bausch. The Archive includes Pina Bausch's complete artistic legacy, which she maintained during her career as a dancer, choreographer and Artistic Director of Tanztheater Wuppertal. Its primary purpose is to document the history and the artistic process of the company and to provide source material for dancers, artists, administrators, students, researchers, and other interested persons who seek to evaluate the impact of Pina Bausch on the history of artistic, sociocultural and intellectual developments. It is also meant to facilitate and support the reconstruction of the pieces' (Pina Bausch Foundation 2016).

about which voice in the score is the authoritative voice. It leads one to wonder: Who is exactly the 'I' who is speaking in the first person narration of the book?

All in all, De Keersmaeker's stated goal to 'give the work to younger generations' takes on a complex shape in *A Choreographer's Score*. By making the first-person narration of Rosas' *Early Works* a key feature of the score's setup, the publication emphasizes the articulation of De Keersmaeker's choreographic ideas, rather than detailing tools and documentation that would facilitate future revivals of the work. Nevertheless, it is clear that in case of such attempts this publication would be an invaluable source. *A Choreographer's Score* is an excellent example of what the efforts of a dramaturg-researcher can result in.

1.4 A culture of dance transmission

Since its premiere more than three decades ago, *Rosas danst Rosas* has been interpreted by several generations of dancers (De Keersmaeker and Cvejić 2012, 115). When the performance is taught to new dancers, the company primarily relies on a combination of physical demonstration and verbal explanation by experienced dancers in the studio. As in many other dance companies, video recordings of previous stagings can be important mnemonic devices when a work is revived. This was the case when Rosas revived *Elena's Aria*, for example. But *Rosas danst Rosas* has been transmitted on such a regular basis that consulting videos is hardly necessary. To learn the choreography, dancers rely on a document containing the choreographic structure, which provides the skeleton of the dance. The rehearsal process itself can take up to two months, but it saves time when a new dancer joins a cast in which the other members are already trained. The main challenge for a new cast is to figure out a shared timing. As one dancer points out: 'Dancing *together*, that is really something that needs to grow. You need to try, and then try again. And when there are changes in the cast you need to adapt to new personalities' (Van Wissen 2014).

However, the ease in this transmission process was not in place right from the beginning. The first replacements in the cast had already been made before teaching the choreography to an entirely new cast in 1992. As a member of the original creation and the rehearsal director of the current cast, Fumiyo Ikeda is one of the main authorities on *Rosas danst Rosas,* in a position second only to De Keersmaeker herself, who remains in charge of final decisions. In dance practice, the role of 'transmitter' (Gardner 2014) is often entrusted to dancers who were part of the work's creation, as is asserted by Pina Bausch researcher Norbert Servos:

> Every person involved in the creation of a piece stores a vast wealth of detailed information in his or her physical and mental memory, and knows about the system of their complex connections. Only those who know how to create this complex richness and its interactions can revive the spirit of a piece. (Servos 2007, 189–190)

When the first replacements in the cast had to be made, Ikeda and De Keersmaeker were forced to shift to an outside position with regard to the work. Ikeda remembers that it was only at this point that she became aware of the precise structure and much of the details of the performance:

> Because I was part of the creation process, the performance was so evident for me. I *thought* I knew many things, but I didn't. In the beginning I didn't know how to teach it and I had to analyze the piece first. Then I got used to explaining it. (Ikeda 2014b)

Although there are multiple dancers who are able to teach the choreography, each of them is bound to teach the dance using a slightly different style. When watching a stage recording from the 1990s, Penkova comments: 'You can see that this generation learnt the dance from a different dancer. Because you see her power, you can see a little bit of Roxane [Huilmand] in all of them' (2013). De Keersmaeker therefore now relies on Ikeda as the sole rehearsal director, in order to give dancers the same basis. However, Ikeda and De Keersmaeker's interpretation is also different and even they may not always agree on what the 'essence' of the work is that should be preserved (Loemij 2014).

1.5 Breathing with intention

To gain more insight into the dancers' experience with *Rosas danst Rosas*, I conducted a series of interviews with five Rosas dancers from different generations of performance casts. All dancers had performed the work more than 100 times. They also all had experience with teaching the choreography to other dancers in various contexts: as part of the curriculum at P.A.R.T.S., in workshops in Belgium or abroad, or within the company itself. The questions in the interview were not scripted in detail. Instead, I invited the dancers to address the following question in accordance with their own insight: 'How would you describe your experience with dancing *Rosas danst Rosas*?' ('How are you *doing*?') As a follow-up, I asked more specif-

ically about their experiences with learning, remembering and teaching the choreography. ('How do you *know* how you are doing?') In addition to these interviews, I attended several *Rosas danst Rosas* workshops for external dance students and a day of the rehearsal process with a new performer within the company.

Even this fairly modest exploration yielded many striking insights into the dancers' experience of *Rosas danst Rosas.* I want to focus here on what the dancers' accounts reveal about the way the movement qualities described in *A Choreographer's Score* physically take shape as part of the performance style that is typical for Rosas. Furthermore, I address how dancers deal with the radical repetition of movement cells, which is a defining aspect of the work. How do dancers keep the movement alive? How do they articulate this performative knowledge?

An initial, revealing observation was made during a workshop taught by a Rosas dancer (Elizaveta Penkova), during which she introduced the first movement of the choreography to an external group of dance academy students. The students' general strategy was to first try to get a grasp of the overall structure of a movement sequence by way of 'marking' (Kirsh 2010), and then to continue to enhance the expression and details of the movement and aligning their breath with the dance phrases. Penkova demonstrated the movement while simultaneously adding an explanatory layer of speech, which further informed the details of the dance:

> Move your hands away from each other as if you're stroking a water surface, then lift them up and let the water fall from your fingertips. Now you put pressure on your arms and you move upwards. Not only your breath is moving, all your muscles are breathing. Your arms keep pushing into the floor. Then your head suddenly moves: 'Somebody turns on a light'. Then you realize: 'Nothing is there' and you sink down, while letting go of the breath. (Penkova 2013a)

The figurative language of this description is very powerful. Indeed, specific mental imagery is often evoked in vocabularies in dance transmission practices. This functions as an important clue for dancers in their performance of a choreography. It helps dancers to articulate idiosyncratic movement qualities and to direct their intention. In other words: What happens in dancers' heads when they dance *matters*. As De Keersmaeker put it with regard to *Rosas danst Rosas:*

> The oneness of the four dancers is partly due to joint timing, for instance to the fact that they fall at exactly the same instant. But even when all the lines coincide beautifully there is simultaneously a field that expresses something else as well, something that happens inside their heads and which they want people to see. (Laermans 2012, 88)

Here, however, I propose to take a closer look at an element that stood out most during this workshop: the emphasis the dancer put on breath. The first movement of *Rosas danst Rosas* is performed in silence for a duration of 35-40 minutes. The dancers need to use their breath to tune in together, to be able to move in unison and to establish the right rhythm. One dancer comments: 'I think the breath really is the key of the first movement. It enables us to stay together' (Youn 2013). By learning to attune to each other's breathing, the dancers are able to make the timing of their movements more precise. 'Of course when I turn to somebody I look at their movements, but my first attention goes to the ribcage, I *see* the breath or I *hear* it, it's really breath, breath, all the time' (Penkova 2013b). The process of finding out how to breathe together is an important part of learning to perform the choreography. Penkova remarks on how the cast of dancers affects the dynamics of this process:

> The first part is so much relying on the breath and the rhythm of all four of us. You can feel that Sandra has this way of making 'slow'. Anne Teresa's heartbeat is slightly different, everybody has a personal tempo. For Sandra, Tale's fast is fast, but for Sue-Yeon, Tale's fast is not fast enough, so it's so important to tune and to listen to the breath. (Penkova 2013b)[16]

Indeed, while instructing the students, Penkova often repeats sentences like 'You are breathing one breath', and 'There are no counts here, you only have the breath to stay together.' Moreover, the breath is not only used by the dancers to synchronize, it also plays a crucial role in shaping the expression of the movements. In the demanding, repetitive structure of the choreography, breath plays an important role in avoiding a mechanical repetition of the movements. It is the instrument that keeps the expression alive. Penkova says, 'The breath gives the color to the whole scene. The breath communicates that it is something more than movement.' The dancers are also encouraged to connect the intention of the movement to the direction and control of the breath. Penkova:

[16] The dancers that are referred to in this quote are Anne Teresa De Keersmaeker, Sandra Ortega and Tale Doven.

> This is something that is often emphasized by Anne Teresa and Fumiyo [Ikeda], it is a *breath with intention*. It is something you really need to emphasize; you have to breathe out and really mean it. You have to create a movement with your diaphragm; the diaphragm movement is the generator. I cannot start the movement without the diaphragm; it is the propeller that creates the rest. You can compare it to speaking. If I speak my mouth pronounces the words, but if I don't have the breath, I could not communicate the words. (Penkova 2013b)

This quote draws attention to the importance of the diaphragm for dancers. The diaphragm is a dome-shaped muscular partition that separates the thorax from the abdomen; it is strong and resilient. When it contracts, the volume of the thorax increases, so that the lungs are filled. Dancers continuously make use of intra-abdominal pressure to support their balance and to regulate the intensity of their movements. In addition to controlling breathing, contracting the diaphragm also helps dancers to move with less effort, for example when straightening and bending their spine. Another striking aspect of this quote is the comparison the dancer makes between dancing and speaking. She draws a parallel between the expression of a dance movement and the *enunciation* of speaking, pointing to the fact that in both examples of human expression control of the diaphragm is essential.

The breath also has a crucial function in articulating the contrasting movement qualities 'attacked' and 'suspended' that play a key role in the choreographic structure. A description of these movement qualities is included in *A Choreographer's Score*'s 'Short glossary of frequently used technical terms' (244-5). Here, 'attacked' is described as 'quick, intense, dynamic, accented as by a vigorous beat; analogous to *sforzando*, a strong, sudden accent on a note or chord, "suddenly with force"' (244). 'Suspended' is described as 'pulling out, slowing down, without accent, and defying gravity by arresting a movement or a position; analogous to *legato* (a smooth, slurred effect on notes, leaving no audible spaces between them) and *tenuto* in music (holding or sustaining a single note)' (245). 'Holding a note' also invokes 'holding your breath', although this analogy is not made explicit here.[17] The analogy drawn here between movement qualities and musical terms is striking. The comparison of De Keersmaeker's movement qualities with musical terms is an example of an element in *A*

[17] However, this analogy is all the more apparent in the recent Rosas performance *My Breathing is My Dancing* (2015), a duet performed by flutist Chryssi Dimitriou and De Keersmaeker, 'who dances in the steps of the flutist's breath' (Rosas 2015). This performance is discussed in more detail in Chapter 6.

Choreographer's Score that leads to confusion about how the voices of the two authors are entangled in the first-person perspective from which the text in the book is written. In the DVD interview, De Keersmaeker describes the quality of the *phrase lente* as 'slow and suspended'. In addition to these adjectives, in the book the term *legato* is used to describe these qualities, for example in the description of the first movement (De Keersmaeker and Cvejić 2012, 86). The use of such a technical musical term does something different here than compensating 'for a precision that the spoken word sometimes lacks' (Cvejić, 12). The inclusion of this term reveals the identity of the musicologist writer (Cvejić), while the text is in fact written in a first-person perspective, relating to the choreographer (De Keersmaeker). Even though the relationship between music and dance is one of the main subjects of De Keersmaeker's work and she is very knowledgeable about music, this does not necessarily imply that technical terms such as *legato* and *tenuto* are the most adequate terms to describe her work.

Although I did not perform an in-depth study of the ideas of Laban as part of the research for this thesis, it does seem that the Effort/Shape terminology that is used in Laban Movement Analysis offers a far more specific armamentarium to identify what happens in the attacked and suspended movement qualities. Effort, as noted by Charlotte Wile, 'is analogous to music dynamics, and [to] adverbs and adjectives that describe the manner in which movements are executed' (Wile and Ray 2010, 74). Wile further describes Effort as

> the bodily expression of the mover's conscious or unconscious feelings, impulses, or motivations. Its variables include dispositions toward time (sustained or sudden), attention to space (focused or all encompassing), activation of body weight (lightly or strongly), and movement continuity (free flowing or controlled). (Wile 2010, 74)

Effort factors are described in terms of weight (light/strong), flow (free/bound), time (sustained/sudden) and space (indirect/direct).

In what way, then, could the attacked and suspended movement qualities in *Rosas danst Rosas* be described using these Effort factors? The attacked phrase can be characterized by Strong Weight, Bound Flow, Sudden Time, Direct Space. The suspended phrase is more versatile when it comes to Effort factors. It displays Strong and Light Weight, Bound Flow, Sustained and Sudden Time and Indirect and Direct Space. Such a basic evaluation of the two qualities immediately shows that there are several factors that the attacked and sus-

pended phrase have in common. The *phrase lente* contains various accents, such as the gesture in which the fingertips snap together above the ground and also the quick turn of the head (as if 'somebody turns on a light'). In these movement accents, effort factors can be identified that also lie at the root of the attacked phrase: Sudden Time and Direct Space. This is for instance the case with Bound Flow. This common factor can be recognized in the descriptions of dancers who often speak about resistance. In the interviews, dancers usually indicated the movement quality 'suspended' with the term 'slow'. They associate 'slow' with terms like 'resistance' and 'a feeling of endlessness'. A dancer related that the rehearsal director (Ikeda) articulates this resistance as 'really not wanting to wake up.' Penkova adds: 'It better be something good [to wake up for], so if it's not something good…you're reluctant. So more and more, you get a little irritated even' (2013a). Such a description is useful for dancers, because it helps them to imagine a specific body state they should be looking for.

The dancers describe 'attacked' as not just fast, but both fast and very precise: one should be able to see every movement that also appears in the 'slow' version. The 'attacked' movement quality is also characterized by an accelerated movement that ends in a sharp 'stop', a moment in which both the breath and the movement briefly come to a halt. Ikeda relates the 'attacked' quality to the concept of 'pulling and releasing', an important motive in Rosas' oeuvre that can be traced back to the influence of Fernand Schirren.[18] During a rehearsal, Ikeda explains 'attacked' by using the metaphor of a bow: 'The more you pull, the faster you go. If you don't pull it is not strong enough' (2014a). 'Pulling' is not the only principle, Ikeda points out; it is a combination of 'pulling' and 'twisting'. In the interview, she picked up a towel and twists and pulls it to demonstrate the idea:

> It's not only straight, there is also a spiral. Only pulling is not strong, turning makes it much stronger. [This spiral] is everywhere in the body. Also in the brea-

[18] Fernand Schirren was De Keersmaeker's rhythm teacher at the Mudra dance school and in the second half of the nineties De Keersmaeker invited him to teach at P.A.R.T.S. (Schirren 2011). De Keersmaeker has called Schirren her most important teacher (T'Jonck 2006, 57). The core exercise that Schirren used was to ask dance students to create a basic, even rhythm with two (drum)sticks on a wooden table. Left, right, left, right. The students' objective was to find the *boum*. At the core of Schirren's philosophy of rhythm stood the alternation between the principles *ET* and *boum* (Plouvier 2002, 280). In between these exercises, Schirren spoke about rhythm, dance and life. De Keersmaeker learnt how she could translate Schirren's lessons of the rhythmic beating of the sticks to the movement of her feet over the ground (De Keersmaeker in Schirren 2011, n.p.). Schirren's lessons may thus be recognized as a vital foundation for De Keersmaeker's acknowledgment of walking as the basis of her choreography ('My walking is my dancing'). Just like drumming, the repetition of the seemingly basic movement of walking (left, right, left, right) can become a captivating performance depending on the precision of the timing.

> thing; it doesn't only go up and down, there is a spiral in the breath as well that gives it much more depth. (Ikeda 2014a)

At the time of the first revival of *Rosas danst Rosas* in the early 1990s, De Keersmaeker explained: 'I adhere to the writing itself, the sovereignty of the structure that persists, independent of the particular performers' (2012, 115). Here, the central role that is assigned to the *logos*, the written score, in the transmission process becomes again apparent. However, in the work of Rosas, as Mark Deputter puts it: 'Structure is never just rational; emotion is not limited to meaning. That, of course, has also to do with the core material of choreography: the human body with all its idiosyncrasies, emotional charge and energy' (Deputter 2012). Indeed, De Keersmaeker herself has described the dancer as 'an organized energy field' (Laermans 2012, 87). Whereas interviews with dancers acknowledge this 'sovereignty of the structure', they also reveal other aspects that present the performance as constantly changing, living tissue. As one dancer remarks: 'It's not a choreography in which you try to do the same each time, it's alive, it's very much alive' (Loemij 2014).

These sources show the imaginative use of language in dance transmission, which is rarely articulated outside of this domain. The dancers' accounts provide a deeper understanding of the information that is available in *A Choreographer's Score* by showing how physical know-how connects to choreographic principles. Workshops, rehearsals and interviews with Rosas dancers highlight various ways in which dancers use breath as an instrument for the expression of dance movements.

1.6 *Rosas danst Rosas* by De Mey: How film articulates movement qualities

A well-known source relating to the choreography *Rosas danst Rosas* is the award-winning film of the same title made by filmmaker Thierry De Mey (1997). How does this film perform *Rosas danst Rosas*? The origins of the film can be traced back to the creation of the choreography, 14 years earlier. Together with composer Peter Vermeersch, De Mey had closely collaborated with De Keersmaeker in 1983 to create a musical score that would work well with the choreographic ideas that she envisioned for the performance. De Keersmaeker: 'We wished to bring choreography and musical composition together by creating a dramaturgical framework that could guide both movement and music.' Although it is hard to believe when considering the overpowering and gripping musical score that was composed by Vermeersch and De Mey, this was actually the first time that De Mey had written music, since he was

mainly a filmmaker at the time. In 1997, fourteen years after the performance premiere, De Mey directed the film *Rosas danst Rosas*. By then, the performance had already been in the company's repertoire for more than ten years, had been danced by several casts, and had acquired canonical status in the international dance field.

Although the choreography was radically shortened for the film, the dance material that *is* shown closely follows the choreography of the stage performance. The four performers that are part of the stage performance were not the only ones to appear in the film; dancers that were part of earlier casts also made an appearance. This choice effectively visualizes the importance of the performance within the company. De Mey chose to stage the performance in the former technical school of architect Henry van de Velde in Leuven. The architectural features of its rooms, hallways and other spaces resonate with the importance of geometrical features in De Keersmaeker's work. De Mey skillfully depicts the tension between inside and outside, between showing and keeping secret, which are important motives in the performance. For instance, in several scenes, a dancer in a hallway or other room of the building that appears to be otherwise empty looks straight into the eye of the camera while dancing, which suggests an exclusive position of viewers and gives them the impression that they are let in on a secret. At other times, the viewer is invited to take on the perspective of a voyeur, as the camera hovers along the outside of spaces, looking in on the dancers through windows and door frames. These motives are also emphasized by other choices for set and direction. For instance, the seductive slow solo of Michèle Anne De Mey in the third movement, in which she alternately reveals and covers her breast, is set in bright sunlight on the roof of the building. The passing of the day that is thematized in the choreography is visualized in the film by filming in pre-dawn darkness, daylight and twilight. Although the passing of the day and inside/outside are key motives of *Rosas danst Rosas*, in the stage performance these motives are suggested in a much more abstract way, for example through the use of lighting design. Finally, the film's montage is aligned with the intense, machine-like and shifting rhythms of the musical score, jumping from one perspective to another and rhythmically alternating between establishing shots and extreme close-ups of dancers' faces.

De Mey's profound knowledge of De Keersmaeker's artistic ideas and style is evident in the way he stages the contrasting movement qualities 'slow' and 'attacked' in *Rosas danst Rosas*' first movement. In the performance, this part of the choreography takes place at the far end of the stage, which creates a large distance between the audience and the dancers. This distance is emphasized even more by the closed bodily expression of the performers ly-

ing on the ground. Their gaze remains directed downwards, even when they raise their upper bodies up from the ground by pressing their arms to the ground. The film employs a radically different strategy. The camera is positioned quite close to the dancers in a room that — even though it contains no furniture of any sort — seems to breathe the intimate atmosphere of a bedroom. The performance of the four dancers is filmed from different angles. It takes in a frontal perspective that shows an establishing shot of the dancers, but it also moves to the sides of the room. From this perspective close-ups of the dancers can be seen while they are lying down on their sides; a point of view that is never available when watching the stage performance. The extreme close-ups of the women's faces pulls the viewer right into the intimate atmosphere of the themes that De Keersmaeker was inspired by when she developed the choreography: the time between sleeping and waking and the moments of talking to a lover while lying in bed.

However, it is not only these visual strategies that make the dancers' expression so tangible. The strong amplification of the sound of the dancers' breath in the film is a brilliant move. The audible breath makes it easier to perceive how the dancers tune in to each other. It intensifies the viewer's perception of the 'slow' and 'attacked' movement qualities. In the slow version, the breathing is similarly slow and supports the resistance in the stretched, spine-twisting movements on the ground. The attacked version is characterized by sharp breaths. The viewer can hear and see in great detail how the breath is sucked in, stopped and held, and then powerfully pushed out of the body. The movement of the breath is first in alignment with the sideward turns as the dancers roll over the ground. Later a similar alignment with the breath occurs during the upward and downward movements of the upper body, which are supported by the arms. Complete video recordings of the stage performance would certainly give more insights into the 'what and where' of what happens on stage, but by amplifying the soundtrack of the breath and creating a dynamic montage, De Mey's film successfully highlights movement qualities and core ideas in *Rosas danst Rosas*.

The difference between stage and film version is not limited to making the breath audible. As in the rest of the film, only a small selection of the first movement is included. This selection includes the entrance of the dancers; their fall to the ground; the first attacked sequence ('la phrase attaquée') and the first slow or suspended sequence ('la phrase lente'). In the interviews I conducted, several dancers commented after seeing this excerpt of the film that they continue to perform the first movement of the choreography exactly as shown in the film. However, a close comparison of this excerpt of the film with the corresponding part

in a stage recording of the performance reveals significant differences.[19] These differences do not concern the choreography itself, but the pace in which it is performed. Both the attacked and the slow phrase are performed much faster in the film than they are on stage. In the attacked phrase this difference is slight with regard to movement cells A-D. In the performance of cell E, the final movement cell of the phrase, the dancers are standing on their knees before dropping to the ground and rolling on their side, facing right. In the film, the knee stand in cell E is held for 3-4 seconds. However, in the stage performance this knee stand is stretched much longer, lasting more than half a minute (36 seconds).[20] The significant difference in pace between the film and the stage performance is even more apparent in the suspended phrase, which lasts 7 minutes in the film, compared to 10.5 minutes on stage. This different pace is noticeable in the dancers' use of their breath. In the film, the breath continues to be (audibly) used to reinforce the expression of dance phrases, whereas in the stage performance the pace in which the movement phrases are performed is too slow for the dancers to stretch their breath from the beginning to the end of the corresponding movements, as they have long run out of breath along the way. This difference has significant consequences for the intensity of the performance in the film, which was, as noted above, already heightened by the proximity of the camera. These and other differences between film and performance shed a different light on De Keersmaeker's conviction to adhere 'to the writing itself, the sovereignty of the structure that persists' (2012, 115).

This conviction is also incorporated in *A Choreographer's Score,* in which the film is used to illustrate and segment the movement cells in the first movement. In this way the *Score* authenticates the film as a legitimate source for the piece. Indeed, since its creation, De Mey's film has become one of the most important sources for the performance. In fact, the film appears to be *equated* with the performance itself, because of the same choreography lying at its basis. De Keersmaeker is aware of the effects of this development, as was demonstrated in a public conversation with André Lepecki (De Keersmaeker et al. 2014). In this conversation, De Keersmaeker recalls Lepecki's surprise after seeing *Rosas danst Rosas* performed in the early 2000s, while having seen the performance before in the early 1990s.

[19] I compared De Mey's film with the stage recording of *Rosas danst Rosas* at Lunatheater, Brussels, June 1995, which is part of the Rosas Visual Library. The cast of this performance is the same as the cast that performs the first movement in De Mey's film (namely: Cynthia Loemij, Sarah Ludi, Anne Mousselet, Samantha van Wissen).

[20] Note that in the book of *A Choreographer's Score*, the movement cells of the first movement are listed to be only four movement cells: ABCD, whereas in the DVD interview on *Rosas danst Rosas*, De Keersmaeker lists ABCDE, five movement cells in total.

De Keersmaeker to Lepecki: 'Your experience of the blackbox experience was wiped out by the De Mey film. The stage was then almost too static' (De Keersmaeker et al. 2014). Although the film and the stage performance are based on the same choreography, the effect they have on viewers is fundamentally different. This leads to questions that are at the core of the actual debate on dance research and documentation, such as: to what extent can we experience a dance through its documentation? For instance, Caroline Rye notes that 'The danger exists in that, through this accessibility, an ease of consumption is produced and the record can all too quickly become a substitute for the live event it re-presents, a substitute that cannot provide evidence of exactly the thing it purports to record' (2003). De Mey's *Rosas danst Rosas* film illustrates Rye's point and confirms Auslander's view on the performativity of performance documentation:

> There is no question but that the performance document becomes a surrogate for the original performance: we rely on documentation to provide us with information about performances that we have not seen, and we take the information to be about the performance, not the document. (Auslander 2014)

1.7 Dancers' voices as a source of dance knowledge

In the analysis of his experiences as rehearsal director of a Pina Bausch performance, Stephan Brinkman underlines the highly creative aspect of working on a reconstruction: 'Although ostensibly a reconstruction may seem like a repetition of the past, precisely what it demands is to discover something new in the repetition, and to accept the challenge of extracting something unique from the familiar' (2014, 95). Sally Gardner makes a similar point when she writes about dance transmission in terms of a continuous process of translation by the dancer: 'The dancer's role in translating, but also in mistranslating, spurs repetition and, potentially, insights and discoveries, allowing future dancers to be writers' (2014, 236). Indeed, dancers' accounts of the transmission and performance of *Rosas danst Rosas* show how deeply creation remains embedded in dancing the choreography again and again. To keep the repetitive patterns that are so characteristic for this choreography alive, a constantly shifting translation of the score to the stage is required. As choreographer Jonathan Burrows remarked: 'Any piece of choreography, any score, can work only if it enables the dancers to rediscover their own internal dance and let them take flight. Without that there is no life' (2000, 32).

While *A Choreographer's Score* offers many insights into De Keersmaeker's choreographic craftsmanship, it does not shed much light on the entanglement of choreographic devices with the physical reality of the dancer's experience. Interviews with dancers offer an inside look into the transmission practices of choreographies. As a source of dance knowledge, interviews necessarily involve incompleteness and inadequacies. However, their value lies in making an experience that would otherwise have remained unarticulated outside the studio accessible. As is observed by Ikeda, kinesthetic and verbal communication plays a dominant role in the dance studio:

> There is no use in making notes about things that are said during the rehearsal apart from the formal structure of the choreography. The things that are said about the movement quality, those are things that your body should learn and that should be stored inside your body. You shouldn't write them down. (Ikeda 2014a)

The strategies and techniques that Rosas dancers use to translate De Keersmaeker's choreography to the stage constitute a singular performative knowledge that offers opportunities for new analytical perspectives on this work. Indeed, despite the critical observations I have made in this chapter with regard to *A Choreographer's Score*'s resistance to contemporary methods of research, its detailed information opens up more in-depth engagements with this work. Complex choreographic structures are a key aspect of De Keersmaeker's poietics and are typically the focus of discussions of her work. However, as Bräuninger has recently suggested, further study of Rosas' work could benefit from an 'alternative approach — one that highlights its performative impact' (2014, 58). Dancers' accounts of the performance can offer a deeper understanding of the performance when it comes to issues of how to perform certain movement qualities, how to dance together and how to keep the repetition of movement cells alive. Their observations can be used to reinterpret dance material and other existing sources, thus expanding the realm of what is recognized as 'dance knowledge'.

What happens when radical repetition of movement cells and other choreographic devices, as articulated in *A Choreographer's Score*, are mapped onto the dancers' bodies that carry out such repetitions? How can the embodied reality of choreographic concepts of repetition and duration be reflected upon, not just within a single dance, but in a long-term repertory practice during which injury, aging and cast changes will inevitably affect the performance? Making the connection between choreographic ideas and dancers' voices pro-

vides a deeper understanding of what strategies they use to learn, to perform and to transmit dance, and, in the specific case of Rosas' oeuvre, how dancers deal with repetition and make the score come alive - again and again and again.

1.8 Conclusion

The presentational mode of *A Choreographer's Score*, in which recordings of interviews allow De Keersmaeker to both describe *and* show dance movements, resembles the regular process of dance teaching and learning. In this way, the publication reaffirms a core belief that dance should be taught and learned through body perception and mimicry. It emphasizes the high value that dance practitioners attach to tacit knowledge or the 'know-how' of the dancer, which is acquired by watching and doing. Since there is usually no direct need for external representation of these processes in dance practice itself, detailed references to this type of knowledge tend to be under-represented in dance literature.

This chapter explored how different presentational modes of the same creation — live performance, performance recording, score, film version — over time have resulted in different performances of the same choreography. Interviews with dancers of the Rosas company draw attention to features of performative knowledge that are not made explicit in *A Choreographer's Score,* especially the crucial role that the dancer's breath plays in the performance of *Rosas danst Rosas* (1983). The breath is essential for the coordination and control of the timing of dance movements. The direction of the breath is also used to give expression to the specific movement qualities the choreography requires, such as 'attacked' and 'suspended' movement phrases. Thierry De Mey's direction of the film *Rosas danst Rosas* (1997) also emphasizes this aspect of the performance with a strong amplification of breathing sounds and close-ups of the dancers.

While oral and bodily communication may well be the gold standard of dance transmission, this does not mean that this type of tacit knowledge transmission is unproblematic. Embodied dance knowledge is unbeatable in its depth and detail, but it is also subjective and unstable. Even within the same dance company, opinions about core ideas of a performance can be quite different and subject to change. This chapter has proposed that researchers could learn more about these performing strategies of dancers, by for example closely observing processes of dance transmission, conducting interviews with dancers, and analyzing film and video material. In the following chapters I argue that such research on the know-

how of dancers not only benefits dance practice itself, but is also of high interest to experts outside of dance practice who are engaged in practices of corporeal computation.

Chapter 2

Dance as Knowledge

> It seems clear that electronic technology has given us a new way to look. Dances can be made on computers, pictures can be punched out on them, why not a notation for dance that is immediately visual?
> — Merce Cunningham, *Changes: Notes on Choreography* (1968)

> The possibility of a body that is written upon but that also writes moves critical studies of the body in new directions. It asks scholars to approach the body's involvement in any activity with an assumption of potential agency to participate in or resist whatever forms of cultural production are underway.
> — Susan Foster, "Choreographing History" (1995, 15)

2.1 A genealogy of 'dance knowledge'

A striking feature of the contemporary field of dance practice and research is the way in which motion capture technologies are increasingly applied in the effort to analyze, interpret and preserve dance. Considering dance's typical resistance to being notated in words or other symbols, these practices may be read as an alternative ways of bringing dance into discourse. A central claim of this thesis is that it is crucial to trace the development of the connection between 'dance' and 'knowledge' in order to grasp and identify the various motivations that lie at the basis of the contemporary encounter between dance and motion capture. To substantiate this claim, this thesis can be read as a selective genealogy of this contemporary notion of 'dance knowledge'. The striking notions of dance knowledge in the contemporary discourse of dance studies did not arise out of nowhere. This phenomenon is part of a development that, ideally, should be investigated by conducting a critical excavation that meticulously unearths various cultural-historical layers. A comprehensive genealogy of this type would certainly be valuable in its own right, but the scale of such an endeavor exceeds

the aims and boundaries of this dissertation. Instead, I focus on a carefully selected set of scientific, technological and artistic developments that have significantly contributed to the current concern with 'dance as knowledge.' By tracing some of the origins of this concern, the groundwork is laid for a critical reading of the extraordinary event that is at the focus of this study: The entrance of the dancer into the motion capture volume. It is important to know more about various notions of dance knowledge to come to an understanding of the practices that have ensued from this event. As will become clear in the course of this thesis, the ambiguous responses to this practice are closely tied up with conflicting and continuously evolving ways of understanding how dance can be 'known' and what 'dance knowledge' may include or exclude.

As my use of the term *genealogy* already indicates, my examination of the origins of dance knowledge is inspired by the method Michel Foucault developed in his groundbreaking historical inquiries, and perhaps best exemplified by *Discipline and Punish: The Birth of the Prison* ([1975] 1995). In *Discipline and Punish,* Foucault describes genealogy as a 'history of the present'. His method does not consist of trying to understand the past on its own terms. Rather, the aim of his genealogical method is to trace the origins of a general mode of thinking that he considers to be restricting and shaping the conceptual environment of a specific contemporary practice. In *The Archaeology of Knowledge* ([1969] 2012), Foucault uses the terms 'archaeological framework' or *episteme* to describe such a mode of thinking. Foucault's work shows how discourse analysis — the analysis of a wide range of statements on one subject — reveals patterns that enable or constrain the emergence of new ideas and concepts. Furthermore, a central feature in Foucault that is significant for this thesis is his recognition that human bodies will be affected when social and cultural systems shift and develop. He draws attention to the way in which objects, technologies and architecture structure human thoughts and behavior. Consider for example his analysis of how the panoptic architecture of the prison produces docile bodies (Foucault 1977, 195-228).

Foucault's work has had a lasting impact. This impact can also be recognized in the contemporary research interest in 'vital materialism'. Two years after the original publication of *Discipline and Punish*, psychologist James J. Gibson wrote the article 'The Theory of Affordances' (1977), on which he later elaborates in *The Ecological Approach to Visual Perception* (1979) - a work that had a big impact on studies of human-computer interaction. Gibson's work also continues to influence current research, political theorist Jane Bennett's 'vital materialism' (2010) being a prominent example. A core question posed by Bennett is: 'Does our

thinking about political agency — about what can make things happen in the public arena — take adequate account of material agency?' (Bennett 2007, 133). The acknowledgment of the 'active participation of nonhuman forces' and the 'thing-power', which Bennett proposes, was already present in the work of Foucault, albeit in different terminology. Indeed, the importance Foucault attributed to the corporeal and material dimensions of historical change has always been closely associated with his work. As philosopher Gary Gutting asserts, a 'Foucaultian genealogy, then, is a historical causal explanation that is material, multiple, and corporeal' (2005, 47).

Foucault has also inspired this study through his insight into how discourses are simultaneously structured and shaped by the relationship between knowledge and power. The discourse around dance knowledge is shaped to a large extent by a struggle between parties that all have their own stakes in, and their own say about, the topic. These parties include, but are not limited to, dance practitioners, dance scholars, philosophers, computer scientists, film directors and game designers. Representatives from these parties claim specific types of authority when it comes to the question of what it means to 'know' human movement through motion capture. Their answers to this question mutually influence each other in the multidisciplinary dance knowledge discourse, which, as a result, is continuously shapeshifting. At the same time, over time, this discourse has acquired some discernible, prevalent features. One of these features is a widely shared interest in deliberately moving dance into a more explicitly discursive domain, that is, to mediate various types of dance knowledge into formats that allow for a 'sustainable reading' of dance.[21]

Critics of this approach argue that such strategies produce a metaphorical conceptualization of dance that is undesirable. In their view, such a conceptualization turns dance into a demarcated, tangible object, which can be known and thus also *controlled*, thus undermining the precious singularity that is at the heart of dance experience. In this sense, such new approaches represent a considerable shift compared to long-standing ideas of dance as a phenomenon that, ultimately, cannot be grasped, especially due to the embodied nature of dance transmission and the ephemerality inherent in its performance. Such views propelled the resistance of dance to recording and capture to mythic proportions. Dance as an 'object of knowledge', on the other hand, presents the idea of dance as a phenomenon that can be

[21] William Forsythe's notion of 'choreographic objects', which is discussed later in this chapter, can be regarded as a prime example of an explicit strategy to transpose dance into a peculiar type of discursive object, one that comprises a distinctly tangible sense of the term 'object'. Forsythe has often stated that the lack of a 'sustained reading of dance' motivated him to create 'choreographic objects'.

studied and understood to a deep extent, even when researchers themselves do not have the possibility to engage in the rigorous, long-term process of embodied learning. Understanding dance as knowledge thus causes a rupture with the mythical celebration of dance as a phenomenon that is ultimately ephemeral and ungraspable.

I distinguish a number of developments that have contributed to the contemporary shift of dance knowledge into a more explicit discursive domain. I have based this selection on its relevance for the subject of this thesis: practices in which motion capture is used to create digital renderings of dance knowledge. This selection provides a contextual framework that allows for an approach of these practices combining both specific, individual influences and larger-scale developments occurring in different schools of thoughts. Significant recent developments that have promoted the view of dance as knowledge since the turn of the century include: The influence of cognitive studies on the performing arts (McConachie and Hart 2006); the growing area of 'practice as research'; and the austerity measures in the arts in the aftermath of the financial crisis of 2008, which have prompted several coping strategies, including what I call 'strategies of self-visualization'. With these strategies, the dance field has deliberately set out to appeal to the values of 'knowledge economies'.

Furthermore, a shift can be recognized in a series of critical 'turns' in which the acknowledgment of the bodily basis of cognition is of central importance. Partially overlapping in chronology and content, these turns have been alternately designated as the experiential turn, corporeal turn and practice turn (Schatzki et al. 2001). In this chapter, I discuss how the notion of 'tacit knowledge' (Polanyi 1958; 1966) has been taken up as part of this paradigmatic shift, which attaches great importance to the embodied basis of knowledge. The impact of this paradigmatic shift, which roughly starts to have an effect in the 1970s, coincides with the final two developments that I believe are relevant for the notion of 'dance knowledge' gaining prominence. The first is the professionalization of dance studies as an autonomous, academic discipline, which I touch on in the subsequent section of this chapter. The second is the impact of the arrival of digital technology on ways of thinking about the documentation and transmission of dance. The possibilities of the computer, as will become clear in Section 2.4 of this chapter, stirred the imagination of the dance field and gave rise to the possibility to 'compute' the dancing body, which then became a prime research topic of both artistic and analytic pursuits.

2.2 Dance studies enters the academy

Despite damaging austerity measures in the past decade,[22] the dance field continues to grow on a global level and is becoming increasingly connected, making the most of digital networking, international co-productions, workshops, residencies and international dance festivals. Although dance studies has firmly established itself as a professional research arena, as attested by a steadily increasing number of university programs, international conferences and publications, it is still a relatively young academic discipline. It continues to be engaged in the legitimization of the position it occupies within the academy and in the development of its attitude towards the dynamic between dance research and practice. During the significant growth of dance studies of the past three decades, the curricula of dance schools have also undergone developments that have broadened the scope of the knowledge and abilities a professional dancer needs to have at the end of such a program.[23]

The relatively late establishment of dance as an autonomous academic discipline is a telling aspect of the struggle for recognition of dance as a subject worthy of rigorous study. While art history and musicology became autonomous academic disciplines at the beginning of the 20th century, university curricula of dance studies, theater studies and performance studies in the United States and in Northwestern European countries were first set up in the 1920s. Max Herrmann is generally recognized as the founder of theater studies in Europe. He wrote a plea for its academic institutionalization in 1919, which was realized by the establishment of an institute for theater studies in 1923 at Berlin University. In Belgium, the Netherlands, and the UK, this area of studies was established as an autonomous discipline in the 1970s and 1980s.[24] In various European countries, theater studies emerged by claiming independence from the existing disciplines they were a part of. This was English literature (Shakespeare), Classical literature (Greek tragedy), history or art history. These influences were also long felt in the early-established Berlin institute, where the professor who chaired the theater institute until 1944 was a professor in literature (Julius Petersen). Dance studies

[22] The following texts discuss recent substantial budget cuts in the arts in the Netherlands, the UK and Australia respectively: Van Heuven (2013), Bishop (2011) and Croggon (2016).

[23] De Keersmaeker's P.A.R.T.S. is an example of a school that has achieved much success by creating conditions for students to reflect on contemporary dance and choreographic practices. The school's founding documents state that 'The institution's main educational purpose is to train 'thinking dancers' (…) A thorough training in traditional, modern and contemporary dance techniques is therefore complemented with extensive classes in theatre, music and theory' (Laermans 2015, 287).

[24] There are many national differences on a global level. I mention the contexts here that I am most familiar with.

has gradually gained terrain in such newly established theater and performance studies departments.

In the United States, dance studies emerged from practice rather than by severing itself from another academic discipline. Ellen W. Goellner and Jacqueline Shea Murphy describe this development as follows: 'Dance studies entered the academy, if not through the back door, then through a side door — a gym door, to be precise. Modern dance first appeared in college and universities in the United States in physical education departments' (1995, 3). In continental Europe, there was a wider educational divide between theory and practice, which thwarted such a development.

In the US, the specific transition of the study of dance from physical education to an academic environment produced a unique set of ambiguities and prejudices. Susan Foster, whose dance scholarship has been deeply influenced by her dance making, recalls that during her time at college (in the 1970s), she did not get academic credit for dance courses. 'Dance was regarded as a non-cognitive activity,' she says (Foster 2014). When she was teaching at the department of dance at Wesleyan University in the early 1980s, she was asked by the librarian whether she could give him some exercises to 'slim his hips'. Others inquired: 'You also give massages, right?' (Foster 2014). When Foster became chair of the dance department at UC/Riverside in 1990, she created the first doctoral-level program in critical dance studies in the United States. In the UK, the first dance program in higher education was introduced in 1975 at the Laban Centre (Bannon 2010).

Foster has been a powerful advocate of the mutual enrichment of performance practice and academic research by dance scholars. However, prejudices about the non-cognitive basis of dance continue to be partially responsible for the hesitant embrace of dance studies as a legitimate academic discipline. This has resulted in the downplaying of specific subjects of interest, such as the creative processes, transmission practices, and embodied knowledge of dancers. Goellner and Shea Murphy observe that:

> Writing about dance was sometimes seen as deauthenticating, as though analysing it or theorizing about it would detract from the evanescent meaning of the movement. (…) Behind these prejudices, in large part, was dance's grounding in physical bodies and in the now familiar conceptions about and distrust of the body and bodily practices held by Western scholars working in a logocentric tradition. (Goellner and Shea Murphy 1995, 4)

Here, Goellner and Shea Murphy draw attention to two key issues that have frustrated the development of dance studies. First, if written analyses of dance are discarded because they are not thought to give access to legitimate insights in dance, it becomes difficult if not impossible to build up a discourse that allows for a critical study of dance. The second issue is the problematic position of bodily practices in Western academia, which has long been permeated by logocentrism: The idea that language constitutes the world and that meaning is always constructed and expressed by language. Conquergood, for example, warned of the dominance of propositional ways of knowing in the academy:

> What gets squeezed out by this epistemic violence is the whole realm of complex, finely nuanced meaning that is embodied, tacit, intoned, gestured, improvised, coexperienced, covert — and all the more deeply meaningful because of its refusal to be spelled out. (Conquergood 2002, 146)

This deep-rooted focus on the expression of speech and written language has helped to downplay the study of bodily expression. Language that is used to describe bodily features seems to be limited, considering the complexity and richness of bodily or 'non-verbal' communication. For instance, it is striking how little vocabulary there is in English to describe in detail the features and expressions of the faces of people that we have the most intimate knowledge of. Foster makes a similar claim as Goellner and Shea Murphy when she writes:

> Traditional dance studies, replete with the same logocentric values that have informed general scholarship on the body, have seldom allowed the body this agency. Instead, they have emphasized individual genius over the rehearsal process and the social networks and institutional frameworks that enable the production of dance. (Foster 1995, 15)

Such logocentric values are also evident when considering the role of notation in dance history. Under the influence of technological developments and changing social attitudes towards dance, the history of dance notation has undergone several shifts in the choice of what dance features are written down. When dance notation emerged in the Renaissance, it was common to use letters and other visual symbols denoting the spatial pattern of the dance. The writing of dance, *choreography*, did not (yet) refer to the embodied dimension of the dance. Dance historian Mark Franko observes:

> Like writing itself, notation was divorced from the expressive realities of what linguists call *enunciation;* that is, the act of producing sounds or movements in real time and space are separated from their essentially "oral" character. Treatises in which notation occurred are notorious for providing no insight into the physical dynamics and stylistic detail of movement. (Franko 2011, 322–3)

Even though 'the historical evolution of notation increasingly highlights corporeality' (328), as Franko notes, both dance research and practice are still influenced by the logocentric heritage of choreography. Written scores may highlight limited features of a dance, for example its spatial distribution and the alignment of movement phrases, chronologically unfolding in time, with musical scores to visualize this linearity. At the same time these scores may downplay other dance features, such as the corporeality or the 'enunciation' of the dancing body.

In the past two decades, Practice as Research programs have also spurred on the debate about the different ways in which dance can be understood as knowledge. This can be illustrated by the work of dance scholar Anna Pakes, who emphatically proposes to examine the epistemic status of dance. In her article "Knowing through Dance-Making: Choreography, practical knowledge and practice-as-research" (2009), Pakes explores the question: Is choreography a way of knowing in its own right? She acknowledges that writers such as David Best, Graham McFee, David Carr and Betty Redfern have been 'keen to assert the legitimacy and value of dance within educational curricula' (Pakes 2009, 10). These studies reflect the growth of dance as a topic of practice and research in primary, secondary and tertiary education in the 1980s. Pakes assesses the underlying aim these studies have in common:

> Much of this writing highlights the cognitive processes involved in making, performing and watching dance – clarifying the contribution dance can make to cognitive development. A clear connection between choreography and particular kinds or domains of knowledge is thus revealed. (Pakes 2009, 10)

Pakes' observation shows that the identification of cognitive and intellectual features of dance practice is proven to be necessary in order to be able to legitimize dance as a topic of educational curricula. Pakes observes that the emergence of PhD degrees in Practice as Research marks another key development in the discourse on dance knowledge, because these developments have acted as a stimulus to further questions with regard to the epistemic nature of dance practice:

> If research (at least at higher degree level and beyond) is the generation of new knowledge, then treating dance practice as a form of research raises important epistemological issues. What kind of knowledge do choreography and performance generate? Is this knowledge specifically about the practice of dance, or also other domains? How does dance practice develop original insight, and how is this disseminated and shared? (Pakes 2009, 10)

These questions testify to the nature of this debate, which continues to be tied to the legitimization of dance practice predominantly occurring in terms of scholarly inquiry. A problematic aspect of this debate, as Pakes also indicates, is that it is rarely made clear what types of knowledge are distinctive for dance, and what this dance knowledge includes and excludes.

2.3 Dance notation as epistemic framework

Dance notation systems have played an important role throughout Western dance history as epistemic frameworks for the study and transmission of dance and movement. Efforts to establish dance notation systems have often explicitly been linked to endeavors to foster a cultural status and a place of authority. This is demonstrated by the earliest books on dance, which appeared in 15th-century Italy, when pageants and 'balli' were used as means of propaganda for Renaissance courts. Dancing masters were in demand and highly esteemed, because they were 'well conversed in the elaborate etiquette as well as the steps required on the ballroom floor' (Hutchinson Guest 1984, 43). Franko observes in *Dance as Text*, his study of baroque dance: 'During the sixteenth and seventeenth centuries, dance theorists and practitioners raised the question of how dance can be read' (1993, 14). Indeed, this period brought forth several pioneering works on dance that justifiably continue to receive attention in dance history curricula. At the end of the 16th century, Thoinot Arbeau's *Orchésographie* was published, a study of French Renaissance social dance that included instructions on ballroom behavior, as well as drawings of dancers and step instructions next to musical bars. In 1700, Raoul-Auger Feuillet published his *Chorégraphie ou l'art de d'écrire la danse*, based on a pre-existing system by Beauchamp, in which he details a notation system that would be widely used throughout the 18th century (fig. 4). Another momentous publication was *Lettres sur la danse et les ballets* ([1760] 2004), written by the French dancer and ballet master Jean-Georges Noverre, which articulated technical standards for ballet.

Dance notation expert Ann Hutchinson Guest has distinguished approximately 85 dance notation systems that have emerged over the past five centuries (1984). In her study

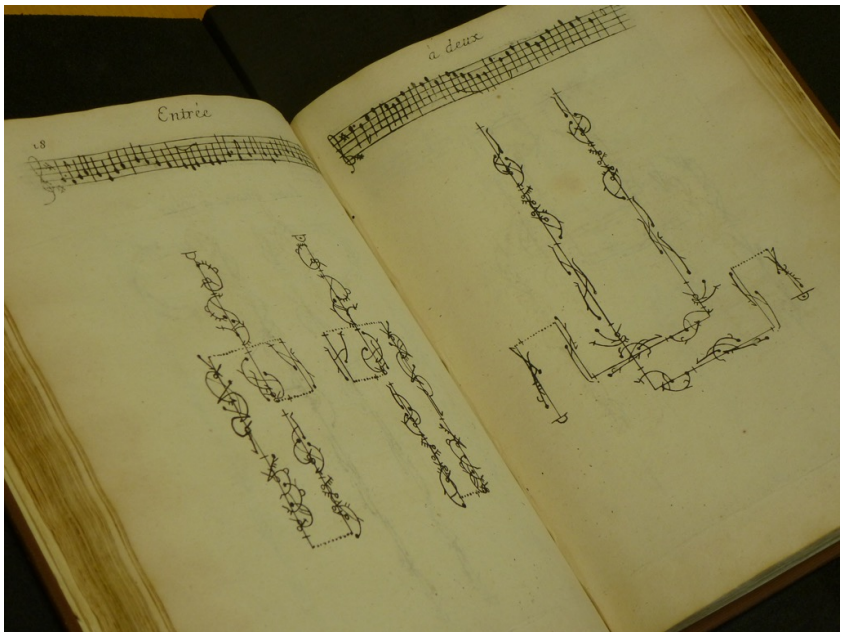

Figure 4. Raoul Auger Feuillet's *Chorégraphie, ou l'Art d'Ecrire la Danse* (Paris 1700) on exceptional display in the New York Public Library. Photo: Laura Karreman.

Choreo-Graphics: A comparison of dance notation systems from the fifteenth century to the present (1989), Hutchinson Guest describes a selection of these dance notation systems, highlighting their specific advantages and disadvantages. Hutchinson Guest explicitly framed her research as a way to promote notational systems as a primal means of communication in 'the language of dance'. She notes that 'the advent of a practical, functional dance notation system has been called 'a Gutenberg revolution in the dance' (1984, xi). Hutchinson Guest articulates the view that the possibility of writing and reading dance in notation systems opens up a deeper experience of dance and fosters dance preservation: 'Much has to be gained by moving dance out of the restrictions of the 'oral-visual' tradition into a literate one. Choreography has been called 'the throwaway art' because so many ballets were allowed to be forgotten, no attempt being made to make even verbal notes or draw floor plans' (1984, xi).

First introduced by dance theorist and choreographer Rudolf von Laban in the journal *Schrifttanz* (1928), Kinetography Laban or Labanotation has gained the most recognition as a means to describe dance and, later on, a wide range of movements in a symbolic notational system.[25] Gabriele Brandstetter notes on Schrifttanz that

[25] Labanotation was introduced by Rudolf Laban in the journal *Schrifttanz* (1928). Laban's notation system was further developed by his student Albrecht Knust after the Second World War. Labanotation continues to be developed further.

> Schrifttanz was focused on archiving *and* producing choreographies, a means of dance analysis, and 'dance education' as well as 'dance research'. It was meant to be a medium to canonise dance and at the same time an instrument to institutionalise it: 'The goals is written dance' - stated the programmatic introduction, written dance as a means to allow a wide distribution and a democratisation of dance *works* through reproduction in notation. However, the programme of a general introduction of this comprehensive Schrifttanz model to culture and education remained utopian. (Brandstetter 2007, 37)

The same can be said about Labanotation, which was subsequently developed and continues to be one of the most frequently used movement notation systems. As Franko has remarked: 'However influential it became, though, not even Labanotation became as broadly disseminated among dancers as musical notation is among professional musicians. Dance notation has been specialized and not the subject of a universal professional literacy' (Franko 2011, 327). Indeed, it should be noted that the use of dance notation systems has been — and continues to be — related to specific dance genres and styles. Generally speaking, the use of notation systems is fairly common in ballet companies, but these systems are rarely used in many 'contemporary dance' practices.

Dance's resistance to being written down in symbols with a stable meaning has greatly impeded dance-historical efforts and the preservation of dance legacies. But this resistance has also been identified as a valuable feature, its untraceability conferring a subversive power to dance. This is a tension that characterizes the dance field, one in which the universalizing claim of dance notation systems is seen as threatening and devaluing the singularity of specific choreographic styles and concepts. For instance, dance critic Laurence Louppe writes in *Traces of Dance* (1994) about the singular score writing and drawing styles of choreographers such as Lucinda Childs, Merce Cunningham, Anne Teresa De Keersmaeker and Mary Wigman:

> [These scores] have no precise cultural status, they occupy no place of authority or of symbolically invested reference. (…) [N]o stabilizing power, no corporative interest ever opposed their incessant transformation. No councillor, no clerk or federation of typographers ever bound them in place, on the strength of convic-

> tion and for particular advantage, unlike verbal and musical notation (Louppe 1994, 19)[26]

When moving beyond the concrete topics that Hutchinson Guest analyzes in her work, a more encompassing intent of her research becomes visible. 'Dance is science', Hutchinson Guest writes, at the very beginning of *Dance Notation* (1984). 'But a science', she continues, 'can only be developed, described, discussed, disseminated through being recorded — in words, figures, and/or symbols — in brief, through notation' (1984, xi). I argue that Hutchinson's observation falls in line with a widely recognizable effort, progressively gaining ground in the second half of the 20th century, that seeks to move dance into an epistemic framework by making use of notation. Increased attention for dance notation systems and related topics such as methods to archive, transmit, re-enact and reconstruct dance finds resonance with a set of cultural, technological and scientific developments that spur on and accommodate an understanding of 'dance as knowledge'. When it comes to the debate on dance notation, there are always also dissenting voices, which speak to the belief that notation systems are essentially normative and inadequate to represent the singularity of dance and its embodied reality. Such a critical stance is taken by, among others, Katja Čičigoj (2014). She argues that Hutchinson Guest's writing on dance notation is based on an essentialist understanding of dance, in which dance can be 'saved' from its disappearance, claiming that 'inscribing dance into normative registers of writing on dance and dance-writing (…) produce[s] an elusive 'retention' [of dance]' (2014, 107-108). The focus on dance notation as the epistemic framework of dance has also led to the predominance of the choreographic dimension of dance knowledge in dance history.

A parallel to this development can be found in dance history, where a change occurs at the beginning of the 19th century. Franko points out that at this time, the focus of the 'host material' of the dance score shifts from the notation of the dancer's trajectory to the visual display of the body of the dancer. As Franko puts it, 'while the treatise might be considered a technical manual, in it, for the first time, writing addresses not only the *what* but

[26] Although Louppe calls these examples 'dance notations', it should be noted that there is a significant difference between these singular choreographic scores and scores that are based on dance notation systems. Dance notation systems have been developed to allow for a comprehensive symbolic representation of dance movements in order to communicate, document and analyze choreographic works.

also the *how* of dance' (Franko 2011, 326).[27] Contemporary digital experiments in dance notation embrace a similar shift; they are engaged in their own struggle about how digital media may be used to write not only the *what* but also the *how* of dance. These observations trigger questions that tie into relevant issues for contemporary developments in the dance field such as: How can digital texts mediate procedural dance knowledge? What are the implications of this development, when digital texts increasingly become the 'host material' of the dance score?

Dance's typical resistance to being pinned down in writing seems to be partly responsible for its warm embrace of dance notation in digital text. Emerging digital renderings of dance knowledge are shaped by programming and computer plotting: a type of writing that is characterized by movement rather than fixedness. These renderings are becoming important agents in the dance process itself. They introduce metaphorical expressions of dance that would not necessarily have emerged from the process in the studio alone. Dance notes, which have been described as 'living scores' by choreographer Wayne McGregor (deLahunta, McGregor, and Blackwell 2004, 68-69), can be a source of inspiration for the design of digital renderings of dance knowledge. Scores and notations are concepts of writing dance that have long been structuring signifying strategies in dance history. New understandings of these concepts may allow for the interpretation of these digital appearances of dance as a meaningful practice. The upcoming section details the account of one of the pioneers in this area in order to illustrate how the encounter between computer and dance was imagined in its early history.

2.4 What a computer can do

At the beginning of the 1960s, a young, newly graduated engineer named A. Michael Noll was hired to work at Bell Laboratories in Murray Hill, New Jersey. The Bell Labs were known for their pioneering approach, yielding cutting-edge inventions. As Noll writes in an autobiographical account: 'In the 1960s Bell Labs was a great research facility that encouraged considerable freedom to take chances and explore uncharted avenues of discovery' (1994, 39). Initially, Noll worked on the assessment of telephone transmission quality. But a summer project in the research division directed his attention to the opportunities that computer plotting offer for artistic drawings. This was one of the directions in which Noll would remain

[27] Franko refers to the dance treatise by Carlo Blasis, *An Elementary Treatise upon the Theory and Practice of the Art of Dancing,* 1820.

very active, and for which he later gained considerable recognition as a pioneer in computer art. After being granted a permanent promotion to the research division, Noll's research took a different turn. While simultaneously working on a part-time basis on a doctoral degree at the Polytechnic Institute of Brooklyn,[28] at Bell Labs Noll began a new line of inquiry, sparked by a passionate interest in dance. The observation that lies at the basis of Noll's ideas was that the same basic principles underlying computer techniques that were being developed for scientific purposes could well be used for 'the analysis of shapes and motions in dance' (Noll 1967, 43). Not without a sense of drama, Noll argues that the computer offered promising ways to deal with the dilemma of dance's ephemerality:

> I am a dilettante concerning choreography, and some of my ideas might be altogether completely unacceptable to the dance community. The act of artistic creation is mysteriously nebulous, and any tampering with it should rightfully be viewed with suspicion and carefully assessed. But the stakes are extremely high; the loss of such inspired choreographic masterpieces, that come to my mind, as George Balanchine's *Apollo*, Martha Graham's *Appalachian Spring*, Jerome Robbins' *Les Noces* would be an artistic catastrophe. Something can be done. Scitific research into the process of human movement notation and choreography should be actively encouraged and supported. As part of this research, I would recommend an investigation of the possibilities of the computer. (Noll 1967, 45)

Following his identification of the lack of easy and affordable ways to notate and preserve dance as one of the main problems of the dance world, Noll proposed a set of ideas for tools to support dance analysis, dance preservation and the creative process. According to his estimates, some of his ideas were already within the reach of computer innovations of the time, while others appeared to be too ambitious due to the 'extremely powerful pattern recognition that would have to be performed by the computer' (Noll 1967, 44).

Noll argues that dance notation systems and film recordings cannot function as sustainable means to preserve dance. Dance notation systems are little used, time consuming and expensive. Noll also explains why film is not an ideal method to score dance:

> Although film is an excellent emergency precaution that will prevent the loss of many of our choreographic masterpieces, it is not, in my opinion, the ultimate solution. This is because film records only one company's particular interpreta-

[28] For his doctorate research, Noll investigated the use of a three-dimensional force-feedback device to enable the user to feel shapes and objects simulated by software in the computer.

> tion of a work. The ballet is a creation of the choreographer, and it is his original conception of the work that must be recorded and preserved. (Noll 1967, 43)

Most controversial, perhaps, was Noll's proposal that computers could bring about a transformation of the dance process in which the time dancers and choreographers need to spend together in a studio could be radically reduced. Rhetorically, he asks: 'Is it necessary for the dancers to be present when the choreographer creates? Is this not wasteful of the dancers' time, which might be better spent in rehearsing and further training? (44)'. Responding to Noll in the same issue of *Dance Magazine*, dance notation expert Ann Hutchinson comments that the interaction between choreographers and dancers in the studio is in fact rather essential for any creative process in dance (Hutchinson 1967). For Noll, however, disengaging the act of choreography from the studio had the added advantage that the creation of a score bore no traces of specific corporealities, which he figured would allow for an easier restaging: 'The traditional method [of the creative process of dance] is also restrictive because the resulting work is strongly related to one particular corps of dancers and their abilities' (44). The assignment of the role of co-authors to the dancers thus unnecessarily complicated the integrity of a choreographic score's creation. As dance pieces tended to be mostly notated after their creation, this was another idea emerging from the logic of repeatability of digital technology that rubbed the beliefs of many in the dance field in the wrong way. Nevertheless, Noll was quite right to assume that with the computer, new creative dance forms would emerge.[29]

Noll's proposals to overcome these obstacles included a device he called a 'dance notation typewriter'. This typewriter would not only make the time-consuming work of the dance notator more efficient, it would also allow for new sharing possibilities. In his description of this computational dance notation typewriter, Noll rather accurately foresaw the co-creational opportunities that networked computers would offer dance practices several decades later: 'The computer and graphical output equipment might be centrally located and time-

[29] Eventually, Noll's prediction about an increasing spatial distribution of the creative process outside the dance studio did become reality, perhaps even more so than he could have imagined. If anything, nomadic conditions are a very real part of the existence of most contemporary dancers. Due to time and financial constraints, extensive preparations via networked communication precede and accompany the process in the studio. The migratory existence of many dancers led Laermans to describe the Brussels dance field as follows: 'Because of the frequent border crossings, the multi-territorial nature of the involved production or distribution circuits and its obviously hybrid make-up, the notion of a transnational community rather than an international one seems appropriate when defining the Brussels dance world' (Laermans 2015, 289).

shared with many other users, all communicating with the computer over telephone lines' (Noll 1967, 44).

Another major disadvantage of film, according to Noll, was its limited 'dimensionality'. To overcome the restricted space of the two-dimensional rectangular 'page' (see Introduction, Section 0.1), Noll proposed an idea that comes surprisingly close to the principles of current optical motion capture technologies. He proposes to convert dance to a digital format by making use of film recordings from multiple perspectives. These recordings would then need to be converted to a 'numerical format digestable by computers' (44). By itself, however, this conversion would not be enough. The computer would need to have a way to distinguish the dance movements on the film. To solve this problem, Noll suggested that bright lights be attached to the bodies of the dancers and that their performance should be filmed in a dimly-lit room. This recording setting would make the dancing body appear on the film as traces of light, allowing for easier recognition by the computer. By making use of different camera positions, the three-dimensional location of the dancers could be calculated by the computer. Moreover, the computer would be able to recognize dance movements and convert them into 'motion patterns', thus opening up new possibilities for dance notation, visualization and analysis. According to Noll, 'these patterns could then be translated into any desired dance notation and drawn by the computer on microfilm or other suitable materials' (44).

Noll believed that it would ultimately make more sense to preserve choreographies by visualizing the shape of the dancer in a more abstract way than through the photorealism of film. He created a three-minute film of a computer-generated choreography as a prototype. Six stick-figure dancers, depicted by simple lines for the arms, legs, trunk and head, move around the stage following different patterns, while moving their arms and legs, sometimes in unison, sometimes individually (AT&T 1968) (fig. 5). Despite the complexity of human movement, Noll expected that, in time, more elaborate stick figures would be made possible by the analysis of human motion through the conversion of 'pictorial data' by the computer. 'A library of basic movements could then be built within the computer, and particular movements could then be put together at will' (45). The advantage of this process was that the choreographer could compose these movements and at the same time produce a record that could be used in restaging the performance.

Noll showed these prototypes to a number of choreographers. This was the result of the policy of Bell Labs, rather than of a personal initiative of Noll:'[t]here was much emphasis


The display on the screen and the electronic pencil held by the demonstrator are controlled by a digital computer (large metal cabinet containing electronic equipment is seen in part at left). The demonstrator indicates the patterns he wants by writing numerals on an electronically sensitive plate. The computer translates the information to the screen immediately in the form of stick figures. These, says Mr. Noll, can eventually be anatomically more detailed.

Figure 5. Testing a prototype of computer-generated choreography at Bell Laboratories, New Jersey. Figure from"Choreography and Computers" (Noll 1967).

at Bell Labs during the 1960s on educating artists and musicians about the potential for using computers, and many artists and musicians visited the Labs to observe first-hand what was being accomplished' (Noll 1994, 43). One of these choreographers was Merce Cunningham. While Cunningham showed genuine interest, the required technology could not yet be made available outside Bell Laboratories (Noll 1994, 43). Although this is speculation, it is not difficult to imagine that it was during his chat with the young artist cum engineer Noll in a room at Bell Labs — filled to the brim with cutting-edge gadgets — that Cunningham first conceived his idea for the famous 3D-motion creation software LifeForms. Either way, a year after viewing Noll's stick-figure film, Cunningham writes in *Changes* (1968, n.p.): 'It seems clear that electronic technology has given us a new way to look. Dances can be made on computers, pictures can be punched out on them, why not a notation for dance that is immediately visual?'

It would take another two decades before Cunningham's pioneering use of LifeForms set an inspiring example of how the creative interplay between choreography and dance could materialize as a practical tool. Noll is generally credited as the first person to suggest the application of computers to dance (Calvert et al. 2005, 6) and, as far as I have been able to retrace, he was the first to propose a setup that closely resembles the digital optical motion capture environment for dance that emerged later. However, my extensive discussion of his ideas is not meant to put him on a pedestal as the great visionary that stood at the birth of motion capture applications to dance. Noll's contribution is not an isolated phenomenon; it was part of a much larger development. The innovative Bell Labs were well funded and hired the most promising graduates, but they were also very well attuned to recognizing interesting experiments. It was in all likelihood only a matter of time before a particularly curi-

ous engineer with a talent for art and drawing would recognize the possible interplay of computers and dance.

The main reason for discussing Noll's account in detail here is because it poignantly illustrates a number of features that still continue to characterize the complex interaction of technology, art and science lying at the heart of the encounter of digital motion capture and dance in practice. The experiments at Bell Labs in the 1960s demonstrate the new habits of seeing and knowing that continue to characterize the discourse on digital dance capture today. The idea for a 'dance notation type writer' illustrates the remediation of existing schemes of representing dance into digital media. The idea to attach lights to the body in order to digitally capture the trajectory of body movements lies at the foundation of the development of digital optical motion capture technologies. Moreover, the progressive environment of Bell Labs emphatically welcomed and accommodated researchers with combined interests in art and electrical engineering. This opened up a perspective on the potential effects computers would have on different dimensions of dance practice: How the creative process would be influenced by co-creativity, by 'networked' computers and the computer as a choreographic tool, and how dance preservation and transmission would be influenced by new capturing possibilities.

2.5 Prototypes for sharing dance knowledge

From its early developmental stages, then, digital technology attracted the attention of the field of dance and performance. After Cunningham's early recognition of the potential of the computer in the 1960s, he collaborated with the team of Tom Calvert at Simon Fraser University from the 1980s onwards to develop the LifeForms software, which allowed him to create choreographies with the computer.[30] Spurred on by major developments in computer technology in the 1980s, with the launch of the personal computer and the graphical user interface representing two crucial milestones, the 1990s would herald the impressive growth of a community concerned with dance and technology. Motion capture and motion sensing technologies offered a whole new range of interactive possibilities in 'digital performance', in which the performer's movement could trigger auditory and visual effects (Dixon and Smith 2007). The growth of this research area becomes evident when taking stock of the sudden

[30] Thecla Schiphorst describes the creative learning process that followed the installation of the *LifeForms* software in Cunningham's Westbeth studio in New York in December 1989. Schiphorst assisted Cunningham in his exploration of the diverse features of the software. This process resulted in *Trackers* (1991), the first of a series of choreographies Cunningham created with *LifeForms*.

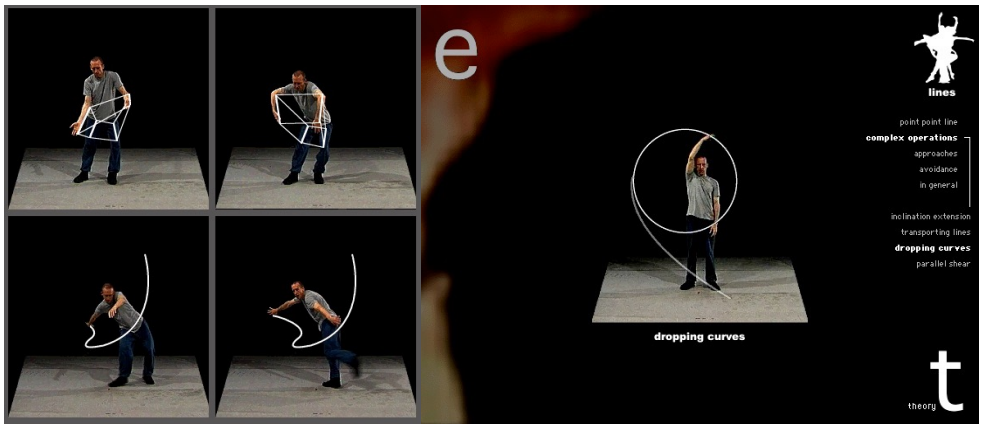

Figure 6. William Forsythe, *Improvisation Technologies* (1999).

emergence of 'multimedia' publications, such as CD-ROMs and websites, and the establishment of companies that explore artistic applications of digital technology such as Troika Ranch (Dinkla and Leeker 2002; deLahunta 2010).

Over the past two decades, the dance field has continued to manifest itself as an experimental playground in which dance practitioners, designers and dance researchers explore the opportunities of emergent digital technologies for the communication of dance knowledge. Recent experimental approaches of notational practices continue to grapple with the problematic epistemological status of dance, and they all contribute partial answers to the question of how dance knowledge can be shared across research disciplines. Forsythe has been an important instigator of the need to articulate and publish expert knowledge about dance practice through his projects *Improvisation Technologies* (1999); *Synchronous Objects for One Flat Thing, reproduced* (2009); and the digital scores of *Motion Bank* (2010-2013). *Improvisation Technologies*, which was developed by Forsythe in collaboration with Chris Ziegler (ZKM Karlsruhe),[31] shows how the geometrical inscription that is at the basis of ballet dance can be used as a conceptual point of departure for dance improvisation (fig. 6). *Improvisation Technologies* was initially meant for internal use by Forsythe's dancers at Ballet Frankfurt, but as soon as it was published as a CD-ROM, it triggered interest from

[31] Since playing a major role in the design of *Improvisation Technologies,* Chris Ziegler has remained involved in the creation of digitally enabled choreographic resources of various kinds, notably *Nagarika*, a project that compiles and categorizes the movement sequences of two specific Indian movement traditions (DVD-ROM: Vol. 1 *Bharatanatyam* (2006), Vol. 2 *Kalarippayattu* (2011)). The research he conducted as a designer for the motion-sensing installation *Double Skin Double Mind* stood at the core of the research project *Inside Movement Knowledge*. After this project he has continued to work on the project *Pre-Choreographic Elements* with Bertha Bermudez, who has played a protagonist role in a series of research projects concerned with notation that were initiated by Emio Greco | PC dance company.

many international dance schools, which ended up incorporating the CD-ROM in their curricula.[32] The interest in this project even stretched beyond the field of dance towards other disciplines such as architecture (deLahunta and Shaw 2006, 60). Norah Zuniga Shaw states that it was this aspect of the success of *Improvisation Technologies* that inspired Forsythe to position interdisciplinary research for communicating choreographic ideas at the core of The Forsythe Foundation. Shaw describes the Foundation's aim as follows: 'to create multiple approaches to documenting dance that acknowledge the complexity of choreographic thinking, while increasing its cross-disciplinary intelligibility, and defining new territory for dance studies' (deLahunta and Shaw 2006, 60). Forsythe says his aim for *Synchronous Objects* was to 'show how a piece develops from the inside, how it functions, how it's put together. To demystify the process and elucidate the principles of choreography' (60).[33] Zuniga Shaw, who led the research team for *Synchronous Objects* at Ohio State University, relates the central purpose of the project to reveal the knowledge inherent in choreographic practice:

> So if it is about scoring but not about reconstructing then what is the central purpose of this effort? In part, the project seeks to illustrate what those of us in dance already know but struggle to articulate, that moving is a thinking process and that choreography is a form of knowledge.[34] (deLahunta and Shaw 2006, 60)

Describing the work of Forsythe in particular, social anthropologist James Leach argues that digital media are especially adept at showing the aspects of process and making (2013). Leach recognizes these practices both as a pursuit of intellectual recognition by the dance field and as a response to the demands of knowledge economies:

> By finding modes to capture and make available the knowing and the knowledge making practice of dance, they promise to demonstrate the worth of contemporary dance as a knowledge practice in its own right and to thus reposition the

[32] P.A.R.T.S. is an example of a dance school that has incorporated *Improvisation Technologies* in its curriculum.

[33] *Synchronous Objects* was realized through a collaboration between the Forsythe Foundation, the Ohio State University Dance Department and the Advanced Computing Center for the Arts and Design.

[34] Norah Zuniga Shaw adds: 'It is also about constructing new ways for dancers to leave behind, big, meaningful, engaging traces that relate to their dances performed in the ever-vanishing moment, but also have their own aesthetic integrity. The project seeks not only to capture the vitality of the piece but also to construct a new way of looking at dance, one that considers both discipline-specific and cross-disciplinary ways of seeing and ways of thinking' (deLahunta and Shaw 2006, 60).

> practice and its cultural recognition and valuation. This route to recognition, absolutely responsive to contemporary political economy, to the needs and strictures of a 'knowledge economy' (where the usefulness of the arts is continually questioned) is enabled through the making of choreographic objects. (Leach 2013, 8)

Forsythe's work does not stand by itself in its aim to design new ways to make dance knowledge accessible. There is a growing awareness about the need to articulate and publish expert knowledge about dance practice. Other projects, such as the digital dance archive *Siobhan Davies RePlay* (2009), the research project *Pre-choreographic Elements* and the online platform *Oral Site*, to name some significant examples, offer new perspectives on dance and performance by creating multimodal interfaces to access the work.[35] Another striking example of how such innovative interfaces can take the shape of an actual object can for instance be found in the work of Jane Hawley and Richard Merritt, who imagine how people could relate to dance movement data rendered into a tangible object through a 3D printer (2015). Texts, sounds or (interactive) graphics are designed to enable a reflection on the work as an addition to the experience of viewing the work itself, thus providing alternative perspectives of how dance may be known. A broad spectrum of 'dance knowledge' thus becomes apparent. In this respect, these projects aspire to what Dwight Conquergood distinguished as the 'constitutive liminality' of performance studies: 'its capacity to bridge segregated and differently valued knowledges, drawing together legitimated as well as subjugated modes of inquiry' (2002, 151-152).

Projects such as William Forsythe's *Synchronous Objects* are presented as 'intended to serve as a prototype for sharable principles of visualizing information and facilitating understanding of time-based arts.' Leach has proposed to look at these digital experiments of dance as 'prototype socio-technical essays' (2013, 3). Leach argues that these projects are 'prototypes of new relational forms: experiments in building new groups, new constituencies and new audiences' (2013, 3). In the previous chapter, I discussed Anne Teresa De Keers-

[35] *Siobhan Davies RePlay* (2009): www.siobhandaviesreplay.com, *Oral Site*: www.oralsite.be, *Pre-choreographic Elements*: www.ickamsterdam.com/index.php?id=4,5. *Pre-choreographic Elements* is a continuation of previous research projects around documentation, notation and transmission of dance: *Inside Movement Knowledge* (2008-2010) and *The Notation Research Project* (2004-2007), the results of which were discussed in *Capturing Intention* (Scott deLahunta, ed., 2007) and <*Notation*> (Bertha Bermúdez and Scott deLahunta, eds., 2010). Another publication that resulted from this project is *Transmission in Motion: The Technologization of Dance* (2017), edited by Maaike Bleeker. This volume includes detailed project descriptions and contributions that delve deeper into implications of the developments that are reflected by these projects.

maeker's multimodal publication series *A Choreographer's Score* in relation to the transmission process of the choreography *Rosas danst Rosas* (1983). *A Choreographer's Score* can also be considered to be an example of such a prototype. This project was triggered by the question of how to give a dance to younger generations. It communicates core principles of Rosas' works by experimenting with different presentational modes.

Forsythe's work in this area has been an important inspiration for De Keersmaeker, who notes that 'remarkably few texts on the craftsmanship and on the compositional tools of dance exist. Forsythe taught me you should share this knowledge, even though it is rather normal for choreographers to keep it to themselves' (De Keersmaeker 2014). Musicologist and performance scholar Bojana Cvejić, with whom De Keersmaeker collaborated closely on this project, observes:

> [I]n comparison to music, visual arts, theater, and cinema, dance suffers from a significant lack of self-reflective writing that would illuminate choreography as an authorial poetics. This may be said more bluntly: In order for dance to be 'taken seriously,' it needs to take itself seriously. The more we, *amateurs de danse* and scholars, can learn from choreographers and dancers about their notions and methods the more complex our experiences and thoughts will be, as we will have to account for the tension between choreography as an art and any theory whatsoever that attributes a sense to it. (Cvejić and De Keersmaeker 2012, 8)

Indeed, the current development of these and other projects that 'take dance seriously' seems to be increasingly motivated by a political concern: The need to relate to audiences through alternative channels in order to extend the legitimization of an artistic practice beyond the fleeting encounter in a theater setting. Cvejić observes that the emergence of these projects 'evidences an urge on the part of choreographers to reflect on their methods and share them with a broader, more heterogeneous readership' (Cvejić and De Keersmaeker 2012, 7). These 'strategies of self-visualization', as I propose to call them, are motivated by multiple concerns: To reach new audiences, to preserve a legacy, to share artistic knowledge, and — last but not least — to bring dance into visibility in ways that are amenable to financial support.

2.6 An epistemology of choreographic objects

Forsythe has played a leading role in giving impetus for a re-examination of dance as a practice that involves thinking as well as the creation and transmission of knowledge. This is ex-

emplified by his ongoing experiment with what he calls 'choreographic objects.' The diverse projects — mentioned above — that are the result of this re-examination have typically focused on highlighting the singular features of a specific practice or oeuvre. These features, and the sophisticated design in which they are presented, provide a wide array of ideas on what is — and what is not — considered to be part of dance knowledge. The design and format that is used for these projects in turn also limits and shapes the knowledge that can be shared. But what types of dance knowledge can be shared in this way? In these projects, what does 'dance knowledge' include? What aspects of dance are highlighted, and what aspects receive less attention? And to what extent do these experimental formats broaden the scope for understanding what type of knowledge is involved in dance practice?

In "Choreographic Objects", a short but powerful text that reads as a manifesto, Forsythe asks: 'is it possible for choreography to generate autonomous expressions of its principles, a choreographic object, without the body?' Forsythe explains the advantage that such a choreographic object would have. It allows for a sustained reading of dance, which dance's ephemeral nature tends to make an obstacle. Forsythe writes:

> The choreographic idea traditionally materialises in a chain of bodily action with the moments of its performance being the first, also, and only instances of a particular interpretation. The idea's enactment is not sustained and cannot be repeated in the totality of its dimensions by any other means. As poignant as the ephemerality of the act might be, its transient nature does not allow for sustained examination or even the possibility of objective, distinct readings from the position that language offers the sciences and other branches of arts that leave up synchronic artifacts for detailed inspection. (Forsythe 2011, 91)

A principal function of choreographic objects for Forsythe, then, is that they transpose choreographic ideas into a different 'mode' that allows for a closer examination of these ideas because of their abstraction from the ephemeral, bodily-based event that the dance performance constitutes. 'A choreographic object is not a substitute for the body, but rather an alternative site for the understanding of potential instigation and organization of action to reside' (92). The abstraction of choreographic ideas from the dancing body stands at the center of Forsythe's notion of choreographic objects:

> Denigrated by centuries of ideological assault, the body in motion, the obvious miracle of existence, is still subtly relegated to the domain of raw sense: precog-

> nitive, illiterate. Fortunately, choreographic thinking being what it is, proves useful in mobilising language to dismantle the constraints of this degraded station by imagining other physical models of thought that circumvent this misconception. What else, besides the body, could physical thinking look like? (Forsythe 2011, 91)

Indeed, as I have shown above, historical dance sources confirm Forsythe's statement that the ideological status of the dancer has long remained inferior to that of other stage performers such as the actor in text-based theatre. And yet, this quote does not seem to counter the traditional view completely. Forsythe acknowledges the dancing body as 'the obvious miracle of existence', but then proposes to 'circumvent' this illiterate reputation of the dancing body. Even though Forsythe interprets this denigratory attitude towards the dancing body as a 'misconception', he continues to claim that it is 'choreographic thinking' rather than the dancing body that is able to 'mobilise language' that allows us to imagine 'other physical models of thought'. This is not an unproblematic way of thinking. By bypassing the dancing body as a source for choreographic ideas, it seems that Forsythe at least in part *reaffirms* the inferior status of the dancing body that he claims to denounce.

Although Forsythe does not explicitly refer to Foucault here, it seems that his notion of 'choreographic object' may well be better understood by examining Foucault's definition of a 'discursive object' in *The Archaeology of Knowledge* (1972).[36] In the section 'The Formation of Objects', Foucault describes how 'psychiatric discourse finds a way of limiting its domain, of defining what it is talking about, of giving it the status of an object - and therefore of making it manifest, nameable, and describable' (Foucault 2012, 46). Forsythe's proposal to imagine a choreographic object is similarly motivated. Choreographic objects distinguish choreographic ideas as 'discursive objects', which offer a clear focus of attention within the discourse of choreographic practice and allow for a 'sustained reading'. By proposing to render choreographic thought as a 'choreographic object', Forsythe's aim is quite similarly aimed at 'making it manifest, nameable, and describable'. This is illustrated by one of the closing lines of his essay: 'Ideally, choreographic ideas in this form would draw an attentive, diverse

[36] Note that Franko's article "Archaeological choreographic practices: Foucault and Forsythe" draws attention to the fact that Forsythe has been a 'serious reader of Foucault since the 1980s' (Franko 2011: 98). Franko investigates the influence that Foucault has had on the work of Forsythe up to the 1990s. By 'thinking Foucault through Forsythe', Franko aims to find out how Foucauldian thought has been adaptable to choreographic practice and what this practice may tell us about Foucault's 'virtual silence relative to choreography' (98).

readership that would eventually understand and, hopefully, champion the innumerable manifestations, old and new, of choreographic thinking' (Forsythe 2011, 92).

A key difference with Foucault's description of the discursive object is that Forsythe specifically insists that the choreographic object would be able to function as a 'physical model of thought' that allows for a 'sustained reading'. As I noted earlier, he draws this specification in accordance with his belief that choreographic ideas can only be studied carefully once they take on a form that escapes the embodied and ephemeral nature of the dance performance itself, 'to alter the temporal condition of the ideas incumbent in the acts, to make the organizing principles visibly persist' (92). The fact that these choreographic objects all manifest themselves in the digital realm is in accordance with his view of the choreographic object as 'a model of potential transition from one state to another in any space imaginable' (91). It is this aim in particular that is reflected in *Synchronous Objects*, which featured innovative dance data visualizations, expressed through its central question 'What else might physical thinking look like?' (Forsythe 2009). Choreographic objects, such as the digital scores created by William Forsythe, function as both practical and creative applications for dance practitioners.

2.7 What is tacit knowledge?

A new direction in the understanding of dance knowledge is to be found in the discourse around tacit knowledge. The term tacit knowledge was introduced by Michael Polanyi in *Personal Knowledge* (1958) and further elaborated in *The Tacit Dimension* (1966). Polanyi observed that there is an unarticulated intelligence in skillful doing and knowing. In *Personal Knowledge,* Polanyi argues that tacit knowing underlies all articulate communication and scientific pursuits of knowledge. The 'tacit component' or inarticulate dimension of intelligence directs and shapes the articulation of ideas in speech, writing and science. Polanyi observed that this direct connection between tacit and articulated knowledge impacts what people believe and accept to be true: 'the premises of science are tacitly observed in the practice of scientific pursuits and in the acceptance of their results as true' (Polanyi 1958, 171). Polanyi thus identifies tacit knowledge as the touchstone of all knowing, stressing that there will always be a discrepancy between the tacit knowledge that is involved in performance and what we can articulate in words. As Polanyi puts it: '[O]wing to the ultimately tacit character of all our knowledge, we remain ever unable to say all that we know' (1958, 99).

To underline the importance of personal knowledge for what we are able to learn and know, Polanyi draws an analogy with skills such as swimming, playing the piano and riding a bicycle. Knowing the premises of such a skill is not sufficient for learning them. Detailed knowledge about the centrifugal and gravitational forces that have an impact on balance will not help one to learn to ride a bike, nor does the knowledge that retaining an excessive residue of air in the lungs keeps one afloat help someone with learning how to swim. Polanyi shows that while knowledge of these premises is not in itself enough for people to learn new skills, acquiring such 'focal knowledge' of skills does have advantages, for example for teaching and improving these skills:

> Indeed, the premises of a skill cannot be discovered focally prior to its performance, nor even understood if explicitly stated by others, before we ourselves have experienced its performance, whether by watching it or by engaging in it ourselves. In performing a skill we are therefore acting on certain premises of which we are focally ignorant, but which we know subsidiarily as part of our mastery of that skill, and which we may get to know focally by analysing the way we achieve success (or what we believe to be success) in the skill in question. The rules of success which we thus derive can help us to improve our skill and to teach it to others — but only if these principles are first re-integrated into the art of which they are the maxims. For though no art can be exercised according to its explicit rules, such rules can be of great assistance to an art if observed subsidiarily within the context of its skillful performance. (Polanyi 1958, 171-172)

The great value of Polanyi's thought with regard to the discourse on dance knowledge becomes evident here. Just like other arts and skills, dance needs to be learned through experience and is largely based on mimetic transmission. When a dancer is taught a choreography or a technique, two processes happen simultaneously. There is the corporeal transmission, in which dancers learn how it *feels* to perform the dance. Then there is a parallel trajectory, in which dancers learn how to correctly describe their experiences in terms of the vocabulary that is associated with a specific performance or style. By receiving feedback from a choreographer and other dancers, a common ground is created in which agreement is shaped about how their personal dance experience can be brought into accordance with concrete dance phrases, movement qualities, or other specific features of a work or technique. Hence, a key

insight gained from Polanyi is that although 'explicit rules' are in themselves not sufficient to learn a specific skill, they can nevertheless be very useful in the process of teaching dance.[37]

In Chapter 1 I discussed several issues related to tacit and focal knowledge[38] in practices of dance transmission within the Rosas company. The process of teaching dance can be illustrated by the experiences of Fumiyo Ikeda. Ikeda is the rehearsal director of *Rosas danst Rosas,* and one of the dancers of the cast that created this piece in 1983. She remembers that it was only at the point where she had to teach the choreography to other dancers that she gained a different awareness of the precise structure and much of the details of the performance. Even though she knew the piece by heart, this did not mean that the transition to teaching the piece to others was effortless. 'I *thought* I knew many things, but I didn't', says Ikeda (2014b). She had to analyze the work in a way she had never done before in order to transmit it to others.

Applying Polanyi's theory, it becomes evident that the task of transmitting the choreography prompted a deliberate analysis of the skills and patterns of the choreography, through which Ikeda acquired a 'focal knowledge' of the choreography. There was no need for her to articulate this focal knowledge in order to master her performance of the work, as Ikeda explains: 'the performance was so evident for me'. Despite her deep knowledge of the work, it was clear that teaching the choreography required a translation to a different type of knowledge, a knowledge that articulates the 'rules and premises' of the performance. When Ikeda says that she thought she knew many things but didn't, Ikeda obviously knew how to *dance Rosas danst Rosas* very well. However, what she did not know, and so had to learn, were the type of articulations necessary to introduce new dancers to the highly sophisticated tacit dimension of the work, which had until then been known exclusively to the four dancers that had created it.

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[37] Polanyi was by no means the first to distinguish between types of knowledge related to (bodily) practices. An early and often-referenced representative in this debate is Aristotle. As is observed in the recent comprehensive study *Revealing Tacit Knowledge*: *Embodiment and Explication*: 'Aristotle's distinction between theoretical (*epistêmê*, *nous*, *sophia*), practical (*phronêsis*) and productive (*technê*) virtues can be understood as a first systematic classification of tacit and explicit forms of knowledge' (Adloff et al. 2015, 8). Other key references in this area that I do not further elaborate on here are Donald Schön's notion of knowledge-in-action, introduced in *The Reflective Practitioner* (1983) and — one of Schön's main inspirations, in addition to Polanyi — Gilbert Ryle's distinction between 'know-that' and 'know-how' in *The Concept of the Mind* (1949).

[38] Note that where Polanyi uses 'focal knowledge', dance researchers have used the term 'explicit' or 'propositional' knowledge for the type of knowledge that is the counterpart of tacit knowledge.

2.8 Dance knowledge as tacit knowledge

Whereas the debate on the relationship between tacit knowledge and propositional or explicit knowledge started in philosophical and epistemological studies, in the 1970s, spurred on by Polanyi's work, the discussion spread to areas such as science studies, cognitive linguistics (Lakoff and Johnson 1980; 1999), and sociology. Pierre Bourdieu's notion of habitus and his 'theory of practice' (1977) were particularly influential, leading to the so-called 'practice turn' in the 1990s (Turner 1994; Schatzki 1996; Schatzki et al. 2001). The practice turn in the dance field can be exemplified by new inquiries into dance technique, such as Ingo Diehl and Friederike Lampert's mapping of contemporary dance techniques which starts off with the question 'What do we know when we dance?' (2011).

A prominent example of the translation to discursive and practical knowledge in the field of performance studies can be found in Diana Taylor's *The Archive and the Repertoire* (2003). Taylor writes: 'By taking performance seriously as a system of learning, storing, and transmitting knowledge, performance studies allows us to expand what we understand by "knowledge". This move, for starters, might prepare us to challenge the preponderance of writing in Western epistemologies' (Taylor 2003, 16). Dance scholars Catherine Stevens and Shirley McKechnie have distinguished between procedural and declarative knowledge as two types of knowledge belonging to the performance knowledge of the dancer:

> Complex dance vocabularies challenge the view of human memory as a storehouse of linguistic propositions. Creating and performing dance involves knowledge that is procedural (implicit knowledge or knowing how to perform various tasks) and declarative (explicit knowledge or knowing about states of affairs such as dance and phrases of dance). (Stevens and McKechnie 2009, 44-45)

This topic has also played a role in dance-historical debates. Dance historians have often problematized the gap between present knowledge of the historical dancing body and what has been written down in dance notation. For example, Claudia Jeschke argued that notation systems should be considered as 'texts of performative knowledge' (1999). Franko asserts the pertinence of Jeschke's proposal:

> It is less a question of holding onto or recovering a particular choreographic work than of rediscovering states of the body that lay at the core of the work and its reception. Without the recovery of those states, choreography itself cannot be adequately recaptured and rearticulated. (Franko 2011, 330)

Such knowledge of 'states of the body' (Franko) for the recapturing and rearticulation of dance practice is acquiring new importance in the debate on digital dance capture, in which motion data can be recognized as new 'texts of performative knowledge' (Jeschke). Because motion capture technology records the three-dimensional contours of the body of the performer, bodily motion data have become a primary reference point for digital representations of dance. The gap between embodied knowledge and digital movement data gives rise to a complicated challenge. The challenge, lying at the center of the transposition of body-centered to data-centered transmission, is to make digital renderings of dance data accessible and intelligible. This emerging research requires a new analytic approach to dance that is not readily available in existing dance literature. After all, a large part of dance is concerned with embodied knowledge that is rarely articulated in writing or other types of notation. To interpret the dancing body in motion capture — *to make motion data speak* — entails the desire for a new articulation of 'performative knowledge'. Until now, such articulations have usually been confined to the live exchange taking place in dance transmission processes. A new challenge in dance research, then, is represented by the acknowledgment and further investigation of the craftsmanship and the embodied knowledge of the dancer.

Recent dance research shows examples of a more experience-based approach that also investigates the tacit knowledge of the dancer. An intriguing example is the research project *Moving-Memory* by Anne Grete Eriksen (2014), in which she asks dancers to articulate how their memory of dance pieces works. Eriksen's analysis is surprising because it not only reveals common mnemonic strategies, but also shows how strongly these strategies tend to vary from one dancer to another. Examples of such mnemonic strategies are: listening to the music, counting along with steps and phrases, rediscovering the 'feel of the movement', recalling spatial patterns of the choreography, remembering the atmosphere of the room where the performance was learnt, or sensing the positions of other dancers and objects on stage. By providing such a detailed account, the project *Moving-Memory* provides more substance to the often-heard, but rather general, and as yet seldom investigated claim by dance scholars and practitioners that in dance, 'the body is the archive'.

2.9 What a body can do

The plea to appreciate performance practice and technique as a way of transmitting and generating knowledge is also the core message of the recent study *What a Body Can Do:*

Technique as Knowledge, Practice as Research (2015). Written by performance scholar and art practitioner Ben Spatz, this project is an example of the growing interdisciplinary interest in embodied practice, which has been called the 'practice turn' in contemporary theory (Schatzki et al. 2001). Taking the Deleuzo-Spinozan question 'what can a body do?' as a starting point, Spatz proposes an 'epistemology of practice', arguing that 'embodied technique is a vital area of ongoing exploration, in which the potential for valuable new discoveries has in no way been exhausted' (2015, 5). To enable this exploration, Spatz posits that technique should be understood as an epistemic activity: an activity that engages with or produces knowledge. Although the embodied knowledge of the performer has been increasingly part of the theorization of performance, Spatz points out that these studies often lack precise descriptions of what this embodied knowledge entails: '[W]ithout a more robust epistemology behind it, the concept of embodied knowledge may not be as effective as it deserves to be in transforming assumptions about knowledge both within and beyond academia' (23-24). Moreover, Spatz states that academia's ongoing difficulty in acknowledging 'practice' as epistemic in nature is caused by the division between 'theory' and 'practice' that has historically shaped scholarly fields. Spatz criticizes the effect of this divide: 'The epistemic distance that separates scholar from subject has been seen as enabling objectivity and has historically been accepted as a key standard for academic rigor' (221).

Unfortunately, this epistemic distance between scholar and embodied practices has caused considerable mistrust of practitioners towards academia. As one would assume the performing arts to be of primary concern for performance studies, for art practitioners it can be bewildering to relate to the way in which performance research takes shape in academia. How does this scholarly research correspond to the type of inquiry that performance practice is concerned with? Spatz points out that coming to terms with this division between theory and practice enables an understanding of 'why universities, despite having all the necessary resources to conduct sustained and even large-scale embodied research projects in performance technique, have for the most part not done so' (222). In other words, when it comes to performance practice as an object of academic study, the question arises as to why certain topics concerning performance practice are included in the research agenda, while others are excluded from it. Indeed, Spatz connects this observation to Jacques Rancière's notion of the 'distribution of the sensible', which Rancière positions at the center of his politics of aesthetics (2004).

At the core of *What a Body Can Do*, then, stands the recommendation to further validate and promote embodied research at the university. To support this recommendation, Spatz engages in a critical analysis of Practice as Research (PaR). PaR programs allow students to combine artistic practice with scholarly research in order to obtain Masters and PhD degrees. They have been developed over the past two decades in various European countries, in the United States, Australia, and South Africa, among others. Precisely because they touch on the core tensions between the epistemic activities of performance practice and academia, the format, content and evaluation of these programs have been the topic of fierce debate. To broaden the scope of embodied research at university, Spatz argues that it is necessary for researchers to find a way to make new areas of knowledge available to scholarly rigor. In this endeavor, it is not helpful to state that performance necessarily escapes description because of its ephemerality. Spatz states that '[t]he tendency in performance studies to romanticize the ephemeral should be tempered by a greater appreciation of repetition and transmissible knowledge as the basis for all kinds of practice' (60). He further observes that:

> The question of whether and how embodied research can find a home within the academy is therefore substantially a question of the extent to which it can be documented. Documentation is not a secondary, logistical question but an essential part of academic epistemology. Documentation, in the broadest sense, is the difference between knowledge, which may or may not be documented, and scholarship, which necessarily engages with an archive across epistemic distances both synchronic and diachronic. (Spatz 2015, 242)

Spatz makes a sound observation by identifying documentation as the key issue in this debate. It is for this reason that one of the major concerns of the field of performance studies during its emergence over the past three decades has been the topic of documentation and the archive. The interest in these topics specifically arises from efforts to bring into agreement the knowledge that is inherent in practice with the requirements of scholarly rigor. In this endeavor, technique should be the focus of this type of documentation. Spatz suggests that this type of documentation would most probably benefit from a multimedia format: 'What would a multimedia document look like, if its purpose were to make the embodied technique of a given practice available to interested parties across geographic an temporal distance?' (Spatz 2015, 241).

The multimedia projects and publications designed to disseminate dance knowledge that have appeared during the past decades constitute a possible response to this question.

Indeed, these types of projects seem to be in line with what Foster envisioned when she wrote:

> The possibility of a body that is written upon but that also writes moves critical studies of the body in new directions. It asks scholars to approach the body's involvement in any activity with an assumption of potential agency to participate in or resist whatever forms of cultural production are underway. It also endows body-centered endeavors with an integrity as practices that establish their own lexicons of meaning, their own syntagmatic and paradigmatic axes of signification, their own capacity to reflect critically on themselves and on related practices. (Foster 1995, 15)

Indeed, Spatz's proposal of an 'epistemology of practice' seems to be closely related to what Foster suggests with the establishment of 'lexicons of meaning' of body practices. What is telling in both examples is the dominance of a specific metaphor that is deeply associated with the dancing body because of its choreographic history — that of a body that writes. Foster speaks about the 'body that is written upon but that also writes', which in this context is only partially metaphorical. The dancing body is culturally inscribed, but when it is involved in writing 'lexicons of meaning', it is involved in the literal act of writing. 'Writing' here echoes yet another layer of meaning. The dancing body that is involved in the writing also suggests an empowerment of the dancer. Having long stood in the shadow of the choreographer as the primary author of a work, by getting involved in writing, the dancer acquires a voice.

2.10 Dance knowledge in motion

The creation of digital scores, choreographic objects and other digital mediations of dance constitutes a new way of accessing dance knowledge. The author of this digital score is not necessarily limited to just one choreographer or dancer. It is a collaboratively written, multimodal score that can be shared and edited in a network. Rather than sitting in a closed database or collecting dust on an analogue library shelf, these digital scores present themselves not as an inviolable authority marked by stillness, but as a multi-authored open source that is perpetually in movement. The score is no longer presented as an authoritative, stable point of reference that exists outside of the dance. Instead, the score dances along with the dance itself.

A remarkable feature of such scores is that they are often presented primarily as instruments to support the creative process of dance. Their potential to function as a score or tool for preservation is typically only mentioned afterwards. More than two decades before the conception of *LifeForms*, Cunningham already envisioned how the computer might provide us with tools that would serve both the creation *and* preservation of dance.
He also knew which of these functions would have his preference: 'It is conceivable [that] one could choreograph with such a device. This appeals to me. More than the museum I like the actuality' (Cunningham 1968, n.p.).

The fact that dance practitioners recognize creation and movement as their core domain presents a specific challenge when digital capturing technologies are employed to mediate the knowledge of this practice. What brings artists to experiments with motion capture and sensing technologies is their curiosity to find out something new and unexpected. Whereas science tends to use technologies as instruments to find an answer to a very precise question, for the artist it is often exactly the other way around. Rather than aiming to find answers, what is central to artistic research is to articulate new questions that are evoked by the interaction with these technologies.

'More than the museum I like the actuality.' Cunningham's quote also articulates an idea that pervades dance history: the resistance of dance to being written down, its typical refusal to exist outside the dance itself. More than the museum, dance itself likes the actuality. It is no wonder then, that in the present discourse around dance knowledge and choreographic objects, a preference for movement metaphors can be perceived, at the expense of metaphors indicating stillness or fixedness. A telling example is the fact that designers and users of digital tools are inclined to avoid the term 'archive'. They do not see their work being affected by 'archive fever', because they do not pursue any type of 'domiciliation' of data, the 'house arrest [in which] archives take place' (Derrida 1996, 10). Rather, their objective is an ongoing interaction with the material, an interaction with users who bring their own needs to the material, and have the ability to adapt and edit it themselves. They focus on expanding conditions for 'creation', 'exchange' and 'transmission' at the expense of the establishment of an authoritative source or score. All of these are terms that connect *knowledge* with *motion* — and this is not accidental. On the opposite side we find 'recording', 'documenting', 'capturing': Terms that imply an image of the dance or dancer as a still object. These processes try to turn dance into an object that can be made intelligible through a traditional positivist approach: analysis, categorization and, ultimately, storage in the right place.

The connection of knowledge and motion also opens up another line of thought, with which this chapter ends and simultaneously opens the way for the following chapters. Thinking of dance as knowledge offers opportunities to shift ideas on scientific processes. This is an idea that has been discussed by Gabriele Brandstetter who imagines in her article "Dance as Culture of Knowledge" how dance could 'shift the boundaries of what we consider to be knowledge and science and in doing so begin to set our understanding of knowledge in motion' (2007, 41). Considering dance as knowledge creates an awareness about the exclusion of movement in our systems of knowledge. As Brandstetter writes: 'dance in particular, with its transient space-time form, makes us aware that the traditional concept of cultural memory is static, architectonic, quantitative and encyclopaedic; the performance aspect, the *movement* inherent in any active recollection is often cut off' (39). Such an awareness not only effects a reflection on the aching absence of bodies in performance in our archives. It can also provoke a reconsideration of processes of knowledge finding and communication.

> if we — proceeding on the assumption that dance as the object under investigation cannot be fixed like an immobile object — realise that object blurriness and a temporary structure also affect those artefacts, monuments or test set-ups of knowledge that were presumed to be secure; that a dynamic and contingent relationship between scientist and object of investigation is also being established in other scientific research areas and is changing in the research process: also in disciplines that deal with seemingly fixed objects and reliable results. (Brandstetter 2007, 41)

These thoughts trigger questions about the way in which dance as knowledge challenges established ideas about the relationship between scientists and their objects of investigation. As becomes clear in the following chapter, this topic is located at the core of contemporary experiments of corporeal computation.

Chapter 3

Corporeal Computation: Making motion data speak

> In the spring of 1872 a man photographed a horse. With the motion studies that resulted it was as though he were returning bodies themselves to those who craved them — not bodies as they might daily be experienced, bodies as sensations of gravity, fatigue, strength, pleasure, but bodies become weightless images, bodies dissected and reconstructed by light and machine and fantasy.
> — Rebecca Solnit, *River of Shadows. Eadweard Muybridge and the Technological Wild West,* 2003, 24.

In *River of Shadows* (2003), writer Rebecca Solnit distinguishes Eadweard Muybridge as a figure that played a pivotal role in technological inventions of the second half of the 19th century, an age that is characterized by a transformation of the experience of time and space that is coupled with a change in the perception and understanding of bodies in motion. Solnit vividly describes the creation process of a series of photographs that continue to inspire awe up to the present day. At a time when regular photographs still required an exposure time of around 16 seconds, which made landscapes a convenient topic, Eadweard Muybridge was an inventor, a technophile and a pioneer in making short exposure photographs, which were referred to as 'instantaneous photography' (Prodger 2003). In 1872, Muybridge was hired by Governor Leland Stanford, who was at that time the president of the Central Pacific Railroad, the company that had, three years earlier, completed the transcontinental railroad. Aware of Muybridge's growing reputation, Stanford turned to him to prove his claim that a racehorse at full stride at some point lifts all its feet off the ground. Engaging in a bet with acquaintances from the East Coast who countered his claim, Stanford was set on finding proof for his own hypothesis. A proud owner of fast horses, Stanford was a scientific connoisseur with a special interest in equine motion. Solnit relates the recollections of a friend of Stanford:

> 'It was a hobby with him to explain the phenomena of motion. He always said that nobody understood anything about it, and that he was determined to unravel the mystery of motion. He could not explain it himself, but he was satisfied that all explanations were unsound.' (Solnit 2003, 78)

Stanford intuited that photography could be a means to come a step closer to unravel motion's mystery and he recognized Muybridge as the man for the job (Solnit 2003, 80). For Muybridge, Stanford's assignment meant the biggest challenge yet in his experiments with short exposure photography. To be able to make a photograph that offered sufficient contrast to discern the horse's legs, he calculated that he would need exposures measurable in hundredths of a second (Solnit 2003, 82).

In her detailed account of Muybridge's game plan, Solnit draws attention to an aspect that is not widely known, but was crucial for his eventual success. Muybridge realized that daylight was not enough to establish the lighting conditions he needed to prevent underexposure of the photograph. He needed to find a way to artificially increase the illumination, not in a convenient indoor setting, but out in the fields near Palo Alto that provided enough space for the galloping horse. The solution he arrived at was smart and simple. Muybridge ordered as many white sheets as could be found in the surrounding area. With the sheets Muybridge created two planes; a horizontal one, by draping the sheets on the ground as to create a carpeted runway for the horse, and a vertical one that stretched out alongside the runway, by fixing sheets to poles. This way, Muybridge created an optimal light-reflecting background and underground.[39] Stanford's horse — named Occident, one of the fastest racehorses of the country — 'was trained to trot over this blinding terrain' (Solnit 2003, 82). By employing this method of explicitly staging the horse's movement, Muybridge was able to make the picture that not only allowed Stanford to win his bet, but which also became emblematic for the deeper recognition of the potential of photography to bring moving bodies into visibility, coupled with a rendering of moving bodies into discernable and intelligible units.

As I show in this chapter, it is exactly this aspect that digital motion capture technologies have in common with early photography: both are praised for their potential capacity of revealing movement features that escape human perception and to thus create new ways to

[39] Note that the original picture from 1872 was lost. See fig. 7 for an example of subsequent movement studies.

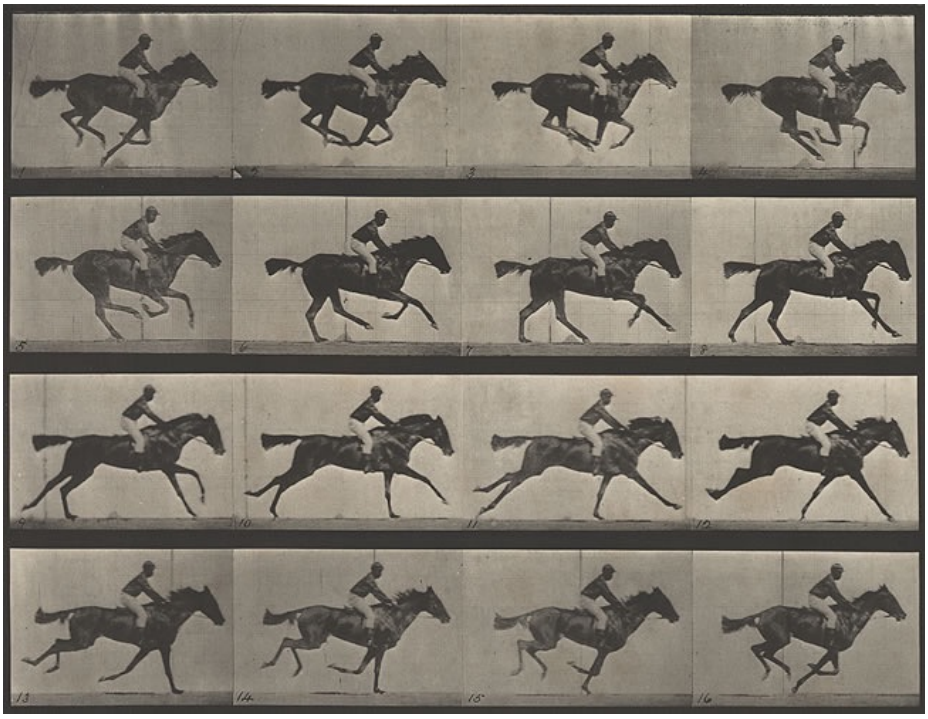


Figure 7. Eadweard Muybridge, *Horse in Motion*, ca. 1886. Photography collection, Harry Ransom Center.

attach meaning to bodies in motion. Muybridge's 19th-century experiments — and other important contemporaries working in areas of film and photography — set the tone for a notion of 'motion capture' that has continued to exert influence on the transmission of dance and movement knowledge from the 1870s to today. Based on my research of contemporary computational practices of motion capture and dance, I have found that it is crucial to be aware of this heritage of recent motion capture history in order to better grasp why these practices have taken shape the way that they have. What I term 'the motion capture imaginary' is a conceptual instrument that offers a way to position such contemporary practices as an an integral part of these cultural-historical developments.

I chose to open this chapter with the example from Muybridge's motion studies, because it clearly illustrates the importance of three topics that I want to single out in my discussion of these practices, and which reappear in subsequent chapters. These topics are: 1) the *optical bias* of motion capture practices, 2) the explicit *strategies of staging* that are involved in these practices and 3) the particular *notions of dimensionality* that are inherent in these practices. I further explain these topics in what follows. For now it suffices to point out that they are all linked to the way motion capture technologies conceptualize movement and thus invite a specific way of reading and understanding moving bodies in accordance with this conceptualization — the motion capture imaginary.

This chapter hinges on two interrelated lines of argument. First of all I show that the above-mentioned topics – optical bias, staging, dimensionality – should be understood in relation to the problematic status of motion capture data as *indexical traces* of dance performance. Second, I demonstrate that the practices that have emerged in this area are inevitably structured by already-existing notions of dance knowledge, which have been introduced in Chapter 1. As becomes clear in this chapter, one of the difficulties that lies at the core of these practices seems to be that as soon as motion capture data are transposed in a sensory output – a visual output is the most common choice in the dance field – the deep complexity of the data can easily be overlooked. Motion capture renderings often rely on a 'remediation' (Bolter and Grusin 2000) of video imagery. I, on the other hand, point out that motion capture imagery has a radically different ontological basis, which harbors a much wider potential than is commonly recognized.

The analyses in this chapter are an example of a media taxonomy, the methodological approach that I presented in the introduction. This chapter consists of eight sections. In Section 3.1, I briefly return to the moment in which Muybridge performed his motion studies in order to further articulate the importance they have for understanding the dance-analytic motion capture practices of the present day. I argue that these practices continue to be rooted in a cultural-historical paradigm that strongly ties visuality to knowledge transmission. In Section 3.2, I present a concise survey of current practices in which motion capture technologies are used to mediate dance for a different range of purposes. My aim here is not to give an exhaustive overview of this broad and richly varied field. Rather, I discuss a selected set of examples to go into more detail about some of the main trends and related issues. In Section 3.3, I map reasons that are given for the use of this technology and discuss ways in which these projects have been critically evaluated. Section 3.4 processes the survey's findings by going deeper into defining motion capture as an 'apparatus of capture'. In Sections 3.5 and 3.6, I problematize two aspects of motion capture as an apparatus: the status of the output of motion capture data as an *indexical trace* of dance performance and the remediation of video in dance capture. In order to test and build on this proposed theory, in the two final sections of this chapter, Sections 3.7 and 3.8, I analyze two case studies in more detail. The first one is Noh Composer, an analytic tool that was built by a team from the Kyushu Institute of Technology, led by Masaki Oshita (2013). I reflect on the implications of the problems they encountered in the creation process of this tool. The second case study is *TWO,* one of the 'digital scores' that are part of Motion Bank, the experimental project conceived

of by William Forsythe that can be accessed online (Hauert, Miller and Motion Bank 2013). *TWO* aimed to explore how optical motion capture could be employed to offer greater insight in the improvisational strategies of choreographers Thomas Hauert and Bebe Miller. I look more precisely at some of the elements of the digital score that relate to Thomas Hauert's work. These elements are illustrative of three often-overlapping aims that motion capture in the dance field typically supports: creation, analysis and documentation.

3.1 Picturing the invisible: Muybridge's motion studies

It is hard to imagine now, in a time when so many people carry smartphones with excellent cameras everywhere they go, and social media such as Instagram and Facebook are used to share massive amounts of the high-quality snapshots that are made with these devices, but once upon a time, photography was a new medium. At the end of the 19th century, photography specifically inspired awe for its capacities to 'capture motion'. If anything, Muybridge's picture of Stanford's horse makes clear how, in this cultural-historical moment, visibility was tied up with the positivist premise of scientific inquiry. The inventions in the area of photography opened up new possibilities for taking on movement as an object of scientific inquiry. Solnit identifies Muybridge's accomplishment as a central event within this transformative time for technological developments:

> [Photography] was now going to cross a great divide, to bring into visibility, as the telescope and microscope had before it, a world hidden to the eye. (…) It was as though a veil had always surrounded the most basic acts, and Muybridge's photography was on the verge of tearing that veil away forever. (Solnit 2003, 83)

The image evoked with the metaphor 'tearing away the veil' emphasizes the revolutionary potential of photography to open up a perspective on everyday movements that had not been available before. Strikingly, the contemporary discourse on digital motion capture technologies is characterized by a similar rhetoric. In the emerging literature on motion capture technologies, the work of Muybridge and Etienne-Jules Marey is often used to illustrate the cultural and historical basis of a visual paradigm that continues to inform our contemporary engagement and understanding of representations (Delbridge 2015; Manning 2009; Salazar Sutil 2015; Salter 2010). Like photography, motion capture is endowed with the capacity to show movements in a way that cannot be perceived with the naked eye. In this respect, I argue, photography and motion capture show similarities in what they are *believed* to do. To

lay a basis for an analysis of the discourse on contemporary motion capture practices, it is therefore helpful to take some more time to consider Muybridge's experiments as an example of the mechanical representationalism of the late 19th century, especially with regard to new notions of the relationship between visibility and specific modes of knowledge that evolved from it.

After his first famous assignment for Stanford in 1872, Muybridge devoted himself to finding new ways to measure the movement of human and animal bodies through photography. These measurements were enabled by specific *strategies of staging* the bodies in motion, not only by setting up the underground and background with white sheets, like he did during the first experiment, but also by displaying a numbered black grid at the background. This grid was a crucial feature in the setup of what came to be known as Muybridge's motion studies. In sequential photographs of moving bodies, the grid provided a fixed reference in the background. As a consequence, to study movement in this manner meant a conceptualization of movement as the changing position of a body in relation to the numbered background grid. Because of this method, Jonathan Crary has interpreted Muybridge's work as part of a refiguration of vision as 'dynamic, temporal, and composite' that unfolded throughout the 19th century (1999, 148). Crary argues that the use of the grid and the sequential presentation mode of photos that characterized Muybridge's motion studies contributed to the new way of addressing the observer:

> Muybridge, with his modular segmentation of images, breaks down the possibility of a "truthful" syntax, and his aggregate presentations set up anatomized field that an observer cannot seamlessly rebind. But the apparent nonhomogeneity and segmentation of his work are actually an opening onto an abstract order of continuities and uninterrupted circuits. (Crary 1999, 140)

To be able to interpret Muybridge's photographic series as *movement* requires an observer to imagine the connection between these segmented, still images and the phenomenal wholeness of an unmediated experience of, for instance, a running horse. The paradox here is that movement becomes an object of study through still images. Mary Ann Doane has remarked on this paradox that 'the irony of instantaneous photography is that its celebrated capability of representing movement is attained at the expense of movement's petrification and paralysis. The perfect expression of movement becomes movement's own antithesis' (Doane 2005, 26).

A second aspect that played a vital role in the revolutionary value of the pictures of the horse in full stride was the optimization of contrast. The more clearly its outline could be contrasted with the background, the more precise its movement could be studied. This is where the *visual abstraction* of photography becomes particularly apparent. Consider the quotation of Solnit at the opening of this chapter. Solnit writes that Muybridge's motion studies did not depict 'bodies as they might daily be experienced, bodies as sensations of gravity, fatigue, strength, pleasure, but bodies become weightless images, bodies dissected and reconstructed by light and machine and fantasy' (2003, 24). It is exactly this discrepancy between the complex, phenomenological nature of the body and its mediated depiction that has problematized photos and other mediated imagery as a legitimate source of knowledge *about* the body.

A third striking feature of the conceptualization of movement through this setup is the specific notion of *dimensionality* it puts forward. By projecting bodies against a two-dimensional grid, only the motion on the horizontal (x) and vertical (y) axes can be researched, the depth (z) axis is not made explicit for a viewer. The grid in Muybridge's motion studies thus operates as a measuring instrument inside the photograph that enables the viewer to study the movement of a subject. In this way, the resulting picture mediates a particular relationship between the viewer and what is seen. Maaike Bleeker's observations on theatricalization of the field of vision in *Visuality in the Theatre* (2008) help to identify Muybridge's setup as a scenographic strategy that aims to underline the truthfulness of what is depicted, even though it is the result of a highly artificial process. The white sheets that Muybridge used not only provided the best lighting conditions, they also isolated the horse from its regular surroundings. In this respect, Muybridge's pictures operate in accordance with the logic of the *finestra aperta*, which Bleeker explains as follows:

> Perspective 'theatricalizes' the field of vision. It creates a 'scenographic space' in which all that is seen is in a sense staged for a viewer. At the same time, this staging aims at an effect that is quite the opposite of being theatrical: the promise presented by perspective is one of directness, immediacy, it is the promise of [Leon Battista] Alberti's *finestra aperta*. (Bleeker 2008, 99)

Recalling the sterile whiteness of a laboratory environment, the sheets offer the promise of showing the horse and nothing but the horse.

It has now become clear how staging, dimensionality and visual abstraction played a role in Muybridge's motion studies. In the upcoming sections in this chapter I show how these thematic layers remain important to consider when making sense of contemporary practices of motion capture. But before I turn to this, I discuss one topic in more detail, because it is crucial for positioning photography as a precursor to motion capture. This topic is photography's capacity to visualize phenomena in a way that is particularly attractive for modern scientific discourse.

The photographic experiments brought phenomena into visibility that up to then had not been visible to the human eye. A clear articulation of this interest as it is commonly expressed can be recognized in a publication that features reproductions of Muybridge's most famous photographic sequences of animals:

> Most important, Muybridge's photographs capture many movements too fast for the human eye to catch. Here are the rapid, often minute adjustments of bone and muscle involved in leg coordination, head movements, shifts of gravity centers and other aspects of living motion. (Muybridge 1985, 'Publisher's note')

The capacity of photography to fixate these instances of 'living motion' added a new dimension to what could be visually comprehended. In his seminal study *Downcast Eyes* (1993), art historian Martin Jay asserts that 'the revelation of aspects of movement hitherto undetectable by the unaided eye', as was done in the 1870s and 1880s by Muybridge, Etienne-Jules Marey and others, 'helped denaturalize conventional visual experience' (Jay 1993, 133). Jay's central argument is that these developments had a profound effect on the understanding of our visual capabilities. Photography expanded the modes in which people could perceive phenomena in their environment. One of the results of this expansion was a destabilization of the trust that was placed in human perception. This can be illustrated by Aaron Scharf's observations on the impact of Muybridge's photographs: '[P]hases of locomotion were revealed which lay beyond the visual threshold. The meaning of the term 'truth to nature' lost its force: what was true could not always be seen, and what could be seen was not always true' (Scharf 1983, 211, quoted in Jay 1993, 134). Scharf's remark is an apt expression of the ambiguous relationship between visual experience and truth that is a key theme in the critical debate on photography and subsequent capturing technologies. By accepting Muybridge's picture of the horse as valid proof in 1872, Stanford and his East Coast colleagues implicitly agreed to trust that the picture indeed showed an empirical truth. Photography

thus provided them with what Don Ihde has called 'second sight': 'a unique instrumentally constituted scientific object for sight' (2002, 47).

The tension between this 'second sight' and unmediated sight has often been problematized in the field of media studies. The common usage of the term 'sight' reveals a tendency to equate vision with perception. Media scholar W.J.T. Mitchell has argued that the ability of photography to show something that is invisible to the naked eye, what Joel Snyder has called 'picturing the invisible', makes it difficult to think of photography as a visual medium in any straightforward sense (2005, 260). Mitchell explains: 'Photography of this sort might be better understood as a device for translating the unseen or unseeable into something that looks like a picture of something that we could never see' (Mitchell 2005, 260). This observation comes from Mitchell's article 'There Are No Visual Media' in which he critiques the colloquial use of the expression 'visual media', declaring it inexact and misleading. He argues that the term wrongfully ignores the other senses that these media involve, specifically touch and hearing. Drawing attention to this phenomenon of 'sensory hygiene', Mitchell notes the continuing influence of ideas on the purification of visual arts, to which Clement Greenberg (1940) significantly contributed by proposing concepts as 'pure painting' and 'pure opticality'.[40] According to Mitchell, sensory labelling of media as 'visual' or 'aural' should be resisted, because those labels fail to convey the complexity of media and because there is no 'pure' visual perception in the first place. Instead, he proposes a way of understanding media that acknowledges the multiple dimensions that are involved in the meaning that they produce: 'It is, rather, a question of specific sensory ratios that are embedded in practice, experience, tradition and technical inventions' (Mitchell 2005, 261).

Mitchell's critique of the emphasis on the visual basis of media can be understood in relation to the critical evaluation of 'visualism' in techno-scientific discourse, as proposed by Don Ihde. Through its fixation of movement, the imagery that was produced by photography seemed more exact, and in that respect more reliable than human sight. Photography resulted in a specific objectification of what was seen, an image that could be *reiterated.* This reiterability was crucial for the recognition of photography's scientific value. Ihde underlines the importance of the reiterability of visualizations: 'One can return, again and again, to the image to detect features overlooked or previously unnoted. It is the instant and restorable feature of the visualization that makes it valuable for science' (Ihde 2002, 45). For Ihde, reiter-

[40] W.J.T. Mitchell distinguishes Clement Greenberg's "Towards a Newer Lacoon" (1940) as his most sustained reflection on the desired 'purification' of the visual arts (Mitchell 2005, 222).

ability is one of the features of what he has termed 'visualism'. With visualism, Ihde designates the cultural habit of the sciences 'to reproduce, display, and reiterate what counts for evidence in visual form' (Ihde 2002, 37). Ihde's theorization of 'visualism' represents a critique that has frequently surfaced in media studies, namely that the sensory bias of the visual in knowledge discourses should be approached as a cultural-historical contingency and should be more thoroughly questioned as such. Ihde associates himself with this critique, and points to insights derived from phenomenological thought that support his view:

> Unlike the older traditions of discrete and separable senses, phenomenology holds that I never have a simple or isolated visual experience. My experience of some object that is seen is simultaneously and constantly also an experience that is structured by all the senses. It takes some deliberate constructive manipulation or device to produce the illusory abstraction that could be called vision by itself. (Ihde 2002, 38)

The 'deliberate constructive manipulation' that Ihde speaks of inevitably recalls Muybridge's hassle with the sheets in order to create the reflecting runway for the horse.

There is a renewed attention for the pioneering experiments of Eadweard Muybridge and his contemporaries such as Etienne-Jules Marey and others in current media and culture studies. These experiments show a particular vision-dependent knowledge discourse that was spurred on by technological inventions that originated in the 19th century. The current interest in these experiments seems to evolve from the observation that they continue to structure the perception and understanding of contemporary representations of moving bodies.

Like photography, motion capture also makes a prime candidate for Snyder's category of 'picturing the invisible'. The impact that photography had on the understanding of visual experience (Jay 1993) and the critical evaluation of the expression 'visual media' (Mitchell 2005) are ideas that are both important for the following inquiry, in which I examine how motion capture is understood to engage the senses and convey meaning.

The visual basis of precursors of motion capture such as photography, film and video has played an important role in the establishment of visual output as the dominant sensory output of motion capture. As becomes clear in the following survey, the positivist premise of the scientific endeavors for which photographic technologies were employed – which may be summarized as *seeing is believing* – can still be recognized as an underlying scheme of dance

capture practices today. Furthermore, in the following I show that this presence of 'visualism' (Ihde 2002) in these practices is reinforced by established capturing apparatuses that are typical for dance, such as notation systems and video, but also by the specific use of the mirror and by body-based practices of transmission. These interrelated apparatuses of dance capture have an impact on the meaning that is produced by each of them individually. The result is a meaning-making process of much greater complexity than may be initially assumed. As Mitchell writes: 'We also need to be mindful that media are not only extensions of the senses, calibrations of sensory ratios, they are also symbolic or semiotic operators, complexes of sign-functions' (Mitchell 2005, 261). Contemporary dance capture practices, it seems, are often designed in a way that perpetuates a dominant, distinctly modern viewing regime. The remainder of this chapter pays specific attention to how this optical bias can be recognized in contemporary practices of motion capture and dance.

3.2 How motion capture mediates dance

I now present a concise map of the field of motion capture and dance. First of all, I will answer some basic questions: What is motion capture? What is it used for? And, more specifically, how is it applied in the dance field? Then, I will address the most important questions these practices generate.

Motion capture is a digital technology that transposes the surface of a moving body into numerical data. Optical motion capture is able to record the three-dimensional trajectories of markers connected to a body in sub-millimeter detail. Reflective markers are connected onto a tight-fitting motion capture suit (fig. 8), or directly onto the skin. The record of motion data consists of three rows of data, that correspond to the three-dimensional coordinates of a marker within the motion capture volume. Because of the high resolution of these systems, the data flow that is produced by this technology becomes very large, which presents challenges for storage and navigation of motion data. By virtue of their digital basis, motion data can be visually rendered in myriads of ways. In their most basic form, these visualizations consists of a 'point cloud' that merely shows an animation of the trajectories of the markers. In another common basic animation, motion data is visualized by means of a mannequin-like model, which is still a rather schematic representation of the body (fig. 9). This model provides a spatial extrapolation of the data that projects a three-dimensional opaque shape in which the main limbs can be distinguished. As part of a motion capture set-

Figure 8. A performer dressed in a tight-fitting motion capture suit, standing in T-pose. Photo by Laura Karreman.

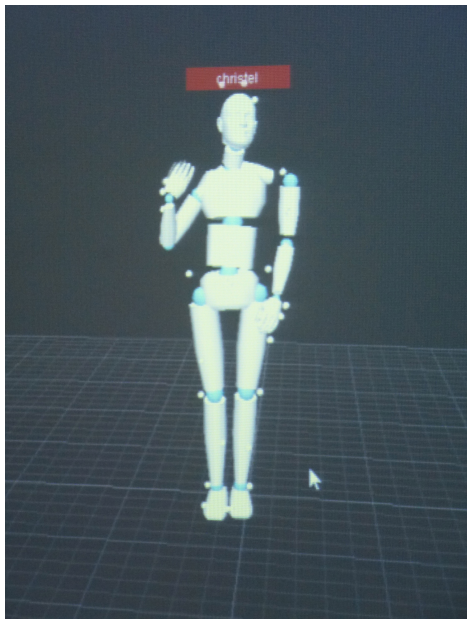


Figure 9. The 'mannequin shape': A basic rendering of motion capture data. Photo by Laura Karreman.

up, these basic animations mainly function as a quick reference that allows operators to follow in real time whether the capturing process is running smoothly.[41]

The quantitative aspect of motion capture data offers the possibility of making detailed calculations that map how the body moves, thus providing the basis for fast-developing research areas such as motion animation and recognition. In applications in movement science, the speed, acceleration and patterns of movements can be closely examined and compared. In robotics, motion data may be mapped onto other, non-human bodies. The possibilities of these technologies are also explored and further developed in the creative industry and artistic realms. The body's movements can be navigated in three dimensions or mapped onto other bodies, both virtual and real. In the creation of films and games, motion data is used to create life-like character animation. Although it represents a much smaller area compared to the domains mentioned above, the dance field has used motion capture for a variety of purposes. In the following survey I distinguish four general aims for which motion capture technology has been used:

1) for artistic and creative aims;
2) as part of dance notation applications;
3) to support motion-based recognition of dance qualities;

[41] Chapter 4 provides a more detailed account of the capturing process and the experience of the performer in the motion capture volume.

4) for archival and pedagogical purposes.

Note that even though these categories are broadly defined, none of the research projects, companies and performance work that are mentioned in the survey neatly fit one of these categories. It is much more common for these aims to overlap.

The application of motion capture technologies as an *artistic and creative tool* has been by far the most visible in the dance field. Throughout history it has been typical for dance and performance practice to incorporate and reflect on emerging technologies, and this also happened with the development of computer technology in the 1960s.[42] As Dixon notes on the adoption of motion capture in performance practice:

> As the obsession with the invisible traces generated by bodies grew, one of the central technologies immediately adopted was the complex system of motion capture (*MoCap).* Motion capture was the digital age's version of Marey's and Muybridge's quest to reveal the hidden traces of human and animal locomotion. (Dixon and Smith 2007)

The growing availability and affordability of digital capturing technologies since the 1990s has spurred on extensive experiments that have explored the aesthetic opportunities and implications of 'digital performance' (Dixon 2007; Salter 2010). Motion capture and motion sensing technologies have often been used as the basis of Gestural User Interfaces (GUIs) in performance, allowing performers and/or audience members to trigger a variety of sensory effects. Notable artistic collaborations that were established in this era and continue to be active include Palindrome (Wechsler 1997; 1998; 2006; Palindrome 2016), Troika Ranch (2016) and OpenEndedGroup (in this context specifically OpenEndedGroup's collaboration with Merce Cunningham) (2016). All these initiatives aimed to explore how the interaction between digital technology and performers could result in artistically interesting work.

It was precisely this artistic objective that led to the development of pioneering programs and systems. In *Entangled* (2010), an expansive study on performance and technology, Chris Salter stresses the importance of 'each group's custom development of the technical systems necessary to carry out their desired performance explorations' (Salter 2010, 268).

[42] A historic performance event that is often named in this context is *Nine Evenings: Theater and Engineering* (1966). Drawing more than ten thousand people in New York city, *Nine Evenings* was a collaboration between thirty electronic engineers from Bell Laboratories, artists from the Cunningham circle including John Cage and Robert Rauschenberg, choreographers such as Lucinda Childs, Deborah Hay and Yvonne Rainer, and numerous performers.

Palindrome and Troika Ranch designed the user-friendly software tools EyeCon and Isadora, tailor-made for practitioners in the dance and performance field.[43] Troika Ranch continues to share its expertise on interactive systems in performance, most recently by hosting the recurring workshop "XBox-Kinect & The Dramaturgy of Tracking" (Troika Ranch 2015). The Choreographic Language Agent (CLA) is a research project that was initiated by Scott deLahunta and dance company Wayne McGregor|Random Dance, and co-developed by OpenEndedGroup. CLA is a programming environment that is presented as an improvisational tool, supporting the composition of dance. It challenges dancers to create dance phrases as their 'solution' to a self-generated sequence of interrelated geometrical objects that is mediated through the screen of their own laptop (deLahunta 2009; Church et al. 2012; OpenEndedGroup 2013).[44].

Cross-disciplinary curiosity and expertise were also fundamental to artistic research that integrates motion capture technology in (dance) performance work. Optical and markerless motion capture technologies were employed in *Motion Bank*, the four-year research project of The Forsythe Company that focused on the creation of online digital scores of choreographic work by Deborah Hay, Jonathan Burrows and Matteo Fargion, as well as Thomas Hauert and Bebe Miller (Kahn et al. 2012).

Other examples of artistic researchers who have sought ways to relate their art practice to academic research include, but are not limited to: Susan Kozel (2007), Ruth Gibson and Bruno Martelli[45] (Gibson 2011; Whatley 2011), and several people who are - or were previously - affiliated to the Australian Deakin Motion.Lab, including Kim Vincs (2011; 2013), John

[43] Frieder Weiss of Palindrome designed EyeCon, a camera-tracking interface and software system; Mark Coniglio of Troika Ranch developed Isadora, the real-time software tool with an interface design particularly aimed at users working in dance and performance (deLahunta 2005).

[44] Artificial intelligence researcher and CLA programmer Marc Downie proposes that the program creates 'a new form of dance notation – one which aids the choreographer in generating dance movements rather than in recording existing movements' (Downie 2009). This performative type of dance notation may be difficult to relate to the conventional idea of a score as a more or less stable template for a dance performance. This type of score may rather be understood as 'a new form of existence for a work, prior to human embodiment' (Blades 2012, 225). One of the motivations to create the CLA was to avoid inviting dancers to simply imitate the moving figures they see on the screen. In this respect, the CLA draws attention to different modes than the ones that are employed by the digital tools mentioned previously, in which video representations continue to play a central role. By offering an interface that features abstract objects instead of photorealistic figures, the CLA responds to dancers' strength to translate abstract animations into bodily feedback. It is a design approach that specifically characterizes OpenEndedGroup, but abstract imagery representing dance movements has already taken many forms, Forsythe's *Synchronous Objects* providing another prime example.

[45] Formerly known as igloo, now as Gibson/Martelli.

McCormick (2014) and Steph Hutchison (2013a; 2013b; 2014; 2015). Other prominent examples of research in this area includes the work of Sarah Rubidge (2008) and Kirk Woolford and others (Norman et al. 2010). Some of these works will be addressed in more detail later. A final example that is worth mentioning here are the Choreographic Coding Labs, an initiative that has evolved from the *Motion Bank* project that is directed at

> digital media 'code savvy' artists who have an interest in translating aspects of choreography and dance into digital form and applying choreographic thinking to their own practice. Working with patterns in movement scores and structures through finding, generating and applying them with results ranging from prototypes for artworks to new plug-ins for working with dance related datasets. (Choreographic Coding Labs 2016)

It is no coincidence that a common trait of all these initiatives is a close collaboration between dance practitioners and computer programmers or 'coders'. A willingness and ability to articulate and communicate the concepts and vocabulary that are central to one's own discipline and expertise have proved to be crucial factors for yielding meaningful insights in such artistic research, as I addressed in Section 0.8.

A second purpose for which motion capture technology has been employed in the dance field is *to support dance notation applications*. Since the end of the 1970s, software has been developed for the purpose of composing and notating dance. Simon Fraser University and Credo Interactive have played a key role in this endeavor by developing Life Forms, which famously allowed Merce Cunningham to create his first computer-generated dance scores (fig. 10 and 11).[46] Life Forms later evolved in DanceForms, a program that allows a choreographer to try out ideas by animating dancers on a stage. These movements can be adjusted manually, but the dancers can also be animated by importing motion capture data. Apart from DanceForms, several dance tools have been developed that support the composition and editing of Labanotation and Benesh notation scores, including Calaban, Labanotory, LabanEditor, Labanotation LED, MacBenesh and Benesh Notation Editor (Calvert et al. 2005). A more extensive overview of dance notation systems that operate in a digital environment and an evaluation of their functionality is provided by Natalie Ebenreuter Swinburne (2005).

[46] An enlightening source on how Cunningham worked with LifeForms is Thecla Schiphorst's Master's thesis "A Case Study of Merce Cunningham's Use of the Lifeforms Computer Choreographic System in the Making of *Trackers*", Simon Fraser University, 1993. Schiphorst assisted Cunningham when he learned to work with the software and was therefore in an excellent position to report on this process.

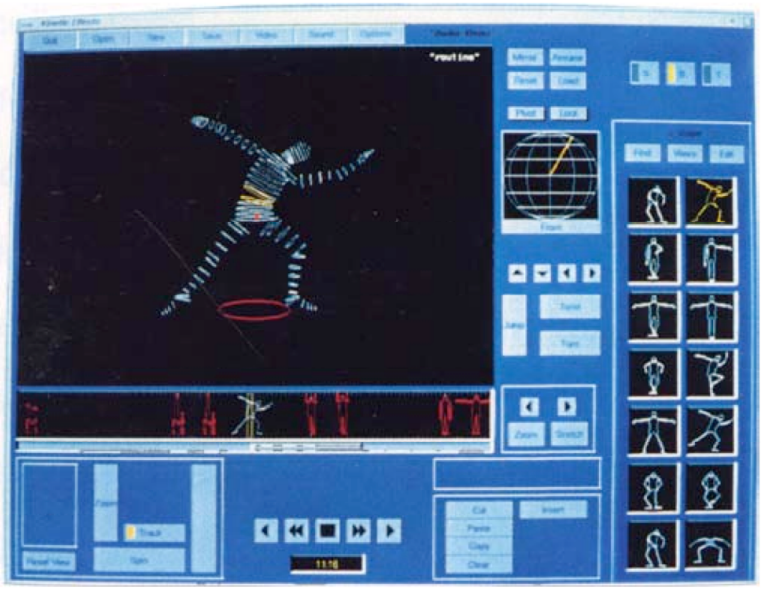


Figure 10. LifeForms interface (1993) by Credo Interactive.

A program that can not only edit, but also visualize dance notation in the form of a synthesized dancing character is more difficult to realize. To achieve this goal, Simon Fraser University has created the prototype LabanDancer (fig. 12), by linking the functionalities of Labanwriter and DanceForms (Wilke et al. 2005). 'But it's not good enough', co-developer Tom Calvert has commented on LabanDancer, 'and the reason for that is that notation is not complete of all aspects of movement. Dance notation systems are not completely comprehensive and consistent' (Calvert 2013). What Calvert means is that notation systems like Labanotation were not designed to support computation of dance movements. Just like the notation of dance is based on the interpretation of experts, its deciphering, in turn, relies on the interpretation of other dance experts, who have more knowledge at their disposal than can be read from the score alone.[47] Calvert and other experts in this area have pointed out that alternative ways of computing dance movements, such as various types of motion capture, are more flexible and less expensive to use for computational purposes than dance notation and will offer new opportunities in this area.

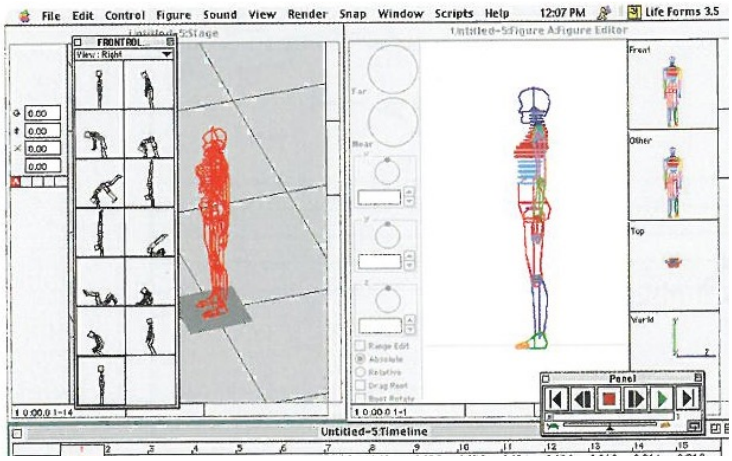


Figure 11. LifeForms interface (1999) by Credo Interactive.

A third category of motion capture-based dance research is constituted by research that aims *to extract dance qualities from*

[47] Nevertheless, research has been done to evaluate what dance notation systems are most suitable for computational purposes, see for instance Ebenreuter Swinburne (2005).

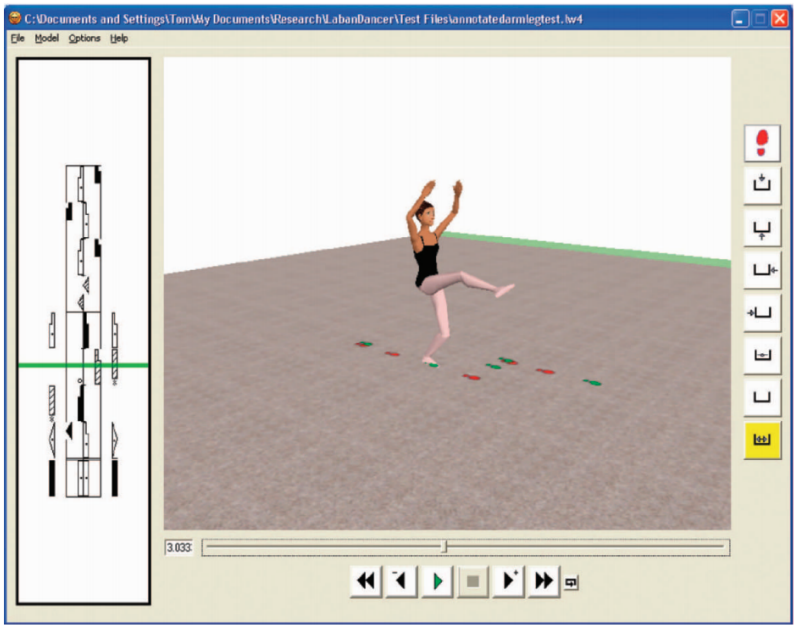


Figure 12. LabanDancer interface by Credo Interactive.

motion data. This type of research can be regarded as a small sub-category of the larger research area concerned with motion and gesture recognition and gait analysis that attracts a lot of attention these days. Relevant examples of dance-oriented research in this area include the work of Antoni Camurri (DIST) and Frédéric Bevilacqua (IRCAM). Camurri and his team developed EyesWeb, an open software platform that was specifically designed to accommodate real-time analysis of expressive gesture in dance and musical performance (Camurri et al. 2002). Their research was specifically aimed at finding ways to recognize *kansei* information. *Kansei* is a Japanese term that refers to feelings and sensibility. This *kansei* or emotional information was marked as a target for information processing by Hashimoto (1997). Using Laban's theory of effort as a conceptual framework, Camurri sought ways to recognize emotional qualities of dance based on physical signals provided by motion capture. For instance, one of their first experiments looked at tenderness, happiness, generosity, serenity and courage in a ballet performance (Camurri et al. 1999). The larger aim of Camurri's research, to find ways to extract qualitative information from motion data, can also be recognized in the work of musicologist and human-computer interaction researcher Bevilacqua. Bevilacqua has developed several tools for gesture capture in performing arts contexts. Based on gesture data, Bevilacqua sought to compute high-level parameters of movements similar to the ones used by choreographers in creation and performance (Bevilacqua 2010). He explains that 'these high-level parameters could, for example, refer to "movement qualities" and would be thus more easily graspable by artists' (Bevilacqua 2007, 2). To allow for the extraction of such features, Bevilacqua developed a 'gesture follower' (Bevilacqua et al. 2007). The 'gesture follower' is basically a motion recognition tool that compares a performance to pre-recorded performances to show the specific gesture vocabulary of an artist. The gesture follower has been

used in dance performances, interactive installations and pedagogical tools for music and dance (deLahunta and Bevilacqua 2007; Bevilacqua 2010). For example, in the installation *Double Skin/Double Mind,* the gesture follower provided audiovisual feedback on the movement of a performer in the installation, based on the specific movement principles of the Emio Greco|PC dance company (Bevilacqua 2007).

The fourth and final purpose of motion capture technology in the dance field that this survey addresses are applications that aim at *dance preservation*, which are often coupled with *pedagogical/ instructional purposes*. In recent years, projects have started to emerge that employ motion capture to document dance performance in order to protect it as cultural heritage. Stavrakis et al. (2012) and Aristidou et al. (2014; 2015) have reported on a project that 'aims to digitize, record, archive the Cypriot folk dance heritage and disseminate it to the wider local community and serve as a reference for related research activities' (2012, 404). In addition to the collection of rare video recordings, folk dance experts performed in a motion capture volume to enable researchers and practitioners to research and better understand these dances. With this project, they aimed to create 'the first high quality digital archive of this kind' (2012, 405), pointing out that there were hardly any databases of this kind available online. This project emphasizes motion capture's ability to study complex dance phrases from a three-dimensional perspective, thus providing an added value to video, which is limited to one perspective. Stravakis et al. also remark that '[motion capture] does not only safeguard the survival of the complete motion objectively; it allows reusing it to study or teach this, usually structured or complex, motion' (2012, 407). The research team does not regard motion capture as a means of recording dance that replaces other modes. Rather, they see motion capture as 'a complementary data channel that should be used in conjunction with text, video and choreographic notation systems' (2012, 407). There are other examples of this type of research. Shinoda et al. (2011) have designed a motion analysis system based on motion capture data of dancers. This can be used to teach *Nihon Buyo*, a Japanese traditional dance. Sato et al. (2011) and Usui et al. (2013) have looked at the use of motion capture-based animation as a feedback tool in learning the traditional Japanese dance styles *Kagura* and *Minbu*. Since the beginning of the 2000s, Hachimura (2006) has researched ways to broaden the possibilities to study dance by experimenting with the motion capture of Noh theater, modern dance, ballet and other dance genres. His research spans a range of analytic, instructional and preservation purposes, and aims at quantitative and qualitative approaches of processing dance movements through motion capture.

As a final note in this section, it is relevant to note that the release of Microsoft's Kinect has had a great impact on a broad range of movement research in both artistic and scientific domains. Kinect combines a motion sensor with a user interface system that enables advanced motion tracking, gesture recognition, and voice control. Kinect was introduced as a consumer electronics device to support video gaming, but was quickly adopted by users in other domains and applications because of its affordability and flexibility in use. Because Kinect's motion sensor records the three-dimensional position of a person's joints over time, Kinect has been used for biomechanical applications, skeletal information and gait analysis (Gabel et al. 2012). Examples of applications of Kinect in dance research and practice include: Laban Movement Analysis using Kinect (Bernstein et al. 2015), gesture recognition in Indian classical dance (Saha et al. 2013), dance training with an augmented reality mirror (Anderson et al. 2013), and a great variety of applications that allow dancers to interact with visual records of their movements, which may support pedagogical and creative purposes. The main difference between Kinect and optical motion capture technologies is that optical, marker-based motion capture provides motion data that are much more detailed. This is why optical motion capture continues to be preferred in creative processes in the film and gaming industry that are aimed at *re-creating* movement, a domain that will be discussed in more detail in Chapter 4.

3.3 Why (not) motion capture and dance?

How could a quantification of a moving bodily exterior provide information about anything worth knowing about the phenomenological reality of a dance performance? The challenge that lies in the corporeal computation of dance is directly related to this question, which has been taken up by researchers and artists alike. Practices of dance computation have triggered both curiosity and enthusiasm, as well as resistance and critique. Rather than simply assuming that the curious attitude towards these practices is naive, and the skeptical attitude is justified because of its critical stance, I find that it is most productive to acknowledge both responses. The incessant confrontation with these contrasting attitudes during my research provided me with frames on which to map my observations of these practices. Artists and researchers who are enthusiastically engaging in this challenge are often not really driven by a perceived necessity of computing dance to *improve* existing dance transmission; rather, they are curious as to what technology *can do.* Their investigations are directed by how technology opens up new ways of experiencing and understanding dance. In a larger perspective,

such projects can be understood as part of the current striving to rethink what it means to be human and connect to others in a time characterized increasingly by technologically embedded selves. A rare example of an extensive discussion on this topic in relation to motion capture is the work of dancer and philosopher Susan Kozel. In *Closer* (2007), Kozel reflects on her experiences in motion-capture enabled performance settings through a phenomenological method that heavily relies on the writings of Maurice Merleau-Ponty, in order to describe the 'closeness between bodies and computers' that is at the heart of this experience (Kozel 2007, xvi). She describes the phenomenological reality of performing with motion capture data as follows:

> [The motion captured figure] exists, it is not exactly the same as me, but it is also not irrevocably different from me, and, in a broader sense, we cannot pretend that the digitisation of our bodies and social relation is going to evaporate or even diminish. Like it or not, we have digital twins. (Kozel 2007, 250)

Kozel's observation displays her curiosity about the extent to which the digitized self can or should be recognized as an 'other'. On a different level, she also points at the urgency of asking this question at a time when our bodies cannot be kept from extending into the digital realm.

More practically, motion capture may also interest dance researchers and practitioners, because it offers them specific opportunities and advantages for their training and research aims. One of the prime advantages of motion capture is the three-dimensional perspective on the dancing body that it opens up, which can offer an interesting expansion of the perception of both dancers and viewers. This can be illustrated by a remark by choreographer and dance researcher Kim Vincs,[48] who writes that the attraction of motion capture lies in the specific spatial and temporal mode it offers to perceive and experience movement:

[48] The Australian choreographer and dance scholar Kim Vincs is a leading expert in this area. As a choreographer, she has created performances that use real-time motion capture applications, such as *Choreotopography* (2011), she has led the large-scale interdisciplinary research project *Capturing Dance*, which mapped opportunities of motion capture for dance analysis, and as the head of the Deakin Motion.Lab, she also collaborates on performance capture assignments for the creative industry. The *Capturing Dance* project, a three-year collaboration with mathematician Vicky Mak-Hau and biomechanist Richard Smith at the Deakin Motion.Lab in Melbourne, Australia was supported by the Australian Research Council Discovery program. A team of artists and scientists came together to explore quantitative analysis of dance style using motion capture.

> The possibility of accessing my movement, or another dancer's movement, in a way that doesn't immediately disappear, but can be replayed and watched over again, from any angle in a 3D volume, allows me the possibility of savouring a movement pathway in a way that is not possible when watching or performing a movement in real time. (Vincs 2011, n.p.)

These 'movement pathways' can be transposed to a variety of different outputs. Motion-capture based animations in the shape of colorful traces that are 'drawn' in real time by movements of dancers have proved to be an attractive way to support the proprioception of dancers while they are learning or improvising. For instance, research has demonstrated that such motion capture visualizations can work as a tool by inciting a reflexive empathic response that extends the embodied cognitive capabilities of dancers in the moment of improvisation (Douse 2013).

Others have enthusiastically embraced motion capture by pointing to the new opportunities it offers for dance transmission due to the different logic with which it operates compared to existing modes of mediating dance. Philosopher and mathematician Brian Rotman expressed this idea in the article "Corporeal or Gesturo-Haptic Writing" (2002) and later as part of his book *Becoming Beside Ourselves* (2008), which revolves around his central claim that computational media challenge alphabetic writing as the West's dominant cognitive technology. According to Rotman, motion capture is an example par excellence of a gesturo-haptic medium, because of its ability to position human movement in the 'orbit of writing'. He writes: '[Motion capture] constitutes a gesturo-haptic medium of vast, unrealized, and as yet untheorized or critically narrativized potential' (Rotman 2008: 43-47). As opposed to symbol-based notation systems, such as Labanotation, capturing technologies like motion capture offer the advantage of a 'continuous topological model', which allows for a more immediate kinematic writing and an easier retainment of the affective quality of the movement. The difference between capture and notation here is of crucial importance. Instead of translating movement into symbols, as is done when speech is transposed into writing, gesturo-haptic writing is a 'mediating technology that escapes purely signifying and the representational by operating within interactive, participatory, and immersive regimes' (Rotman 2002, 435). I return to Rotman's notion of gesturo-haptic media in Chapter 5 as part of my discussion of the kinesthetic quality of motion capture-based dance imagery.

Apart from these positive reviews, a resistant attitude towards these practices is also understandable. Skeptics may claim that there is no way that turning the contours of a danc-

ing body into quantifiable data is going to improve on a process that has proved to be the 'golden standard' of dance transmission since time immemorial: a 'body-to-body' process, in a live setting, in which corporeal communication is usually supported by oral explanations, part of a vocabulary that is typically alive with carefully phrased, powerful metaphors, as has been illustrated in Chapter 1. By recording dance in a motion capture volume, the dancing body seems to be wholly torn out of this context, its surface rendered into a virtual point cloud and the resulting basic animation seemingly devoid of mass, musculature, organs, bones, sweat and breath. Some movement remains. The point cloud moves. But what does this movement express? Can this movement still be likened to dance, understood as a valid reference to dance, even when all of the bodily features mentioned above are so conspicuously removed from our view?

When Salter writes about the moment that motion capture technology entered the field of performing arts, he observes that 'although motion capture could deliver extraordinarily high-resolution kinesthetic detail beyond the human eye, the question of what to do with such masses of data within an aesthetic framework posed both a formidable artistic and technological challenge' (Salter 2010, 267). Indeed, despite many experiments with motion capture and dance that have evolved in the field of dance practice and research, there are not many tools available that help to interpret or visualize the motion data of dance movements in a meaningful way. As Frédéric Bevilacqua, co-developer of the gesture follower at IRCAM, has pointed out: '[w]e can observe [movement qualities] with the human eye, but methods to extract such information from the digital data stream are still in their infancy' (2007, 27). An important part of the challenge here is to think of specific opportunities that are opened up by such complex data. For instance, Vincs has asked: 'The three-dimensional trajectories that are represented by marker data allow for complex quantitative analyses, but how to represent this data in an accessible feedback for artists?' (2011). There is no immediate sensory access to these data. To be able to relate to what has been 'captured', these data need to be mediated in a different form.

An experiment by Deakin.Motion Lab demonstrates the difficulty of rendering motion data in a way that provides accessible feedback, whilst not diminishing the complexity of these data. Using statistical methods such as principal component analysis (PCA) on contemporary dance movement phrases, Vincs and her co-researchers were amazed by the complexity of the movement analysis that was needed to account for the correlation of the data.

An example of an experiment that was conducted using this method is reported on in the article “Snapshots of complexity: Using motion capture and principal component analysis to reconceptualize dance” (Vincs and Barbour 2013). Barbour and Vincs explore the use of PCA as an instrument to investigate how precision, accuracy, repetition and variation in dance movements are embedded in specific performances. Principal components comprise differently weighted movement parameters, which are complex and not immediately intuitive. In this experiment four dancers performed two basic choreographies over thirty times. Subsequently, the inter- and intra-dancer consistency of various segments of their interpretation of the dance phrases were compared by means of a PCA analysis of the motion data. The experiment shows that the movement strategy of the performance of specific segments in the choreography was characterized by variability in some dancers and consistency in others. Many variances were found between the dancers and – to a lesser extent – between the different takes of individual dancers. The analysis revealed the potential of this method to discern movement patterns that may be characteristic for the style of individual dancers.

Barbour and Vincs commented that: ‘While this patterning remains abstract and is not easily interpretable in and of itself, it allows a comparison of the dancers’ movement strategies at a fine-grained, detailed level that is not immediately apparent to ordinary visual observation of the performances' (Vincs and Barbour 2013, 70).[49] This remark shows how motion capture has been adopted as a new instrument that ‘pictures the invisible’, building on the heritage of precursors such as photography and film. The heritage of these precursors in the contemporary discourse on motion capture can also be recognized in the reiteration of notions of objectivity and mechanical representationalism. The reappearance of such notions in the discourse of dance and motion capture may not always be conspicuous. Consider for example the following statement, which explains how motion capture data can be understood as de-hierarchized and ‘semantically blind’:

> The semantic blindness of motion capture data enables quantitative analyses that are independent of the artistic and cultural contexts of dance movements. Mathematical analysis of motion capture data effectively deterritorializes dance, to use Deleuzian terms, because it looks for what is statistically significant rather than what is culturally significant. (Vincs 2011, n.p.)

[49] These findings may indeed have been difficult to pin down by viewing the dance alone, although it must be noted that it is difficult to fully substantiate this claim, because a comparison with a visual observation was not formally part of this experiment.

This is a complex statement that is worth addressing in more detail, because it contains several assumptions that I have found to be typical for this discourse. The notion of 'semantic blindness' is a striking metaphor in this context. It would seem to suggest that motion capture is *unable to see* the meaning of dance. It is another example of the profound connection that is made between seeing and understanding. I would argue that, rather than that motion capture is not able to see the meaning of dance, the real difficulty lies in the effort it takes us to see how motion capture data starts to become meaningful. As has become clear in the discussion of experimental projects in this area, it requires the joint expertise from dancers and programmers to develop such methods. As such, quantitative analyses based on motion capture data can never be fully 'independent of the artistic and cultural contexts of dance movements.' It may well be challenging to connect statistical outcomes of data analyses to the cultural significance of dance. But to set the statistical significance of data analyses against the cultural significance of dance may mistakenly attribute an objective quality to motion data. What appears to be overlooked here – and elsewhere – is the thing that is most culturally significant in this situation, namely, the very choice to use motion capture as a tool to record and analyze dance.

3.4 Motion capture as apparatus

Contemporary practices that mediate dance through motion capture demonstrate that in their effort to make dance motion data 'speak', artists and scholars return to the merits of various already-existing dance media, such as scores, notations, texts and videos. As I noted above, movement notation systems like Labanotation and Benesh are re-evaluated for their use in the digital mapping of movement. New attention is also drawn to the oral and bodily communication processes in the dance studio, which are generally regarded as the unchallenged 'golden standard' of dance transmission. It is clear that as dance performance is being inscribed in a new language of digital scores, ways of seeing that relate to our heritage of dance and performance literacy cannot but resonate and resurface.

The dance capture practices that I have described so far have provided a basic idea of how motion capture not merely functions as a capturing technology, but can also be interpreted as an apparatus of capture because of its specific concern with the abstraction, representation and re-creation of dance, serving specific purposes. André Lepecki has written about choreography as an 'apparatus of capture', because choreography is concerned with answering the question: 'How does one make dance stay around, or create an economy of

perception aimed specifically at its passing away?' (2007, 120). Lepecki refers to Deleuze and Guattari (1987, 424-73), who observed that the concept of apparatus is 'Foucault's major contribution to a political theory of signification' (2007, 120). Moreover, Foucault's notion of apparatus 'foregrounds perception as always tied to modes of power that distribute and assign to things visibility or invisibility, significance or insignificance' (120). Previous examples have already shown how motion capture is employed to transpose dance into a variety of sensory outputs, dominated by visual output, but certainly not limited to the visual alone. In this sense, motion capture's highly manipulable output can be understood to have a broader potentiality than other apparatuses of dance capture.

The following two sections of this chapter zoom in further on motion capture as a medium, by approaching it as an 'apparatus of capture'. They address two topics of the apparatus. The upcoming section deals with the way in which motion capture can be regarded as a 'remediation' (Bolter and Grusin 1999) of video. I argue that the remediation of video by motion capture practices has significantly contributed to the visual idiom in which motion capture is most commonly understood. In the subsequent section I address the question to what extent dance motion data can be understood as *indexical traces* of dance performance, making use of the terminology that Charles S. Peirce has introduced in his taxonomy of signs.

3.5 Remediation: Motion capture and video

Video is one of the most important media that is *remediated* by motion capture in its capacity as an apparatus of dance capture. The notion of 'remediation' was introduced by Jay Bolter and Richard Grusin to describe the 'complex kind of borrowing in which one medium is itself incorporated or represented in another medium' (Bolter and Grusin 1999, 45). At a time when academic attention for digital culture was quickly gaining ground, Bolter and Grusin claimed that the logic of remediation was a defining trait of emerging digital media, arguing that '[t]he digital medium wants to erase itself, so that the viewer stands in the same relationship to the content as she would if she were confronting the original medium' (45). Although their study now appears dated in some respects, a valuable aspect of *Remediation* is that it clearly articulates how media are indebted to each other and how this process also perpetuates the heritage of earlier viewing regimes. As Bolter and Grusin put it: 'The very act of remediation, however, ensures that the older medium cannot be entirely effaced; the new medium remains dependent on the older one in acknowledged or unacknowledged ways' (47). Contemporary motion capture practices provide many examples of processes of

remediation, in which the indebtedness to dance notation systems, photography and film are abundantly present. Here, I will limit my consideration of this topic by focusing to the role of video.

Since its introduction to the consumer market at the end of the 1970s, video has grown into a widely established technology of performance documentation. Providing a much cheaper alternative to film, video was heralded as a savior of performing arts heritage. Indeed, video recording of performances has proved to be a great support for performing arts practice.[50] Video tends to be an invaluable source for revivals, re-enactments and research. Recent developments in this field show that video representations of dancers' bodies have remained a stable visual basis in the design of contemporary digital dance media. Hybrid interfaces combine digital performance annotations with the immediateness of video. The incorporation of dance videos in these environments continues to answer the call for a way of conveying dance knowledge that seems more intuitive and less expensive and cumbersome than using symbolic dance notation systems. Aiming to explore possibilities of digital media to create, represent and analyze dance, multimodal video annotation has become a common feature of these digital tools. These video annotated applications for dance have been developing since the end of the eighties (Cabral et al. 2012).

Even though digital technology has evolved significantly over the past two decades, the basic principle of the interface design of these tools has remained quite stable: a dance video is presented as a visual basis onto which different layers of graphic, textual or audio information are added or attached. A significant development lies in the fact that dance practitioners can increasingly add these layers themselves: the tools have become more user friendly and are more explicitly designed to fit the needs of the creative process. Two projects that have set an important example for this type of media were developed in collaboration with William Forsythe. The DVD *Improvisation Technologies* (1996) superimposed geometric shapes on dance videos to highlight the central imagery on which Forsythe's choreographic ideas are based. The website *Synchronous Objects* (2009), which Forsythe made in collaboration with Ohio State University, includes meticulously animated video annotations that temporarily visualize the shapes that are 'drawn' by the gestures of the dancers.

[50] Although it must be noted that the limited shelf life of non-digitized video material currently constitutes an imminent threat for many under-funded performing arts collections.

To understand the digital annotation tools that are currently being developed, it is crucial to acknowledge how strongly their design has been influenced by the visual basis of video. While dance notation systems like Labanotation and Benesh Movement Notation are still praised for their accuracy and completeness in describing dance movements and while their use continues to be advocated as a valuable choreographic tool (Duerden and Fisher 2007), this practice has been losing ground in the contemporary dance field due to the adoption of quicker and more flexible means to capture dance. Digital video recording seems impossible to beat as the quickest and most flexible tool to record, analyze and document dance.

This dependence on video has profoundly affected dance practice and education: dancers have become experts in translating flat, two-dimensional video images into dance movements. It is easy to overlook that this practice is in fact a relatively new skill, even when compared to the already pre-existing use of the mirror as a related feedback tool for dance performance. Contemporary dancers have developed a keen eye for evaluating dance on the screen: they can estimate detailed spatial relations between dancers, perceive muscle tension and, crucially, imagine the dancer's body from a perspective that is not directly captured by the viewpoint of the camera. Watching dance on video has trained dancers to continuously make these kind of 'visual extrapolations' of the perceived image, which they are able to translate into bodily feedback.

And yet, research has shown that while dancers agree that video can be a useful tool, watching self-images may disrupt their kinesthetic awareness (Ehrenberg 2012). Indeed, several choreographers make a point of avoiding confronting dancers with video recordings during the creative process. For example, choreographer Pieter C. Scholten of the EG|PC dance company has remarked on this topic:

> In principle, we never give things on video or DVD to the dancers. Sometimes if there is an emergency and we are not there. I think it can also be dangerous because you see a result, so you copy from the outside. You need to know from the inside first before you see it. (Dekker et al. 2010, 44).

Despite these objections, it is a common sight to see a group of dancers sitting on the floor of a dance studio watching excerpts in order to discuss their last rehearsal or to study a performance they intend to revive. Video has managed to enter the dance studio and has be-

come a more successful supporting tool of dance transmission than symbolic dance notation ever has.

Video images of dance have become a dominant way that dance is expected to look like on a screen. Its flexibility, accessibility and its detailed, realistic visual representation, together with its organic feel and fluidity, make video a powerful tool to mediate dance. Being used to video, it also easier to forget that the body animation or point cloud that the software of motion capture technologies produces originates from a very different capturing process than that of video. Marc Downie has pointed to the enduring impact of video on 'interactive dance performance', which according to him has caused the innovations in this area to 'plateau'. Downie writes: 'Part of the impasse is caused, I believe, to the interactive dance communities' use of video as the computers' way of seeing the stage' (Downie 2004, 11). Whereas video captures the dancing body in photorealistic representations, optical motion capture tracks a limited amount of predefined points on the dancing body. By means of tape, velcro or glue, markers are attached to the dancer's body that are able to reflect the infrared light of the cameras that are positioned in a grid surrounding the stage. This allows the cameras to accurately determine the three-dimensional movement trajectory of a marker through the capturing volume. Motion data need to be processed through adequate software and interfaces to make them accessible through a sensory output. As I have shown earlier in the overview of dance capture practices, to make this motion data speak meaningfully requires thinking about what questions should be asked to allow for a smart mediation of concepts, structures and experiences within choreography and dance.

3.6 The indexicality of motion capture

At the beginning of this chapter, I identified photography as a precursor of motion capture. As part of the present-day inquiry into motion capture's representational basis, the relationship between the movement that is perceived and the 'truth' of this movement is again challenged. Despite this similarity, the digital basis of this technology imposes a different approach to this issue. Other than analogue photography and film, which produce a tangible record resulting from exposure to light, the record that lies at the heart of motion capture is digital data. When considering the data visualizations that are the most common output of motion capture, the influence of the visual knowledge paradigm that can be associated with photography and film continues to be felt.

The uncanniness of performing in the motion capture setting is that even when dancers may be the subject of interest, it is the data that are abstracted from their performance that function as the primary source of subsequent renderings of their performance. As soon as the motion data are acquired, they may be adapted and manipulated, submitted to algorithms or transposed into different modes or even onto other bodies, which may be graphic animations, robots, or even other humans. Nevertheless, performance in the motion capture setting is only an act of self-erasure *to a certain extent*, because motion data, regardless of the form in which they appear, do carry a certain *trace* or remnant of the original performance. Because of the way in which motion data are grounded in performance, they can be understood as *indexical signs*, in accordance with the definition Peirce used in his theory of signs:

> [An index is] a sign, or representation, which refers to its object not so much because of any similarity or analogy with it, nor because it is associated with general characters which that object happens to possess, as because it is in dynamical (including spatial) connection both with the individual object, on the one hand, and with the senses or memory of the person for whom it serves as a sign, on the other hand. (Peirce in Buchler (ed.) 1955, 107)

In motion capture, motion data can be considered to be the primary indexical traces of the moving body, or, in the case of optical motion capture, the reflecting markers that are *attached to* the moving body. The data flow of motion data can be considered to be a digital footprint of this movement. To use Peirce's terminology, motion data 'hail the attention' to its referent: the moving body. Motion data can be considered as indexical traces because they have a dynamical and spatial connection with the referent they draw attention to, but do not share a similarity with the object. When dance motion data are rendered into a sensory output, for example moving imagery, the data start to constitute more than an indexical trace. In this shape, they gain the quality of an *icon*, because they start to bear a resemblance to their referent. This is why design fulfills such a crucial function in projects that use motion capture to analyze dance. By rendering motion data in a way that brings out kinesthetic properties that are strongly associated with dance, the *indexical authenticity* of motion capture is emphasized. Such imagery thus contributes to the legitimacy and the truth value of motion data renderings. It does not necessarily matter that the visual idiom of this imagery ranges from realistic to abstract. The indexical authenticity reassures the viewer that

this imagery is non-arbitrary, that it is evidence of an existing referent, in this case a dancing body. It thus strives to imitate what Roland Barthes has called the *noeme*, the very essence of photography, the 'that-has-been'. As Barthes wrote in *Camera Lucida*: 'in Photography I can never deny that *the thing has been there'* ([1980] 2000, 76).

However, although it may exploit the idea of the image as an indexical trace, it is problematic for motion capture-based imagery to make this claim. The different steps that are involved in the creative process of this image make it difficult, if not impossible, to establish an exact relationship between image and referent. One can in fact not be sure *what* thing has been there, or even *if* the thing has been there at all. It has often been observed that the digital image severs the link between representation and referent. Consider for example the following observation by Crary in *Techniques of the Observer* (1990) on the issue of referentiality in digital imaging:

> Computer-aided design (…) [is one of the few] techniques that are relocating vision to a plane severed from a human observer. (…) Most of the historically important functions of the human eye are being supplanted by practices in which visual images no longer have any reference to the position of an observer in a "real", optically perceived world. If these images can be said to refer to anything, it is to millions of bits of electronic mathematical data. (Crary 1990, 1-2)

In addition to the high manipulability that computer design allows, it should be added that computer-generated imagery (CGI) not only refers to bits, but also to the complex algorithms that support these design programs. In the work of N. Katherine Hayles, the inquiry of the digital image also plays a central role. To describe the unstable relationship between signifier and signified in the binary realm, N. Katherine Hayles introduced the term 'flickering signifiers', a relationship that can be changed with a 'single global command.' Hayles explains that:

> In informatics the signifier can no longer be understood as a single marker, for example an ink mark on a page. Rather it exists as a flexible chain of markers bound together by the arbitrary relations specified by the relevant codes. (…) As writing yields to flickering signifiers underwritten by binary digits, the narrator becomes not so much a scribe as a cyborg authorized to access the relevant codes. (Hayles 1993, 77; 87)

The shift from 'scribe to cyborg' that Hayles distinguishes can be recognized in emerging modes of digital dance writing. Depending on their ability to 'access the relevant codes', in co-creative projects such as *Motion Bank* and, more recently, the *Choreographic Coding Labs* (2013), the dancer and coder become cyborgs as well as co-narrators in their hybrid creation of flickering signs.

Viewers of digital images, then, can never quite know to what extent they are dealing with a 'fantasy of referentiality' (Didi-Huberman 1984). This is also always a concern in the practices of dance and performance capture that I described in the second section of this chapter. The way in which motion is 'captured' and the modes in which motion data are subsequently processed and manipulated compromises the persuasiveness of the referentiality that is suggested. Consider for example the process of 'cleaning up' motion capture data. This is part of the editing process that is (partially) supported by software and is meant to sift out deviating data and to smooth out data gaps caused by occasional marker occlusions. The downside of these editing processes is that they also inevitably affect and adjust 'correct' data. This is also pointed out by digital artists Gibson and Martelli, who observe that

> the varying steps of the process such as cleaning the data, constructing the skeleton, mapping the model onto the bones tends to smooth out any nuances or interesting glitches. Unfortunately, this process of in-betweening and blending in the production pipeline is often where surprising captures are overlooked because they appear as mistakes. (Jefferies 2009, 47)

The data loss that is caused by the production pipeline is an important reason for why Gibson and Martelli attach much importance to working as much as possible with 'raw material' in their artistic work (47). In their view, such source files retain the fullest expression, which is important, because it increases the believability of the virtual characters they create. Gibson and Martelli: 'The virtuosic can appear bland when rendered in the computer, perfection appears synthetic. To have 32 *fouettes* you only need to record one and then repeat it over and over' (Jefferies 2009, 47). The artistic practice of Gibson and Martelli, which will be examined in more detail in Chapter 5, testifies to the expertise that is required to bring out the refinement of unique movement profiles in motion data renderings.

3.7 Noh Composer: In between motion units

To gain more insight in the corporeal computation of dance movements and to give an impression of the type of problems that occur in this research area, I propose to take a closer look at a program that uses motion capture data to enhance the visualization of dance notation: Noh Composer (fig. 13-14). Developed by Masaki Oshita from the Kyushu Institute of Technology in collaboration with Hosei University, Noh Composer provides an authoring system for Noh performance that is easy to use for Noh practitioners (Oshita et al. 2013). Although its name may suggest otherwise, Noh Composer is not primarily intended to create new Noh dances, but rather aims at facilitating the visualization of existing Noh scores. When Noh students and researchers only have access to the Noh score, it is difficult to imagine what a Noh dance looks like. The research team, which included experts in human-computer interaction, biomechanics and Noh performance, used optical motion capture to record a selection of movements performed by a professional Noh performer, Masaki Umano. His performance corresponded with small movement units, called *shosa*, which make up the vocabulary of Noh dance. Noh dance notation (*katatsuke*) consists of two different types of symbols, one refers to the lyrics, the other to Noh dance, which combines a specific sequence of *shosa*, the small movement units. More than 300 types of *shosa* are known in Noh

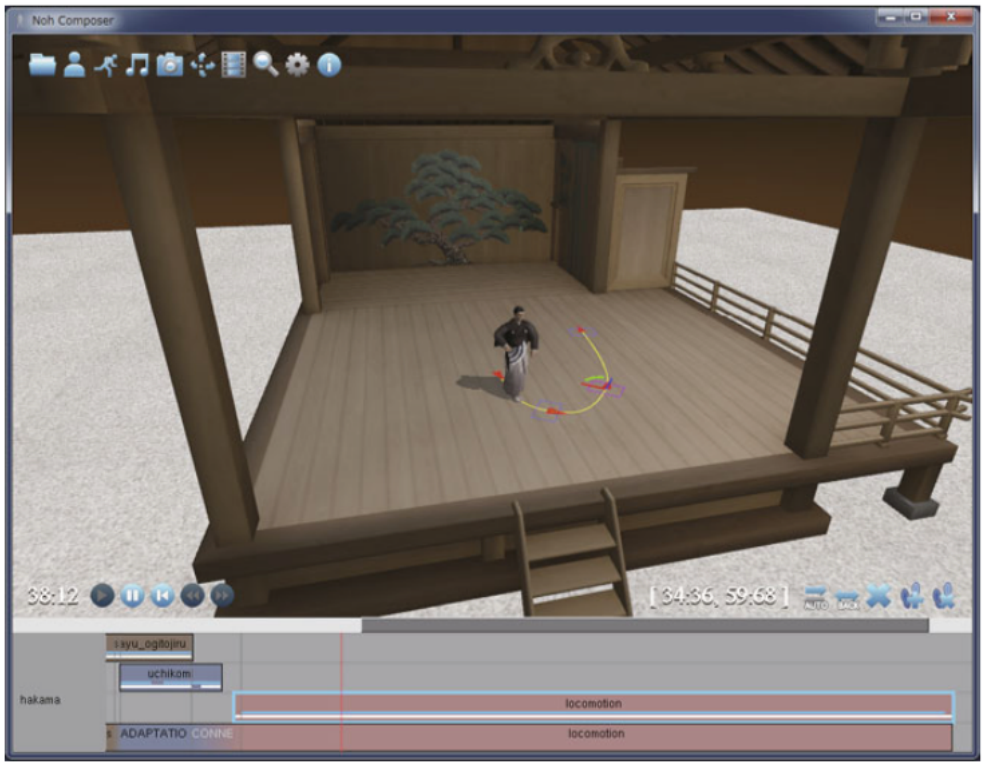


Figure 13. Noh Composer interface. Kyushu Institute of Technology (2013).

Figure 14. Noh Composer interface. Kyushu Institute of Technology (2013).

performance, but the basic vocabulary of Noh dance only consists of around 80 units. For Noh Composer, the *shosa* were recorded individually. The resulting motion data were subsequently edited and retargeted to a virtual dance character that is positioned on an authentic Noh stage. The program allows the user to place the motion units in various sequences and order them in spatial trajectories that correspond to the selected Noh score.

Oshita et al. give various reasons why the Kyushu team chose to work with motion capture rather than Labanotation. 'Because Labanotation describes the movements of each body part individually, it is difficult for users to describe the motions of Noh motion units using Labanotation', they remark (Oshita et al. 2013, 3). By using motion capture, it was easier to achieve natural-looking movement. Oshita et al. were specifically interested in realizing natural-looking transitions between sequential motion clips. They refer to various methods that had been previously developed to enable the blending of one motion into another, but most of these methods are difficult to apply in the interactive animation system that they aimed to develop, in which it had to be possible to easily manipulate motion units and motion paths. Even though the transition between motions is an important focus, the eventual result of their chosen method still has its own disadvantages:

> [S]ince our motion synthesis method simply blends the pelvis positions of a pair of sequential motions without considering the physics or the movement of the center of mass, even though a smooth motion is generated, the generated motion may be unnatural in terms of the movement of the center of mass, which is an important aspect of Noh dance. (Oshita et al. 2013, 11-12)

A natural movement of the center of mass between dance phrases is of course not particular to Noh dance, but to dance in general. Oshita et al. also mention other typical kinetic methods of Noh dance that were necessarily simplified in order to realize an easy-to-use system, such as the great variety in walking speeds, and the subtle ways in which Noh actors express emotions:

> Although Noh actors do not change their expression while dancing, they acquire an amazing ability to express different scenes or evoke the deepest emotions through the smallest of movements, such as slightly expanding the chest, drawing in the chin, or stretching the neck. (Oshita et al. 2013, 13)

The development process of Noh Composer thus also gives insight into other ways in which synthesized animation based on motion capture reduces the complexity of the performance of a professional performer. For instance, the *shosa*, which are based on a 'standard' performance in Noh Composer, are performed in different ways in Noh practice. Performance features of *shosa*, such as speed and movement quality, vary greatly in accordance with the plot and the character of a specific Noh drama. Another example of simplification that occurs in Noh Composer is the animation of the fan, which is an important instrument of expression for Noh performers. Because it is difficult to realize a simultaneous motion capture of both full-body movements and the hand that manipulates the fan, Oshita et al. chose to reduce the complexity of these movements. Four main ways of holding the fan were distinguished

Figure 15. Motion capture for Noh Composer. Kyushu Institute of Technology (2013).

and the one that occurred most often was used in the synthesized movement. By attaching markers to the fan, the direction of the fan could be replicated (fig. 15).[51] The authors of Noh Composer remark about these issues:

> These are special kinetic methods used when performing Noh dances. However, reproducing this detail is beyond the scope of our project. The aim of this research was to develop an easy-to-use authoring system for Noh dance animation and make use of it for deeper understanding of the rules and the system of Noh dance motion. We had no intention of creating an artistic reproduction of Noh dance. (Oshita et al. 2013, 13)

The team evaluated the program by letting Noh students use it to visualize existing Noh scores. The students that tried out the system reported that even though there are many differences between an actual Noh performance and the synthesized motions, the program offered them several advantages, such as being able to view the performer from any viewpoint, even from above and from below. It was also instructive for students to be able to watch the feet, because feet movement is very important in Noh performance, but usually the performer's dress hides the feet. Moreover, since students cannot always practice on an authentic Noh stage, it was helpful for them to be able to view the exact motion path of positions on the stage and to be able to control the speed of the execution of motion units.

Noh Composer is an example that demonstrates that corporeal computation always requires a specific understanding of the moving body in performance, an understanding that is prompted by a specific apparatus. Oshita et al. state that: 'The ultimate goal of our research is to identify how professional performers move their bodies by analyzing the differences between the synthesized motion and the motion captured from a professional performer.' Looking at examples of similar digital dance animation systems it is clear that the existence of basic vocabulary of movement units or phrases, such as in Noh dance and ballet, invite the use of motion capture for analytical purposes. The availability of a description of these motion units is a first requirement to build such an animation system. These types of dances can more easily be 'cut' and recombined or 're-assembled'. Whereas it is also common and useful for dancers to think of a performance as divided in phrases, programs like

[51] An additional problem that occurred with the fan is that it often moved through the body in the synthesized movement, due to the differences in the skeleton and clothes of the actor and the character, which was solved by editing the arm poses manually.

Noh Composer place extra emphasis on the individuality of different motion units by assigning them the role of principal building blocks of their basic structure.

Whereas the metaphor of dance phrases as building blocks is in accordance with the way Noh Composer works, since it is crucial to connect units to each other that give a global impression of an unknown score, this way of understanding dance also causes problems that put the synthesized motion at a distance from the lived experience of a dancer. By the treatment of motion units as separate building blocks, it is *the transition* between these units that becomes most conspicuous. As Oshita et al. mention: 'The ultimate goal of our research is to identify how professional performers move their bodies especially during the intervals between motion units, the dynamics of which is not clearly documented, but passed from teachers to apprentices tacitly during their training' (2013, 2). The space between two separate dance phrases, then, turns into a mysterious abyss which can only be crossed by a temporary suspension of the dancer's natural shifting of weight.

Problematic implications of conceiving of a dance performance as a sum of discrete movement units or dance phrases have also been touched upon by Barnard and deLahunta in their article "What's in a phrase?" (2005). Barnard and deLahunta note the importance of distinguishing dance phrases for watching, making and analyzing dance, but they also show that dividing dance into phrases is a highly subjective process. They conducted an experiment in which they asked dance practitioners to 'parse' or divide short movement sequences into smaller units. These sequences were created by dancers of Wayne McGregor's company Random Dance. It is relevant to discuss their report on this experiment here, even though the movement sequences that were used were different from the *shosa,* the motion units in Noh, in that their choreography was not based on an already-existing dance phrase vocabulary.

What was most striking about the outcome of this experiment was the extent of variation in the placement of start and end points. Based on observations by these participants, Barnard and deLahunta observe that it is difficult to determine what constitutes a dance phrase, because parsing is accomplished in relation to a particular attribute or coherent sets of attributes as they evolve in time.

> Since it is not possible to parse concurrently in relation to all attributes, it is necessary to invoke decision processes and schemes not just for the division of time but also to accommodate multiple perspectives such as the role of the task,

> learning/teaching, and exactly what to attend to in dynamic bodily configurations. (deLahunta and Barnard 2005, 8)

What happens between one unit and the other? The observations made by deLahunta and Barnard serve to illustrate the complexity of determining where a dance movement begins and where it ends. Does dance not defy any concrete limits when it comes to moving from one phrase into the next? For instance, dancers could argue that *mentally* they have already started to move before their physical movement becomes apparent. Also, the transition from one phrase to another affects both phrases. By knowing what comes next, the intent of a dancer will be different. And how to account for the memory of a dance phrase that lingers in dancers' bodies when they move on? I claim that it is the logic of corporeal computation, a principal feature of the motion capture imaginary, that engenders far-reaching attention to movement segmentation. Through its ability to record human movement in submillimeter detail, digital motion capture excels at accommodating this detailed scrutiny of performing bodies. However, even though such investigations will be able to access ever-smaller in-betweens, this does not overcome the semantic impasse that is inherent to such inquiry. By looking at dance as a collection of discrete motion units that can be stacked up as building blocks, it is the profound *interconnectedness* of these blocks that is at risk of getting lost on the way. For dance phrases carry meaning not only based on what is happening in that very moment, but also on what has come before and on what awaits just around the corner, out of sight, but nevertheless already present.

3.8 Motion Bank's digital score *TWO*: Capturing improvisation strategies

The final section of this chapter examines in more detail a case study that explores the use of motion capture as part of an experimental dance score. *TWO: Bebe Miller / Thomas Hauert: Encounters with the dancing mind and the thinking body* (2013) is one of the 'digital scores' that were created as part of the *Motion Bank* project.[52] *TWO* represents the work of two distinct choreographers, Bebe Miller and Thomas Hauert (ZOO company). Although their artistic

[52] The title of the *TWO* score is based on a text on improvisation by David Gere in *Taken By Surprise: A Dance Improvisation Reader* (2003): 'For it is while improvising that the body's intelligence manifests itself most ineluctably, and that the fast-moving, agile mind becomes a necessity. *The body thinks. The mind dances.* Thought and movement, words and momentum, spiral about one another. It is the project of this volume then, to suggest that improvisation, rather than being swathed in mystery, is in fact susceptible to careful articulation of the improvisational moment by no means renders it any less valuable, or any less capable of surprise' (Cooper Albright and Gere, eds. 2003, xiv, italics by LK).

work is quite different, when looking at the score it soon becomes evident why the combination was made. Both Miller and Hauert assign much importance to improvisation as a creative tool. They have both developed specific improvisational strategies, which can be regarded as a type of 'scores for improvisation', since they work with specific instructions. Another similarity between both choreographers is that these exercises rely on the interaction between two or more dancers as a prime means for generating new material. In the work of Bebe Miller this is exemplified by an exercise called 'Redux'. In Thomas Hauert's work, the importance of this interaction becomes clear in the 'assisted solo performances'. For the *TWO* project, Hauert and Miller worked with Norah Zuniga Shaw and Maria Palazzi at Ohio State University, a renowned center of expertise with regard to digital mediations of dance performance.[53] A specific focus of this project was to see how key improvisational strategies could be mediated by using optical motion capture. How could motion data be rendered as part of the score in a way that would offer insights about these strategies? And, more specifically, how could motion capture offer other insights than would be acquired by watching the performance live or on video? I address these questions by focusing on two specific elements of the score. Both of these elements are connected to the work of Thomas Hauert. First of all, I look at how the performance of one of his improvisational strategies is rendered in a motion capture-based graph. Then, I look at the way in which motion data of 'assisted solo performances' are animated in a visual output that the viewer can navigate.

One of the most intriguing examples of an improvisational score that is studied in *TWO* is 'The Careful Scientist'. The Careful Scientist is an exercise that was developed by Thomas Hauert and Zoo company. In *TWO* it is explained that the exercise 'uses a very tight set of rules to complicate the coordination between limbs across the two sides of the body. The ultimate goal of this exercise is to translate the intricate combinations it produces to any joint of the body, including the fingers, toes, and the chain of the spine' (Hauert, Miller and Motion Bank 2013). The first stage of the exercise focuses on arm movements. Dancers can choose from four types of arm actions (fig. 16) and perform them in any sequence they like. But here is the difficulty: The goal of the exercise is to avoid synchrony between the arms. The dancer should perform different actions with each arm and perform these actions with a different speed *and* a different direction. Also, a transition from one action to another should not coincide with such a transition for the other arm. The exercise can be increased in diffi-

[53] Zuniga Shaw and Palazzi also played key roles in the research team of Ohio State University that realized the project *Synchronous Objects for One flat thing, reproduced,* which was launched as an interactive web project in 2009.

Figure 16. *Motion Bank* and Thomas Hauert/ZOO company, *TWO* (2013). Demonstration actions of the Careful Scientist training exercise.

culty when it is extended to the rest of the body, involving the torso and the legs, until a full-body improvisation emerges.[54]

The title of the exercise aptly indicates the type of focus and attitude this requires. The dancer must be careful because of the extreme attention the out-of-sync movements demand. The deliberate avoidance of any symmetry and synchronicity in speeds and relative body positions makes The Careful Scientist a very challenging exercise for any dancer. The exercise prevents an easy flow from emerging in the resulting movement material. The maintenance of various speeds and angles in the different limbs of the dancer imposes a mechanical quality on the dance. To identify the dancer as a 'scientist' also seems apt: the exercise requires the dancers to adapt a contemplative, almost out-of-body perspective on their own movement. This aspect in fact recalls hip-hop dance, which features sophisticated isolations and values dancers' ability to dissect their own movements. Instead of an indivisible wholeness of the body, The Careful Scientist requires dancers to imagine their bodies as consisting of discrete parts, which can move independently from one another. In *TWO*'s section "Habit", Hauert explains: 'The Careful Scientist task is designed to challenge habitual patterns of coordination and attention, as are many of our training exercises. But this one focuses on working alone without an external trigger and performing different actions simultaneously on two sides of the body.' The complex exercise prevents dancers from immersing themselves in an unrestrained flow. It requires their continuous, undivided attention.

For the creation of the digital score *TWO* at Ohio State University, optical motion capture was used to track a sequence of arm movements of four individual dancers performing The Careful Scientist. *TWO* includes a graph that visualizes the transitions between the four

[54] To get an idea of the difficulty of this exercise, I invite you to try out a simplified version. Draw a circle in the air with your right hand at a steady pace. Now start making the same circular movement with your left hand too, but in the opposite direction than your right hand, *and* at a slower speed.

basic acts of The Careful Scientist exercise.[55] Palazzi, one of the creative directors of *TWO*, was involved in the creation of this graph.[56] The motion capture data of the dancers were submitted to an algorithm that was written to sort the data by time, joint, motion and direction. If a motion on a joint started in another direction, the algorithm would mark it as a new motion. The algorithm generated a listing of these actions by time and joint for the full length of the performance captured. The team then visually checked what the algorithm produced. The listing was compared to the performance on video to make sure that they matched. Once the data were confirmed, Palazzi took the data points and manually created the graph that is shown here (fig. 17).

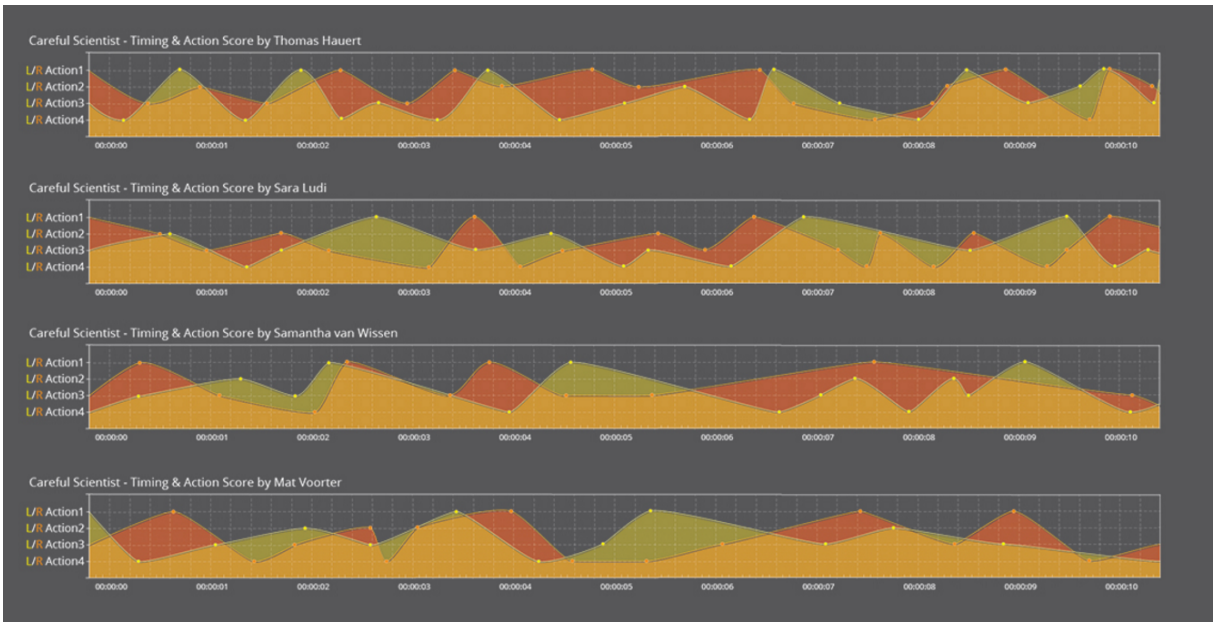


Figure 17. *Motion Bank* and Thomas Hauert/ZOO company, *TWO* (2013). Data plot of timing and action scores of the Careful Scientist training exercise.

The graph is included in *TWO*, but it is not further explained or commented upon in the digital score. When taking a closer look at this graph, several aspects are revealed about the way in which The Careful Scientist is performed. The graph includes patterns that would be difficult to perceive if one would only have access to video recordings or the live performance of the exercise. The graph shows that 1) none of the dancers can entirely avoid initiating an action with both arms at the same time, which is in contradiction with the exercise's

[55] Action 1: Changing direction upper arm points in space; Action 2: Maintaining direction of upper arm in space with rotation at the shoulder; Action 3: Extending or flexing elbow; Action 4: Rotating forearm (fig. 16).

[56] Maria Palazzi explained the creation process of the graph to me in an e-mail message, 15 December 2015.

requirements;[57] 2) the total amount of actions that is performed varies considerably per performer;[58] 3) the total actions that are performed by the left and right hand are never completely in balance;[59] and 4) the arms are moved with different speeds.[60]

In addition to the changing frequency and speed of the performance of the actions, this plot also suggests hypotheses about *movement strategies* that these dancers employ when they do the exercise. After listing the numbers of the subsequent actions of the left and the right arm for each dancer, two observations emerge. The first is that dancers seem to have different preferences for certain actions and for the order in which they perform these actions. The second is that despite these different preferences for certain actions and combinations of actions, a similar underlying pattern can be perceived in all dancers, which consists of a repeated back-and-forth movement between two actions.[61] The motion capture-based graph thus offers various insights into the habitual patterns of the dancers, which may be difficult for them to perceive through proprioception. Finally, it should also be noted that since the graph is explicitly presented as part of a *digital score*, a wholly different function for this graph could of course also be to function *as a score.* The information the graph offers can be used for the creative process of a new performance. Here it would be interesting to see how

[57] Those moments of overlap are visible in the graph when the transition points of the left and right hand have the same position on the x-axis. Although it is hard to read the time axis in the plot in detail, it seems that in each performance, such 'overlaps' occur 2-4 times in this time sequence for each dancer.

[58] Amount of actions per dancer: 40 (Thomas Hauert), 33 (Sara Ludi), 25 (Samantha van Wissen) and 24 (Mat Voorter).

[59] The biggest difference between left and right arm occurs in Sara Ludi's performance, she performs 14 actions with her left arm and 19 with her right arm. The only performance in which left-arm actions are more frequent than right-arm actions is Samantha van Wissen's performance; she performs 14 left-arm actions and 10 right-arm actions.

[60] This speed difference between the arms is most striking in the performances of Van Wissen and Ludi. At one point, they perform four actions with one arm in counterpoint with one stretched-out action of the other arm. It should be noted that I have assumed here that the shorter the distance on the x-axis (time) between two transitions, the faster each action is executed. This assumption should be verified based on a video recording of the tracked exercise, but this recording is not included in the score.

[61] This back-and-forth movement is apparent in both left and right arm movements. In the performance of Hauert, a back-and-forth movement between action 1 and 4 is visible at the beginning of the sequence. In Van Wissen's performance such a back-and-forth movement between action 1 and 4 is apparent, which is juxtaposed with a strong alternation of action 1 and 3 with the right arm. Although Ludi's performance shows slightly more variance, the back-and-forth pattern is also visible here, with action sequences in the right arm including: 2323; 414; 323; 42424 and in the left arm 313; 434; 131.

a re-enactment that is strictly based on the interpretation of the graph would impact the structure and the aesthetic quality of the resulting performance.

TWO also features various other renderings of dance improvisations that were tracked with optical motion capture. In one presentational mode, improvisations can be viewed as part of the score as short clips. In these clips, the dancers' motion data are represented as humanoid shapes that are rather abstract. The dynamically drawn lines that these dancing figures consist of present an expressive image. The clips offer some basic tools for interaction. Viewers are not only able to pause and play, but can also adjust their perspective by circling around and zooming in and out of the figure that is positioned in the middle of a square grid. Viewers are thus in charge of the camera frame and can create their own perspective on the material in the movement range that is available to them. These clips display the advantage of the three-dimensional dance tracking that motion capture provides.

One of these clips stands out, because it follows a slightly different strategy that demonstrates another specific option that motion capture offers. This clip shows an 'assisted duet', a type of improvisation in which the dancer explores new movement with the help of another dancer. The idea of this improvisation is that with the support of the partner, dancers can more easily find different ranges of movement that they would be unlikely to discover while dancing alone. In this case, new movement may be generated by the interference of this 'other' body that may allow for other movement impulses than dancers would be able to generate alone. This could be the result of a specific external physical support that would not be possible for a dancer alone to realize. Or it could be an external influence that cannot be explained physically, but could be caused by a certain energy or movement quality of another dancer. A certain chemistry with another dancer may impact movement material that is being generated.

In the case of the clip that is presented as part of *TWO*, the assisted improvisational duet shown is of Thomas Hauert supporting Sara Ludi. However, in the rendering of the improvisation, only the motion data of Ludi is shown. Hauert is not visible. And yet, his presence can still be felt in the clip, because the dancing figure that represents Ludi shows a dance that could never be a realistic solo performance. At the points where the dancing figure defies gravity, Hauert's absent presence is revealed (fig. 18). In this way, the score's creators use a defining characteristic of motion capture technology to their advantage: the way it records movement in discrete units, thereby offering the possibility of rendering only a limited selection of these units. By leaving out Hauert's motion data (or by only recording the

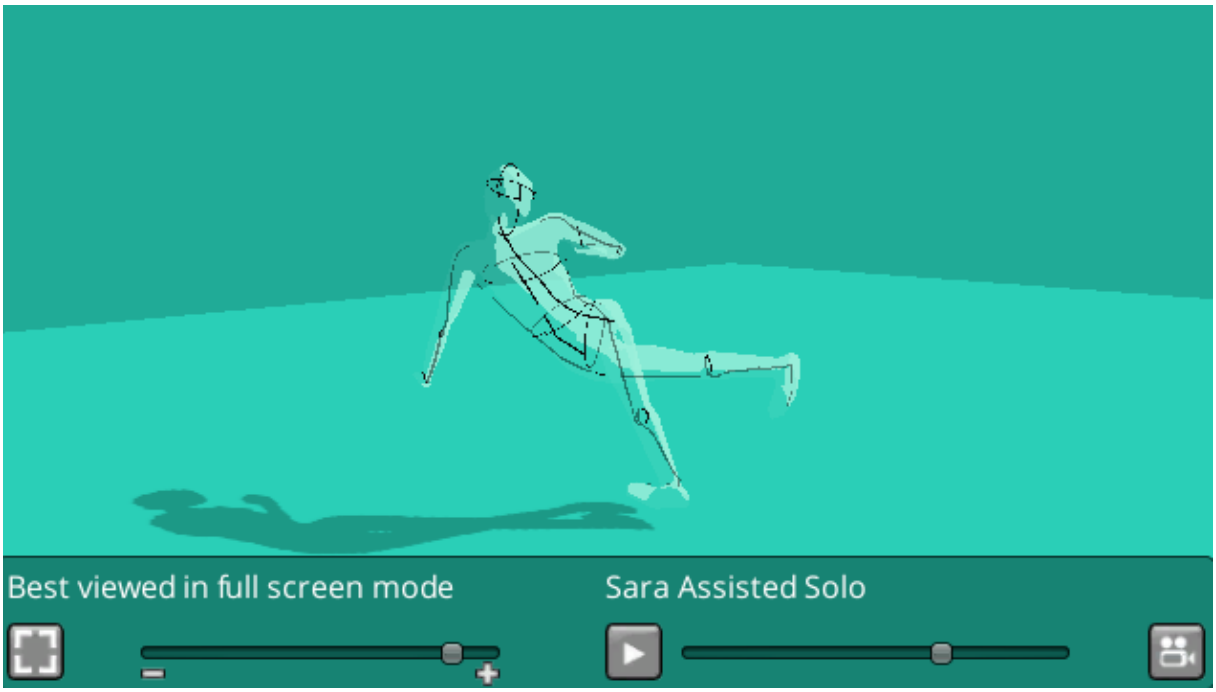


Figure 18. *Motion Bank* and Thomas Hauert/ZOO company, *TWO* (2013). Assisted Solo. Solo by Sara Ludi, assisted by Thomas Hauert.

motion data of Sara Ludi, the strategy that was followed is not explained), only Ludi's movement is visually accessible. A video recording of this same improvisation duet could never have given this perspective. This makes it an interesting visualization for a dancer. If the aim of the duet is to generate new movements, such a selective visualization of one dancer could have particular value. By being able to focus on their own movements alone, without being distracted by the movements of their partner, dancers may be better able to recognize how they can put into action their own proprioception, the way they perceive their own body during improvisation. Because the motion data rendering only shows their own body, it may be easier for them to imagine how they may develop their improvised performance in the assisting duet into an autonomous movement phrase.[62]

3.9 Conclusion

Motion capture can hardly be called a new medium anymore, but applications for dance are still in an experimental phase. The central challenge in designing such applications is to find meaningful ways to interpret dance motion data. Although motion data may be understood

[62] A comparison can be drawn here with Merce Cunningham's use of the software LifeForms. Cunningham manipulated animated dance figures in LifeForms that performed choreographies that would be impossible to perform for dancers in reality, thus creating inspiring and challenging scores for his company.

as an indexical trace of captured performance, processes of corporeal computation necessarily mean a radical abstraction of the complex embodied phenomenon of a moving performer. The media taxonomy of contemporary practices of digital dance capturing in this chapter shows that these practices do not produce a wholly new way of representing dance, but rather tap into already-existing strategies and ways of visualizing and notating dance. The emphasis on the remediation of media with a visual output such as video in practices of dance capture is apparent in the way in which motion data are visualized.

In writing about visualism in science praxis, Don Ihde makes the following observation:

> The better the image and the better the information revealed, the more highly constructed and the more thoroughly technological has been the process of producing this knowledge. If this generalisation holds — and I think it does — then we are today a very long way from the simplistic notions of objectivity and mechanical representationalism of the late nineteenth century. Were we to develop an epistemology based upon current science praxis, we would have to include a deep and critical analysis of precisely this instrumental, technological constructionism. (Ihde 2002, 49)

Ihde's remarks ring true when considering the observations made in this chapter on how motion capture is used to *reveal* dance knowledge. When considering the range of different purposes for which motion capture is employed in the dance field – artistic, analytic, pedagogical, instructional, archival etc. –, a common aspect that can be observed in most of these practices is that they are all research oriented. As has become clear, several researchers engaged in these practices think of motion capture data as an objective trace of dance. However, far from being objective, the motion capture data evolve from a process that is thoroughly constructed. This construction necessarily involves a high degree of reduction and abstraction of the phenomenon of dance as it is perceived during a live performance.

While motion capture data can be understood as indexical traces, the relationship between trace and referent is unstable, manipulable and difficult to retrace. Despite the fundamental differences between motion capture and video, I have argued that ways in which motion capture-based visualizations are designed and presented inevitably *remediate* video and other precursive apparatuses of dance capture. The ways in which motion capture represents dance is necessarily tied up with these already existing modes of looking. At the same time, looking back on how Muybridge employed photography as a method of motion capture, it is clear that digital motion capture has taken the complexity of technological con-

structionism to another level. Indeed, as Ihde says, 'we are today a very long way from the simplistic notions of objectivity and mechanical representationalism of the late nineteenth century' (49). By taking a closer look at the processes in which motion capture data are designed and shaped into specific sensory outputs, specific notions and assumptions about dance can be revealed. In the next chapter, the topic of the indexicality of motion capture is explored in more depth by drawing comparisons between performance capture practices in film and dance.

Chapter 4

The Performance Capture Artist

> The stage actor identifies himself with a role. The film actor very often is denied this opportunity. His performance is by no means a unified whole, but is assembled from many individual performances.
> — Walter Benjamin, "The Work of Art in the Age of Technological Reproducibility" (1935, 32)

> The slipperiness of my ability to decipher and relate to our shared understanding of these movements proves difficult without familiar landmarks and trajectories. I'm on a rollercoaster and I'm blindfolded.
> — Steph Hutchison, *Meta* (2015, 4)

In recent years, a discourse has started to emerge that investigates the implications of the interaction between the actor and the digital realm, with a focus on acting for films and games. In this chapter, I show how these recent insights can also be used in the study of contemporary dance capture practices. In this chapter, I expand on the fundamental insights of the previous chapter. I zoom in on the impact the technological and networked setting has on the performer and consider the high degree of technological construction that is inherent in motion capture practices.

In this chapter, I address the insights of performers who have worked in a motion capture volume in more detail. I argue that instead of performing *for* motion capture, the experience of performers rather tends to be one of performing *with* motion capture. To further articulate this thesis, I draw a comparison between two different types of performance practices in which the performer works with motion capture: 1) acting practices in which motion capture is used for character animation in films and games, and 2) dance performance practices in which motion capture is used as a creative tool. The experiences and insights

that performers in both of these practices have acquired over the past decade have so far received little attention. This chapter zooms in on selected issues related to the deeply co-creative dimension of these practices. Considering the many 'actors' in the networked setting of motion capture, to what extent can performers be acknowledged as primary authors of animated characters (or other sensory output) based on their movement data? And what impact does the interaction between performers and the motion capture system have on the performance technique and aesthetic aspects of a performance? A further investigation of these questions is not only of interest to those who are currently engaged in these performance practices in various capacities. The relevance of these questions goes beyond the artistic realms of film, games and performance that are discussed here. These questions also relate to a confusion that is widely felt, caused by a far-reaching entanglement of bodies and technology in our contemporary digital society. This entanglement may obscure where one body ends and the other begins. The transformation of 'bodies in code' (Hansen 2006) may hide or distort identities, or, alternatively, create ones that are entirely new.

Motion capture technologies are widely employed to support the re-creation of movement in fictional environments. The film industry is the area where motion capture is most famously used for these purposes. Since the beginning of the 2000s, motion capture has supported the animation of characters that played roles in major blockbusters such as *The Lord of the Rings* trilogy (2001-2003)*, Avatar* (2009)*, Dawn of the Planet of the Apes* (2014) and, most recently, *World of Warcraft* (2016). Because of the huge success of these movies, the budgets to invest in the technological development of motion capture-based animation have increased further. These investments, combined with the concentration of programming talent at locations such as Peter Jackson's Weta Digital studio in New Zealand, have contributed to the incorporation of motion capture into more and more sophisticated applications. These developments have also had a significant impact on acting practices. Film actors are currently learning to navigate the particular demands and skills that are required on film sets that are increasingly technologically augmented. This has given rise to a new acting trade, which I call *the performance capture artist.*

In using this term, I follow Gareth Taylor, who describes himself as a 'performance capture artist' on the website he co-hosts, The MoCap Vaults, which is advertised as 'The World's Number One Performance Capture School'.[63] The use of 'performance capture artist' should not be confused with what is conventionally described as a 'motion capture artist'.

[63] I discuss the MoCap Vaults in more detail in Section 4.3 of this chapter.

The term motion capture artist usually describes anybody involved with the creation of the digital character by handling motion capture data. Motion capture artists typically are visual effects artists, including animators, compositors and cinematographers. In motion capture vocabulary, the performer in the motion capture setting is usually referred to as 'the motion capture talent', or, in short, 'the talent'. While the words 'artist' and 'talent' both have positive and creative connotations, the word 'artist' can be said to convey a stronger sense of creative agency, of being in control of the creative process, than 'talent' has. The choice to call a performer a performance capture artist instead of a motion capture talent, then, reflects a more explicit recognition of the performer's creative agency.

The ambiguous status of motion data as indexical trace, also introduced in the previous chapter, returns in this chapter as a central topic when motion capture acting for film is evaluated as a 'crisis of the index' (Auslander 2015). This crisis of the index is exemplified by what Derek Burrill (2005) has dubbed the 'Gollum problem', which, as will be explained in more detail later, is caused by the confusion about the extent to which actors as performance capture artists should be credited for their acting achievements, when digital artists and programmers also play a significant co-creative role. This debate draws attention to the fundamental entanglement of the multiple meaning-making agents in the motion capture setting, which includes human and non-human actors. As such, it further problematizes the positivist-empiricist approach that is present in much analytic dance capture practices, but is often overlooked. Dance as it is performed in a motion capture setting resists an immediate likening to that dance as it would be performed in a conventional stage setting. This is not only for obvious reasons, such as the different environment and the replacement of a dancing costume with a motion capture suit, but especially because of the impact of the radically different 'eyes' that scrutinize the performer's contours in sub-millimeter detail in this setting.

4.1 Performance capture in film: 'Actors don't do motion, they do emotion'

Since the emergence of film at the end of the 19th century, filmmakers have experimented with various kinds of early motion capture technologies to improve character animation. The technique of 'rotoscoping', which was invented in 1917 by Max and Dave Fleischer was an important example of such a precursor of contemporary motion capture. Indeed, in a recent study on the history of computer animation, Tim Sito calls rotoscoping 'the most direct ancestor of motion capture' (Sito 2013, 201). Scenes with real-life actors were filmed and ani-

mators then used screen-to-screen playback of these recordings as a basis for their creation. Sito describes how rotoscoping works by explaining how the Fleischer brothers created the first rotoscope character, Koko the Clown:

> Max filmed his brother dressed in a clown costume. They then blew up the film frame by frame and projected it into a light box, so a piece of registered paper could be placed over a still frame and traced off. The final result was smooth-flowing animation, unique for that time. (Sito 2013, 201)

Walt Disney's *Snow White and the Seven Dwarves* (1937) also famously used rotoscope technology. Motion capture has been understood as a three-dimensional type of rotoscoping, as can be illustrated by the following observation by motion capture expert Alberto Menache: 'A two-dimensional (2D) approach, rotoscoping was designed for traditional, hand-drawn cartoons. The advent of 3D animation brought about the birth of a new, 3D way of rotoscoping. Hence, motion capture' (Menache 2011, 4).

Since the end of the 1980s, digital motion capture technology has been increasingly used to support computer-generated imaging (CGI) of fictional characters, initially in video games, then in cinema. An important advantage of this technology was that animators could use motion data as a basis for their creations instead of having to create the movement from scratch. Another advantage was the possibility to approximate 'life-like' movement more accurately.

However, at the early stages of the technology's development – in the second half of the 1990s – motion capture-based characters were easily recognizable by the rigid and artificial nature of their movements. This was the case in *Final Fantasy: The Spirits Within* (Sakaguchi 2001), the first widely released film that used motion capture for computer-generated character animation.[64] Based on a video game with the same name, *Final Fantasy*'s characters had a rather wooden appearance, which, combined with a poor plot, was not enough to earn much critical praise. Nevertheless, the film was successful in triggering a greater awareness of the potential of this technology in the near future. As a film critic of *The New York Times* commented at the time: 'In a couple of years – or sooner, given the pace of computer technology – the cutting-edge visual effects of *Final Fantasy*, in which the characters' weight

[64] *Sinbad: Beyond the Veil of Mists* (Ricks and Jacobs 2000) was the first feature-length film to use motion capture as its primary animation method, but this film was not as widely released as *Final Fantasy*.

Figure 19. Andy Serkis poses in a motion capture suit during his performance of Gollum during the shoot of *The Lord of The Rings: The Two Towers* (Peter Jackson 2002).

less tread makes it look as if they were moving in zero gravity, will seem quaint and disarming' (Mitchell 2001). Innovations indeed kept up an impressive pace. Only a year after *Final Fantasy,* the quality of the motion capture-based animation of the creature Gollum in Peter Jackson's *Lord of the Rings: The Two Towers* (2002), created by visual effects studio Weta Digital, surpassed all work that had previously been done in this area (fig. 19). Actor Andy Serkis, who played Gollum in the film, has since grown into the standard bearer of an emancipatory movement for the recognition of acting achievements of performance capture artists.[65]

With the arrival of facial capture in film, first featured in *The Polar Express* (Zemeckis 2004), motion editors could create even more sophisticated features. Initially, only body movements had been captured and facial expressions were animated manually. Facial capture represented a significant leap in the technology's development. The simultaneous capture of body movements, facial expression and voice resulted in far more convincing and realistic character animations. The introduction of facial capture also marked the moment that

[65] In 2011, Andy Serkis and Jonathan Cavendish founded The Imaginarium Studios, a performance capture studio and production company that specializes in applying motion capture technology in film, television and video games. Based in London, The Imaginarium has provided performance capture for films including *Rise of the Planet of the Apes* (2011), *Avengers: Age of Ultron* (2015) and *Star Wars: The Force Awakens* (2015).

the technology started to be referred to as performance capture, 'PeCap' or 'PerfCap' (Gomide 2012).

When director James Cameron was asked about the extensive use of motion capture in his highly praised film *Avatar* (2009), he commented: 'I don't like to call it motion capture, I like to call it performance capture. Actors don't do motion, they do emotion' (Wolk 2009). It is a clever way to put it. Cameron's statement stresses the relation between 'motion' and 'emotion', which draws attention to movement as a phenomenon that harbors affect and intention. Simultaneously, it directs the attention away from the reduction that is involved by transposing performance into data. By proposing to call it performance capture, Cameron redeems motion capture from 'merely capturing motion.' Remarks such as these highlight the primary aim the film industry has with motion capture technology: Motion capture enables them to match the creative opportunities that CGI characters offer with the possibility to augment their performance with a believable dramatic intensity. The fact that facial capture turned out to be a decisive factor that allowed performance capture to emerge in cinema can be explained by the central importance of facial expression in the film acting tradition, as has been remarked by Auslander (2015). I return to this topic further on in this chapter.

The most recent developments in this area show increasingly sophisticated results with the combination of motion capture and CGI techniques. A photorealistic animation of human characters that cannot be distinguished from their real selves now seems to be just around the corner.[66] Actor Dominic Cooper collaborated on the film *World of Warcraft* (2016), which features cutting-edge CGI effects. He gives a well-known response when asked about the pace of developments in this area: 'It is not a question whether or not it can be done. It is really a matter of investing time and money' (BBC 2016). Fifteen years after the pioneering but wooden character animations of *Final Fantasy*, such photorealistic animations of human characters would be an impressive step. This is coupled with other revolutionary developments. Consider for example the short documentary that explores the future of CGI, in which one actor mentions: 'I hear that people are getting themselves scanned in order to play parts in the future they would otherwise not be able to play' (BBC 2016). If this is the case, it becomes possible to imagine another extraordinary possibility when taking into consideration the recent astonishing improvements in applications that enable three-dimensional extrac-

[66] Nigel Sumner, who is a digital supervisor at Industrial Light and Magic (ILM), a company started by Star Wars' George Lucas, believes photorealistic humans in film will be possible in two years. ILM is behind it and has used it in the new Warcraft film (Newsbeat 2016).

tion of two-dimensional imagery. When these extraction and re-creation possibilities are fully extended to moving images, it becomes a real possibility to extract actors' performances from existing films and to subsequently include them, in photorealistic detail, in the cast for a new film. Imagine for example that brilliant, but long-deceased performers — say Buster Keaton — could co-star with contemporary actors. The massive budgets that renowned studios such as Weta Digital, Industrial Light and Magic, EA and The Imaginarium can work with allow for a rapid development of innovations. The developments in this area exemplify a common trajectory of technological innovations. Plenty of prototypes are present 'behind the screen', but they need time, money and opportunity to be developed further and, eventually, widely implemented.

4.2 From MoCap to PeCap

Actors that work in a motion capture studio have to deal with unique challenges. To date, very little research has been conducted on the specific implications this setting has for directing and acting. An exception is *Motion Capture in Performance* (2015), in which Matt Delbridge argues for the central importance of the actor in this creative environment and proposes to replace the term 'motion capture' by 'performance capture' or 'PeCap'. Delbridge aims to adopt PeCap, performance capture, as the preferred term to designate the practice in which motion capture is used to record performance. He argues that the use of the term PeCap puts the performer back into the practice's center of attention. An experienced motion capture system operator himself, Delbridge observes that most operating manuals for motion capture systems suggest a workflow that privileges post-production editing processes. They view the gathering of performance data as only one of the first stages at the basis of the production process. However, Delbridge argues that the emphasis should be placed on the performance stage of the capturing process. The skills of the performer and the director should be recognized as being at the heart of this process. According to Delbridge, this shift of perspective will pay off because of innovations in this field that are soon to be expected:

> In the foreseeable future, when PeCap becomes a common and accepted practice across our institutions and industry, the Performance Capture will not need to be 'fixed' post capture. It will exist as a single take, an exact record of what was captured; unedited and streamed real time as a footprint recording of performance. In order for this to occur with the greatest effect, our sense of operation, performance and direction requires a repurposed approach that includes signifi-

> cant changes in the way operators, directors and performers are prepared into the future. (Delbridge 2015, 84)

Delbridge's contribution to the debate on motion capture and performance is valuable because it articulates the impact these technologies have on staging and performance techniques. The discussion of Muybridge's pioneering photography of horses in Chapter 3 already showed the staging techniques that were required to create the artificial setting in which the movement of the racehorse could be captured. There is also a long history of requiring film actors to have their performances recorded in settings that only faintly relate to the eventual fictional environment presented to the spectator. The higher the degree of artificiality these film sets acquire, the more 'making of' films and commentaries seem to have evolved as an independent film genre.[67]

Figure 20. Actors Rupert Grint and Emma Watson in the roles of Ron Weasley and Hermione Granger during the shoot of *Harry Potter and The Deathly Hallows: Part 2* (David Yates 2011).

4.3 A new acting trade: The performance capture artist

A British initiative that gathers and shares expertise about this topic is called The MoCap Vaults. The MoCap Vaults was created by three performance capture artists and directors, each with more than a decade of professional experience in the field: Oliver Hollis-Leick,

[67] For example, due to people's exposure to this genre, it no longer comes as a surprise that the kissing scene of Ron and Hermione in *Harry Potter: The Deathly Hallows* was not in fact filmed in a thunderstorm at a rock waterside, but in a huge studio with 25 crew and a stage empty except for actors Rupert Grint and Emma Watson standing in front of a green screen with some water sprayed in their hair and a wind machine directed right at them (fig. 20).

John Dower and Gareth Taylor.[68] The website of The MoCap Vaults provides information to two groups: actors that aspire to work in motion capture studios and producers that need support in casting, production and training. The website explains why actors require specific skills to successfully perform in a motion capture studio:

> Current casting and talent management groups frequently don't understand the demands of a motion capture shoot. They provide actors with great voices but no movement skills or people that freeze up the moment you put them in a lycra suit. (…) [We] help you find the actors and then train them in mocap technique so that when they hit the studio floor they're ready to go. (The MoCap Vaults 2016)

Specific movement skills are indeed crucial for these performers, as is also shown by the sample of 'talent'[69] in the directory of The MoCap Vaults. Their skills include movement techniques that are required for films and games, such as fighting, stunts and use of weaponry. Almost all of these performers are trained as actors, movement specialists or gymnasts with additional skills such as: 'weapons', 'combat' or 'military'. One profile even lists 'former Royal marine'. The website announces training classes for actors interested in motion capture called 'Moving Digitally: Physicality & Movement for MoCap.'

One of the 'gurus' of The MoCap Vaults, Taylor started out as a professional gymnast and also went to Jacques Lecoq, the renowned physical theater school in Paris. At a symposium that focused on motion capture in performance, he explained how his training at Lecoq greatly benefited his work with motion capture: 'Motion capture acting is mask work, essentially' (Taylor 2015). A teacher in 'neutral mask' at drama schools in the UK, Taylor said that his experience with motion capture has only deepened the physical awareness that he began training at Lecoq. Indeed, actors with mime training are a preferred choice of motion capture casting directors. An article on casting for motion capture lists preferences as follows: 'stunt people, martial arts experts, gymnastic experts, professional athletes, dancers, mimes, costume puppeteers (people who regularly make their living acting within large costumes), pro wrestlers, theatrical stage actors (who possess an excellent physical self awareness), acrobats, actors used to working with green screen' (Motion Capture Society). Performance cap-

[68] Gareth Taylor spoke about his work for The MoCap Vaults at the conference Motion Mapping that I attended at the University of Surrey, November 14, 2015.

[69] As addressed earlier in this chapter, 'talent' is a term that is commonly used in motion capture vocabulary to designate the live performer whose movement is recorded.

ture artists are thus cast for their specific movement skills, for their physical awareness and for their body type.

Despite the amount of detail that contemporary systems are able to capture, motion capture does require another type of acting than regular 'tv-acting.' This tends to cause much confusion among directors who just start working with motion capture and are told that 'the technology picks up everything'. These directors then tell actors that 'the performance needs to be normal, completely natural.' Taylor recounts that after a while these directors get worried and start whispering: 'He looks dead! He looks dead!' 'Of course I look dead', Taylor says, 'because I'm being real, I'm doing a real tv performance.' To come across 'natural' in a motion capture volume requires a different type of acting. Taylor has often experienced having to redo or add to performances by other actors who are not used to motion capture, while being paid less than the original actors. Taylor describes this as one of the main challenges of working in this environment:

> The performers you are working with are not always great. Not because they're bad actors. They just haven't had much integration in the system. They don't know how to use it to its best ability to create a character working with the system. So there are constant problems occurring with this. And you're looking at this performer and can only think: the post-production team are going to have an absolute nightmare with this. (Taylor 2015)

One of the primary aims of the MoCap Vaults is to provide this type of expertise to actors, directors and animators. The website includes some 'free online learning resources', consisting of short video clips that shed light on particular aspects of the work, presented by motion capture directors and performers alike. Short video tutorials introduce actors to the basics of acting in a motion capture studio. For instance, one video provides clues on how acting should be adapted to accommodate marker visibility: 'When you're sitting on a table, bending over, the cameras can't see all of these markers [on the chest]. So just change your position a bit. It's just the same as on a stage, you wouldn't deliver your performance facing away from the audience, you would deliver it *to* them' (The MoCap Vaults 2014). In workshops, the Mocap Vaults offers more in-depth advice on the specific acting techniques that motion capture requires.

Taylor describes motion capture acting as an acting style that is radically 'outward-in'. Due to the high-pressure demands of the motion capture work, the actor has to respond very quickly to the look of a character:

> You have a 2-minute chat about the character with a director who has thought about that character for years. You think about what the looks of the character mean for how it breathes, what the spine is like, how it moves. You get a couple of still images from which you have to get an idea of how it walks. So you're constantly making huge generalisations while all the training inside of you is screaming to want to work in more detail. (Taylor 2015)

Time pressure indeed represents one of the major challenges in motion capture acting. Motion capture is cheaper than hand-animation, but the pace of recording is high. 'They want to get as much shots as they can in one day. But that means they rocket through it. As an actor you're constantly responding on the spot. That attracts me personally as a performer. But for some it traps them' (Taylor 2015). The recording speed that the motion capture actor needs to handle is also apparent in one of the video tutorials of The MoCap Vaults website, which features a recording session with Hollis-Leick in the Giant Studio in Los Angeles. The tutorial focuses on the topic 'Dying for Games'. Hollis-Leick explains on voice-over: 'In the modern day of video games, the expectations from the player are higher than ever before. They want unique, realistic deaths from every angle.' We see Hollis-Leick in a motion capture suit, holding a gun and falling down again and again on a layer of two thick mats, responding to a cue about where he has been hit (left-shoulder, right shoulder, head) in quick succession. Hollis-Leick explains how he creates unique 'deaths' by concentrating on the place that has been hit and what kind of speed and energy he wants the death to have. He also relies on his memory of footage of soldiers dying in World War II: 'The deaths are horrible. It's just a puppet with strings cut'. Once again, the high pace of the work is striking. Hollis-Leick: 'Here I did thirty deaths in 6-8 minutes, with some downtime' (The MoCap Vaults 2015).

The MoCap Vaults is a response to a fast-growing industry that has a demand for actors that have a specific performance expertise at their disposal. Initiatives such as these provide actors, directors, producers and animators with information on a creative industry that started to emerge in the 1990s, but has only started to grow exponentially during the past decade. For performance research and media studies, these emerging expertise platforms

constitute special source material that sheds light on the particular techniques and challenges that are involved in motion capture performance.

This prompts the question: How *new* is this type of acting exactly? It could still be argued that the performance capture artist is no more than a specific category of film acting. After all, film actors have always worked in a thoroughly technological environment. They have to adapt to challenging sets and have to act for the camera. The way in which their performance becomes meaningful is shaped by the montage of the filmed material. This led Walter Benjamin to make a distinction between the stage actor and the film actor. In his canonical essay "The Work of Art in the Age of Technological Reproducibility" ([1935] 2008), Benjamin writes: '*The stage actor identifies himself with a role. The film actor very often is denied this opportunity.* His performance is by no means a unified whole, but is assembled from many individual performances' (32, italics in original). The performance of actors in motion capture can even be considered less of a unified whole. The actor is not denied the opportunity to identify himself with a role, but accounts of these actors show that it is often extremely challenging for them to give depth to their characters. This is caused by the speed of recording processes, the eclectic variety of characters they are asked to play, and the added challenge of the lack of costumes, props and settings that help actors project themselves in a role. Benjamin also draws attention to the specific estrangement film actors experience:

> [A]s Pirandello describes this experience, [it] is basically of the same kind as the estrangement felt before one's appearance *[Erscheinung]* in a mirror — a favorite theme of the Romantics. But now the mirror image *[Bild]* has become detachable from the person mirrored, and is transportable. And where is it transported? To a site in front of the masses. (Benjamin [1935] 2008, 32-33)

Again, performance capture adds a different level to the experience of estrangement that Benjamin signals here. In performance capture, it is not merely the appearance of a performer that is transported. In performance capture, movement data are captured and digitally set on a matrix that is used to drive a computer-generated character. This character does not necessarily retain much resemblance to the performer, although detailed facial capture inevitable reveals similarities, even when movement data is mapped onto non-human creatures. The alienation that performance capture causes exceeds what Benjamin terms 'estrangement' in film acting. In performance acting, it often becomes impossible to understand

animations as a 'mirror image' of actors. This becomes palpable in the promotion reels performance capture artists make to showcase their work. These short clips consist of excerpts from the films and games in which they performed. Covering a scope that may stretch from grandmas to giant orcs, these clips typically show an eclectic range of animated characters involved in (super)human actions, without ever revealing the actor that is behind these appearances.

4.4 The Gollum problem

The confusion that may be caused by the ambiguous interplay between the performer and the motion capture setting is aptly demonstrated by a contemporary phenomenon in the film industry. Despite outstanding acting performances, thus far, no actors in motion capture features have been nominated for an Academy Award in the category of Best Actor; neither have digital motion capture artists been nominated for Best Animation (Delbridge 2015, 2). Although the co-creational process of actor and technology was already inherent in pre-motion capture cinema, this hybrid format is apparently still too new to acquire autonomous recognition. At the same time, this confusion is also understandable. Who is supposed to receive the main credit when the creation process of motion capture-based traces is so profoundly co-creational?

Since the event of motion capture-based film acting or 'performance capture', it has often been observed that the multiplicity of agents that are involved in creating these animations stirs up confusion about to whom the authorship of these characters should be attributed. The compelling entrance of motion capture in the film studio not only created sudden challenges for creative and production processes in the film industry, it also sparked a debate about how film acting should be assessed and evaluated, now that motion capture has radically changed the acting practice in film studios.

The immediate cause for this debate was the interpretation of the Tolkien character Gollum by actor Andy Serkis in *The Lord of the Rings: The Two Towers* (2002). Because of its grand scale and impact, it seemed evident that the film would be a candidate for nomination in various categories of the Academy Awards, including that of Best Actor in a Supporting Role, for which Serkis' impressive performance would certainly qualify. Or would it? Serkis' performance was recorded with motion capture, but the configuration of the motion data necessary to create the full animation of Gollum's character involved much more creative work, which was achieved by a team of skilled motion editors at Weta Digital. Who, then,

would deserve to receive credit for the interpretation of Gollum's role? Both public opinion and the film community appeared to be divided over the matter, the jury of the Academy Awards being a vital representative among them. Whereas the film was awarded Oscars in the category of Visual Effects and in Best Sound Editing and received four other nominations, Serkis was eventually not nominated for his role.[70]

The reluctance of the Academy to nominate any motion capture-based acting performance has been interpreted as a failure to adapt to this new dimension in film acting (Delbridge 2015). At the same time it must be noted that Serkis' achievement has certainly not gone unacknowledged, as is convincingly shown by several other awards he won for *The Two Towers* and the many subsequent awards he has already received for his motion capture-based acting. 'Ironically, it was only by doing this invisible work behind the scenes that British performer Andy Serkis, who provided the voice and movements for Gollum, gained international visibility as an actor,' remarks film and media scholar Tanine Allison (2011, 325).

Even so, the disinclination of the Academy to nominate this type of performance has received critical attention. Derek Burrill dubbed this phenomenon the 'Gollum problem': 'What the 'Gollum problem' suggests is that notions of performance (already an epistemologically slippery activity) become problematized by the new structures and spaces of virtual technologies' (Burrill 2005, 492). The application of motion capture technology in the film studio disrupts the traditional relationship between camera and film actor in such a way that the nature of film acting is called into question. How should the performance of an animated character that is driven by computer-generated imaging, based on motion capture data of a real-life actor be evaluated? Because the motion data of the performance of the real-life actor need extensive editing and configuration before they can be mapped onto the animated character, it becomes more difficult to assess who should be credited for the quality of the character's performance. Both the actor whose performance was captured and the motion editors that are responsible for the mapping of this data on an animated body play a creative part in the performance of the ensuing animation.

Moreover, as the anatomy of the animated character in cinema is often quite different from that of the actor, many adjustments need to be made. Allison gives an example from motion capture application strategies in *King Kong* (Jackson 2005): 'The motion capture software had to be adjusted to automatically reduce, for instance, the distance between

[70] *The Lord of the Rings: The Two Towers* did receive Oscars for the categories Visual Effects and Best Sound Editing and was nominated in the categories Best Picture, Best Art Direction-Set Decoration, Best Film Editing and Best Sound.

Serkis' hip and knee. Gorillas are also able to move in ways that people cannot and the software can be modified to anticipate these physiological differences' (Allison 2011, 329). Even though real-time motion mapping of animated characters is continuously improving, the raw motion data that is produced by actors is never used unedited. At the same time, many strategies are employed that help the actors to approximate the movement vocabulary of their animated counterparts the best they can. For instance, Mike Seymour describes how for *Dawn of the Planet of the Apes* (Reeves 2014) motion capture performers were put through 'ape school', which was run by an actor and movement coach. Ape school involved 'both working out ape choreography and examining that inside the motion capture volume' (Seymour 2014). This was such a success that the same coach was involved in *World of Warcraft*, for which he came up with a specific movement vocabulary for orcs. 'Orc school was the best,' one actor relates, 'we went there for a month, 10 to 12 hours a day' (BBC 2016).

Auslander (2015) points at yet another issue that is at stake in the 'Gollum problem'. In the tradition of film acting, the actor's facial expressions play an important role. Auslander argues that facial expressions in cinema traditionally function as indexical signs, in accordance with the terminology of Peirce's semiotic system. By revealing the inner feelings of the character, facial expressions are used to explain the context of a situation or action. For instance, Auslander cites film theorists such as Béla Balázs and Siegfried Kracauer, who believe the camera to be capable of revealing hidden truths by penetrating through the surface of things (Balázs 1952; Kracauer 1960). Balázs states that facial expressions cannot be faked nor controlled, and in Kracauer's view, the camera is able to reveal the link between mental states and physical appearance. These ideas also relate to the crucial importance of assuming a certain inner state in film acting. This is an idea that has been heavily influenced by method acting, the acting technique based on the concepts and teachings of Konstantin Stanislavski, which he developed in the first three decades of the 20th century and which soon spread through the US through tourings of the Moscow Art Theatre and through the transmission of his practice by his students.[71]

By capturing a limited set of points on the surface of the actor's face and body and by using these motion data as the basis of a newly created animation, the process of motion capture recording fundamentally alters this traditional relationship between the film camera

[71] The American actor and director Lee Strasberg adapted these ideas into an actor's training that stressed the psychological aspects of Stanislavski's practice. Strasberg became famous by teaching his brand of 'method acting' at the Actors Studio in New York throughout the 1950s-1970s.

and the actor's body. The process that is involved in the mapping of the actor's motions on an animated counterpart causes a rupture in the link between mental state and physical appearance that is recognized as such a vital aspect of acting practice. Auslander (2015) argues that it is this rupture that makes it not only difficult for audiences to recognize the emotional state of the character, but also complicates the acknowledgment of the acting achievement of the performer.

In her insightful article "More than a Man in a Monkey Suit" (2011) Allison also shows how filmmakers devise strategies to engage their audiences in these new types of cinematic acting. For instance, Peter Jackson has used online production diaries not only to promote his films, but also to 'introduce discourses of realism and authenticity that influence how viewers respond to and judge the value of the film' (Allison 2011, 325). Split screen clips circulate online, such as the ones that show Andy Serkis in a motion capture suit next to his simian counterpart Caesar in *Dawn of the Planet of the Apes* or Benedict Cumberbatch crawling over the grey-carpeted floor of a mocap studio next to the giant dragon Smaug that rises up from his mountains of gold in *The Hobbit: The Desolation of Smaug* (Jackson 2013). This mode of display, in which actors in motion capture suits are juxtaposed with their animated counterparts, suggests an (almost) seamless transposition of data to animation (fig. 21). Even when these animated characters bear little physical resemblance to the actors, or in some cases have an altogether fantastical anatomy, a similar immediate transposition is

Figure 21. Actor Benedict Cumberbatch during the performance capture process at Weta Digital for Smaug, the dragon in *The Hobbit: The Desolation of Smaug* (Peter Jackson 2013).

suggested.[72] Allison argues that these 'making-of' clips[73] have a double aim. This type of videos, she writes, 'walk a thin line between selling the new (new special effects, new technologies, new spectacles) and reassuring viewers that these new techniques still participate in long-lived cinematic traditions (Method acting, rich characterization, records of real movement and performance)' (Allison 2011, 338). The paradox found at the center of Allison's text seems to be that at a time when digital animation in cinema is more the rule than the exception, the audience needs to be initiated in the production process of character animation to be able to suspend its disbelief.

There is yet another angle from which the Gollum problem can be approached. It was the film character Gollum that became the phenomenon that raised this debate, because with Gollum, for the first time, a highly complex psychological character that was enabled by sophisticated motion capture techniques was presented to audiences worldwide. The powerful influence of the Ring, which Gollum carried for many centuries, transformed the hobbit Sméagol into the damaged creature Gollum. Gollum seems to suffer from a mental illness that resembles schizophrenia. The character is inhibited by two personalities. 'Gollum' is pitiful, but can also be dangerously aggressive and greedy. Occasionally, though, his 'Sméagol' side emerges, which is characterized by innocence, kindness and loyalty, traits that represent his 'hobbitness'. The audiences' fascination with Gollum's character is illustrated by hundreds of websites that try to diagnose his mental illness (is it a schizophrenic disorder, a multiple personality disorder, a dissociative identity disorder?). Moreover, film director Peter Jackson was accused of perpetuating negative stereotypes around mental illness. Still, the way in which Andy Serkis switches between the two sides of this character is impressive. This 'Jekyll and Mr. Hyde' effect perhaps added another impulse to the debate concerning his nomination. The audience's difficulty in trying to fathom Gollum's complex psyche may well have raised more forcefully the question of the 'true nature' of Gollum, not only the true nature of his character, but more importantly the nature of the relationship between the real-life actor and the animated character that audiences worldwide encountered on the screen. Additionally, whereas in *Final Fantasy*, motion capture was used to animate human characters, it is striking that in most recent motion capture-based features, motion capture is almost exclu-

[72] An example is the motion capture scene in *Holy Motors* (2012), directed by Leos Carax. For an excerpt of this scene, see the following online clip: foo foot (2012).

[73] See for example Zant5976 (2014) for a making-of clip of *The Hobbit: The Desolation of Smaug* (2013).

sively used to create non-human or fantastical characters that interact with human actors. There is Gollum in *The Lord of the Rings*, the Na'vi in *Avatar* and Caesar and other apes in *Dawn of the Planet of the Apes.* In each of these examples, motion capture is employed to animate characters that are not human, but nevertheless have many human features and can interact and communicate with the human characters in the film, albeit in a simplified or gestural language (Gollum, Caesar) or a different language that can still be learnt by humans (Na'vi).

The Gollum problem, then, draws attention to a range of issues that emerge in the process of mapping the movements of real-life actors to animated characters. Despite ambassadorial work of pioneering film directors such as Peter Jackson and James Cameron, and expert motion capture performers such as Andy Serkis seeking recognition for this type of acting as equal to traditional cinema acting, the ambiguous attitude towards this new type of film acting remains as yet unresolved. As I have explained above, the main causes for this reluctance include on the one hand the co-creational basis of animated characters in which both performers and motion editors play significant parts, and on the other hand the rupture between facial expression and the inner, emotional state of the actor that occurs in motion capture, which subverts one of the key concepts of traditional film acting.

Motion capture applications in the film industry have a major impact on what motion capture is understood and believed to be capable of. These applications do not so much foreground motion capture's analytic potential. Rather, contemporary blockbusters such as *World of Warcraft* highlight motion capture first and foremost as a *character building tool*. A *likeness* in outward appearance between the actor and the character is not the primary aim here. Instead, the priority is to endow animated characters through movement data of actors with a dramatic intensity that is believable for audiences.

In the next section, I draw a comparison between performance capture in film and performance capture in dance and performance in order to detail how the issues from the former resurface in the latter. There are several examples of artistic research that have investigated what happens when dancers enter the motion capture volume. I focus on two examples that allow for a deeper reflection on these issues and that reveal the capacity of motion capture to act as a co-creative force in the generation of new movement more clearly.

4.5 Assuming T-pose: A dancer's entrance into the motion capture volume

As part of my research I have been able to invite dancers into the motion capture lab of Ghent University. I was particularly interested in what they experienced when they put on the motion capture suit for the first time, had markers attached to them, and were able to move around in the setting while watching themselves rendered into a basic skeleton or point cloud animation on the screen. On several occasions I have also put on a motion capture suit myself, to get a basic sense of this experience. Additionally, I have observed several experienced dancers perform in motion capture studios. In a further elaboration on the basic setup of a motion capture process that I described in Chapter 3, here, I provide a closer description of what happens in those first moments when the dancer steps inside.

Once dancers enter the motion capture studio, they first of all have to put on the tight-fitting motion capture suit, to which a number of reflective markers are connected. The space in which the dancer is able to move is limited to the capturing volume of the motion capture setting. The invisible beams of infrared cameras, which are set up in a surrounding grid, demarcate the volume that is within reach of the apparatus. Not only is the floor surface limited, but some movements may be out of bounds due to a phenomenon called 'marker occlusion.' Marker occlusion occurs when the infrared cameras lose their stable connection with one of the optical markers on the suit, which makes movements such as intense bending and rolling over the floor difficult to capture. Such movements result in a lot of 'data gaps', which may be difficult if not impossible to 'repair' in data processing.

Figure 22. Performance capture artist (Ari Loeb) in T-Pose.

To discover the limits of the capturing volume, both on the floor surface and in their movement vocabulary, dancers may use a projection of a simple rendering of the motion data as visual feedback. As long as dancers remain within the capturing volume, the animation remains smooth and retains a mirror-like continuity. However, as the edge of the capturing frame is reached, the camera's deteriorating data stream can no longer keep the body together. In a desperate-looking attempt to solve the puzzle with too little information, the

image starts to shift frantically. Mismatching limbs start to blink red, evoking associations with the dashboard interface showing a malfunction in an aircraft engine. Fantastical body anomalies are created in the projected animation when dancing on the edge of the apparatus' reach. An elbow suddenly connects to a shoulder, a hand sticks out of a hip, an upper thigh suddenly aligns with the spine.

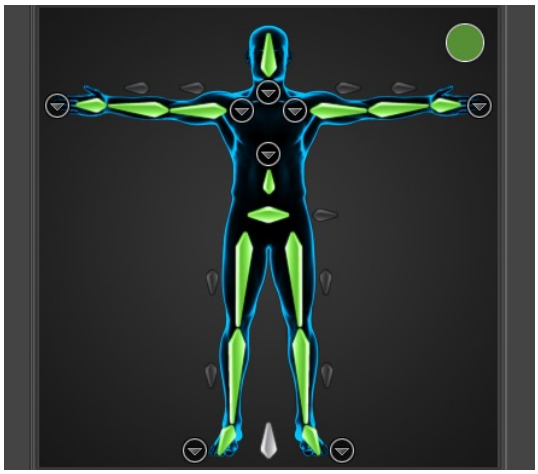


Figure 23. T-Pose in MotionBuilder software.

The only way to redirect the upset data stream is for dancers to step 'back inside.' At the center of the capturing volume, they take on the 'T-pose'. In this position, dancers stand straight up with arms stretching outwards to the sides at the level of the shoulders, so that the body can be recognized again by the system and re-mapped onto the virtual skeleton (fig. 22-23). So when the system has lost track of dancers, they are asked by the system operator to 'return to T-pose'. The T-pose has become the signature *asana* of the motion capture volume. Reminiscent of Leonardo Da Vinci's *Vitruvian Man*, the pose inevitably triggers associations with mathematical proportions, harmony and the idealization of the human form (fig. 24).

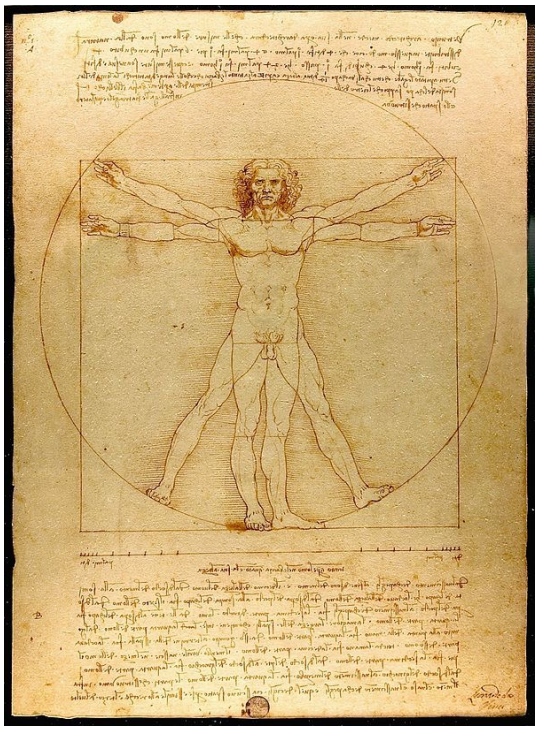


Figure 24. Leonardo da Vinci, *Vitruvian Man* (*Le proporzioni del corpo umano secondo Vitruvio*). ca. 1490. Pen and ink with wash over metalpoint on paper. 34.6 cm x 25.5 cm.

This description reveals the many meaning-making agents that leave their mark on this process. These include the dancer, the suit, the markers, the infrared cameras and the wires that feed the data streams back to a computer that may be running several data processing programs monitored by a system operator. A programmer or 'coder' is responsible for the design of these programs, which also shape any sensory output, such as the moving point cloud in one of the basic rendering options of standard software included in motion capture systems. It is the combined impact of all these

actors, which together constitute the apparatus of motion capture, that gives shape to a singular mediation of dance performance.

4.6 The absence of facial capture of dance performance

When comparing dance capture practices with performance capture in film, the importance that is attributed to facial capture in film contrasts with the general absence of this type of motion capture in dance capture practices. As I have discussed above, in film the event of facial capture brought about a new dimension in motion capture-based film acting, which was marked by the arrival of the notion of performance capture. There are of course manifest practical reasons that have caused the absence of facial capture of dance performance so far, such as high costs and the cumbersome application this technology would involve for dancers. But there might also be cultural reasons for this absence.

James Cameron's remark that 'actors don't do motion, they do emotion' could function as an enlightening point of departure for such a discussion. How would this remark translate to the phenomenon of motion capture practices in the dance field? Since dance exclusively uses full-body motion capture and refrains from facial capture, the opposite statement seems to hold true for dancers; dancers mostly seem to 'do motion'. They may 'do emotion' too, but in full-body motion capture, the dancer's emotion becomes apparent from their full body movements, with the exclusion of their facial expressions. This absence is strange, because it is quite obvious that one of the awkward features of motion-captured dancers is that they lack facial expression.

Moreover, looking at the imagery that is produced by dance capture makes the importance of facial expression for dance spectators abundantly clear. What is the facial expression of dancers? What is the direction of their gaze? Are their eyes open or closed? What can be gleaned from the tension of their facial muscles? All of these questions play a crucial role in how the intention of dance movements is interpreted. The facial expression of a dancer, then, does not really seem to be less important than that of an actor. Indeed, it may be that the tradition of film acting plays a role here. In film, the extreme close-up is connected to the importance awarded to facial expression. In dance, on the other hand, the attention is historically drawn to the body as a whole. The historical pejorative notion of the dancer as 'an actor without brains', may also have influenced the idea that the dancer's face is seen less as an index of psychological complexity than is the case with film actors. The underlying assumption, it seems, is that the face is not the location where dance *takes place*.

Figure 25. Peter Delpeut, *Voor de dans / Dedicated to Dance* (2015).

A recent dance film by Peter Delpeut can be read as a playful critique of precisely this assumption. For the short film *Voor de dans / Dedicated to dance* (2015), Delpeut filmed dancers of the Dutch dance company Leine & Roebana during rehearsals. He made exclusive use of facial close-ups (fig. 25-26). Since the full body movement is completely ignored, the viewer is free to absorb the dancers' facial expressions in great detail. Succeeding in its aim to create a 'portrait' of the dance company, the film provides an intimate and insightful perspective on the members of the company and their practice. By bringing together cultural

Figure 26. Peter Delpeut, *Voor de dans / Dedicated to Dance* (2015).

conventions of film and dance, it is the dance film as a genre that illustrates the exclusion of facial capture from the 'full body capture' that is currently the standard in both artistic and analytic dance capture practices.

4.7 Corporeal interpolation or the 'outward-in' logic of motion capture

Paul Kaiser's description of dancer Bill T. Jones's experience with motion capture during the creation process of OpenEndedGroup's *Ghostcatching* (1999) has created great resonance in the emerging discourse on the entrance of the dancer into the motion capture studio.[74] When Jones had his first encounter[75] with his motion capture-enabled counterpart on the screen, his first question was: 'Who am I looking at?' Indeed, the experience with motion capture technology tends to be a rather alienating experience for a dancer. 'Jones was spooked a bit by all this,' Paul Kaiser recalls, 'especially when his movements were first captured. He felt as if the machines were trying to steal his soul, what primitive people first suspected photographers of doing. He said we were "ghostcatching," which gave us our title' (Kaiser 2003). Kaiser writes: 'Yet afterwards even Jones could see that the moving dots on the computer screen had caught some sort of essence. Then Jones said that if anyone was to reconstitute his movements in the year 2040, this was how they would do it' (Kaiser 1999). The particular mix of alienation and recognition that dancers experience upon their encounter with their digital reflection in the motion capture setting had not been so aptly described before.[76] Kaiser's texts on Jones's experience have remained a frequently quoted source when it comes to the explanation of the experiential realm of the performer in relation to this apparatus.

Since *Ghostcatching*, an extensive reading of this topic has emerged in the shape of Susan Kozel's study *Closer: Performance, Technologies, Phenomenology* (2007). Kozel explains the phenomenological reality of performing with motion capture data and, by drawing on the work of Maurice Merleau-Ponty, Emmanuel Levinas and Gilles Deleuze, sets out to look

[74] The *Ghostcatching* project is discussed in more detail in Chapter 5.

[75] My use of the term 'encounter' here and at other places in this chapter may trigger an association with the use of this term by Emmanuel Levinas. I do not mean to imply his specific notion of this term. It should be noted that Kozel (2007) has shown that Levinas' notions of 'encounter' and 'the other' may be valuable in a further reflection on the digital other that is produced by motion capture. A detailed discussion of these ideas in this context exceeds the scope of this chapter.

[76] That is, as far as I have been able to retrace. Paul Kaiser writes about the creation process of Ghostcatching in multiple texts that are available at the website of OpenEndedGroup. See Kaiser (1999; 2003) and also Kaiser, Downie and Birringer (2008).

for a corporeal ethics that would be able to explain her particular experience with 'otherness' in this setting. Kozel: 'What sort of beings are these digital creatures transfigured and conjured out of human movement? And what is my relation to them?' (2007, 214). In her efforts to find a way to aptly describe how her self-identification is influenced by these digital others, Kozel moves back and forth between feelings of alienation and intimacy: '[C]onfronted with the strangeness of the digital rendering of my movement (…) I stumble over the unexpected and the sheer-not-me-ness of what I expected to be me, I need a more elaborated understanding of otherness' (Kozel 2007, 245).

A closer description of experiences with motion capture from the viewpoint of the dancer is presented in the article "Dancing in suits", which takes as its starting point the observation that the motion capture process places unique demands on the performer (Hutchison and Vincs 2013). Intertwining observations by Vincs (choreographer and dance scholar) and Hutchison (performer and dance scholar), the article provides two mutually reinforcing analytical perspectives of how a motion capture setting 'works' for a dancer. Whereas Vincs gives a precise description of situational features and the characteristics of the setting, Hutchison provides a phenomenological account that offers the reader an inside look into the thoughts and sensations that she experiences as a performer in such a setting. Like Kozel, Hutchison also vividly characterizes her experience in the motion capture setting as one of haptic interaction, in which the technology she interacts with seems to acquire a personal dimension:

> In a motion capture context, my 'dance partners' are not usually other dancers or even other practices, as is the case in my work outside the motion capture studio. My dance partners in motion capture are markers, animations, motion graphics, avatars and the spatial reality of the motion capture volume. (…) As anybody who has ever danced a contact improvisation duet with a partner knows, reciprocality and sensitivity is needed rather than force and the assertion of a predefined intention. (Hutchison and Vincs 2013, 2)

Hutchison's comparison with contact improvisation[77] illustrates her sense of continuously being 'in touch' with the environment as an intimate feedback process between multiple 'bodies', her own and those of the other agents involved. The authorial status of a dancer in

[77] Contact improvisation is an improvisational dance practice developed in the 1970s by Steve Paxton in collaboration with Nancy Stark Smith and others that built on experimental ideas of the Judson Dance Theater and principles of Aikido.

a motion capture-based creative process is not evident. Even when she is the only dancer on stage, a dancer in a motion capture environment always performs an ensemble rather than a solo. Hutchison's account reveals a strong, almost haptic experience of entanglement of body and technology. There is a tangible dialogue between her performance and the feedback from the technology that she perceives. Hutchison gives an elucidative account of the heightened bodily awareness she experiences when being a subject in a motion capture setting:

> Whether the situation is a data capture or simply an exploration of a new process, I feel it is a performance from the moment I put on the suit. I find this the case even in processes that are explicitly provisional and exploratory, and hence more about testing, buffering, adjusting, negotiating, aligning, familiarizing for the system, and not really about how one usually understands performance. 'Performance' is what I feel from the moment I step into the suit. With performance comes a sense of openness and possibility, but also of exposure and vulnerability. (Hutchison and Vincs 2013, 1)

What is compelling here is the specific experience of performance that Hutchison speaks of. This experience is quite different from performing for a regular audience. The feelings she associates with this type of performance are ambiguous. She speaks of 'openness and possibility' but also of 'exposure and vulnerability'. In contrast to a performance on a conventional stage, in a motion capture setting there is no distinction between front and back. In this respect it has more in common with performing in the round. The performer is scrutinized from all sides simultaneously. Apart from its three-dimensional gaze, the non-human audience that is constituted by the motion capture apparatus registers the markers attached to the body surface of the performer in sub-millimeter detail. To successfully perform in this setting means something quite different from performing for a human audience. It requires the performer *to be seen* by the particular eyes of the capture setting, which is constituted by a complex interplay of hardware, software and human programming that has a way of seeing that is in great contrast with human seeing. As Vincs explains:

> The eye, in the sense of its dominating scopic perspective, has no privilege in a motion capture-enabled environment. The eye's habitual ways of conceptualizing bodies are displaced by motion capture, which is not so much more accurate, as differently accurate, organized via designated points (markers) and trajectories, rather than by lines and surfaces. (Vincs 2011, n.p.)

Another challenge for the performer is that the motion capture setting is a much more vulnerable and changeable environment than one would perhaps expect. The markers attached to the dancer's body may shift or fall off. The infra-red cameras that record the marker's reflection are sensitive to changes in temperatures and vibrations in the building. This means that during a day of recording, the system needs to be re-calibrated several times. Each stage and studio works with different setups. This means that the gaze of the many-eyed apparatus that is directed at the performer keeps changing position.

To grasp how to adjust to this unstable gaze and to perform 'effectively' in such a setting requires a learning process. Performers with experience in motion capture settings, like Hutchinson, have learned how they can subtly adjust their movements *to be seen* more effectively. Sarah Rubidge, who has done extensive research into interactive settings of performance and motion capture/recognition technology confirms this: 'It takes time for a dancer to 'bed this in'. It takes 18 months to two years for a dancer to really get used to this sensory system' (Rubidge 2015). Rubidge also quotes an experienced motion capture performer (Carrie Whitaker) she has frequently collaborated with who explains the specific focus she works with in this performance setting: 'It's not you that is important, it's parts of your body that are' (Rubidge 2015). The result is a specific experience for the performer that in personal accounts is often associated with 'touch'. Hutchison's comparison with contact improvisation highlights the intensely haptic sensation of simultaneously *moving in* and *being moved by* in the motion capture volume. Indeed, as Doane has pointed out, 'the unconscious of the digital image, the hidden operative force buried behind the image, is touch' (Doane 2007, 142).

Dancers' experiences demonstrate that performers learn to move in accordance with the anatomical and 'outward-in' logic of the motion capture setting. This outward-in logic is brought about by the fundamental characteristics of the capturing process. Optical markers may be connected to the following positions on the right leg: the hip, the thigh, the shin, the calf, the foot. Motion capture *de-assembles* corporeal movement in the trajectories of these points. Basic visual renderings of optical motion data, which belong to the basic software features of any motion capture system, then *re-assemble* motion data in accordance with a principle that I call *corporeal interpolation.* In this process the movement of the 'unmarked' body surface is calculated from the known values given by the marker points. The corporeal interpolation that is inherent to motion capture similarly allows for renderings of the inner skeleton. As the following two case studies show, the marked bodies of dancers in the mo-

tion capture volume also have a profound impact on the dancers' physicality and proprioception.

4.8 *Emergence*: Distributed cognition and emergent behavior

In the two final sections of this chapter I analyze two related performances that result from artistic research projects that explore how motion capture may be used as a creative tool for a dancer. First I discuss *Emergence* (2014), a performance that demonstrates different modes in which a 'digital performance agent' may use a motion capture system as its sensory apparatus. The performance *meta* (2014) was directly inspired by *Emergence* and aims to convey the specific physicality and movement vocabulary the dancer developed while performing with the digital performance agent in *Emergence.* An adapted version that combined performances of *Emergence* and *meta* was presented at Ghent University as part of the conference *Does it Matter?: Posthuman Prototypes and Composite Bodies in Contemporary Performing Arts* (2015). This conference was organized as part of the larger research project from which this dissertation evolved.[78]

Emergence evolved from the doctoral research project of computer programmer and digital artist John McCormick (2014). McCormick has been engaged in the area of technologically mediated movement performance for a number of decades. During his involvement in the creation process of many artworks in this area over the course of many years, he observed 'an increasing sense of the environment having greater capacity for autonomous action in relation to human presence' (2014, 10). He also noticed that a large part of digital dance practice seemed to have gotten stuck on a developmental plateau, solely focusing on the linear transposition of movement data into a sensory output. McCormick sought to move beyond this kind of 'one-way mapping of human data on a visualization system that has been accomplished many times in dance technology works' (2014, 22). His aim was to find a way

[78] The *Does it Matter?* conference was organized in 2015 by the research center S:PAM at Ghent University with Christel Stalpaert, Kristof Van Baarle, Laura Karreman and Pieter Vermeulen as the organizing committee. The performance was set up by John McCormick and Steph Hutchison in the motion capture lab of IPEM (Institute for Psychoacoustics and Electronic Music), the musicology department of Ghent University. The IPEM is well-known for its experimental research into bodily responses to music, sound and rhythm, approached from the perspective of 'embodied music cognition' (Leman 2008), and making use of motion capture, a wide array of sensors and – very often – self-designed devices. Making use of the OptiTrack motion capture system that is installed at IPEM, John McCormick and Steph Hutchison were able to 'retrain' the artificial intelligent (AI) agent on this location and set up and present three performances of *Emergence* for an audience that included conference delegates, staff from Ghent University and a general audience.

to achieve a genuine interaction between a dancer and a 'digital performance agent'. McCormick performed a range of experiments to see how an artificial intelligence (AI) agent could be developed that could learn a dancer's movements by recognizing them and suggest new movement material based on learned and perceived movements. Notions of embodied cognition and distributed cognition provided important frameworks in the research project for imagining the co-creative relationship between the dancer and the agent. McCormick explains: 'The framework of distributed cognition provided a conceptual structure whereby we could envisage the agent and dancer as a single supportive system rather than developing the agent with self-contained capabilities' (McCormick 2014, 92). The importance of embodied cognition as a conceptual framework for this project was revealed by the decision to use the way in which dance is learned and remembered in contemporary dance practice as a research model:

> Drawing on the analogy of two dancers working together, a common scenario is one dancer creating movement sequences and passing them on the other to learn. In contemporary dance it is not unusual for the receiving dancer to learn the movement and to display personal idiosyncrasies in the subsequent execution of the movement. (McCormick 2014, 3)

Taking these and other observations about practices of dance learning and transmission into consideration, McCormick chose to realize the digital performance agent by means of an artificial neural network. Artificial neural networks (ANN) are 'biologically inspired computational models that seek to emulate the neural structure of biological organisms, and have been used successfully for machine learning and pattern recognition' (McCormick 2014, 3). McCormick opted for a self-organizing map (SOM), a neural network that supports 'unsupervised learning.' This means that 'there is no ideal output suggested to the network, only the input data is provided' (27). The AI agent that was created in this way was able to find its own associations and propose new dance movements, based on the input of movement data from the dancer in a learning process.[79]

[79] McCormick's use of the terms 'emergence' and 'emergent behavior' originate from an essay by Anderson (2003) that applies embodied cognition to artificial intelligence. McCormick writes: 'Anderson posits emergence as a means of explaining how the evolutionary history of an agent can be included in an explanation of the foundations for complex behaviour. (…) The programmed behaviours provide the opportunity for the emergent behaviour yet do not explicitly control the behaviours. Rather the behaviours emerge through the dynamic interaction between the robot and its environment' (McCormick 2014, 92-93).

Figure 27. John McCormick and Step Hutchison, *Emergence* (2014). Dancer: Steph Hutchison.

The setup of *Emergence* combines the live performance of a dancer (Steph Hutchison) with projections on a stereoscopic screen and an audio output that features various sounds and spoken comments (fig. 27). The dancer wears a motion capture suit with a basic set of optical markers. She performs inside a motion capture volume, so that her movements can be tracked (in this case by an OptiTrack system). For some scenes, a Kinect sensor is used to track her movements. The tracked data of the dancer's performance are processed by the AI agent. The visual output the agent generates is projected in Stereoscopic 3D using passive stereo filters. Corresponding glasses were provided for the audience. The stereoscopic projection was used to 'give a greater sense of depth to the objects and to attempt to envelop the dancers in the projected environment' (McCormick 2014, 4).[80]

The performance consists of different scenes that each demonstrate a different feature of possible interactions between the dancer and the AI agent. In one of these scenes, called 'Instrumental', the dancer's body contours are projected on the screen in a humanoid shape. This shape is overlaid with another humanoid shape, in a different color. As the dancer starts to move, her avatar on the screen moves along with her. However, the overlap-

[80] In the performance setting in Ghent, the audience, counting a maximum of 35 people, was seated at one side of the motion capture volume, just beyond the edge of its camera grid, facing the screen that was hung at the opposite side of the grid.

ping avatar, corresponding to the AI agent, then starts to shift. From an explanation that preceded the scene, the spectator knows that the dancer has previously 'taught' certain dance phrases to the AI agent, which it is now able to recognize. First of all, therefore, it mostly looks as if it the agent — represented by the overlapping contours — is struggling to keep up with the dancer, in an attempt to recognize her movements. But the agent does more than recognize these phrases. The dancer mixes movement phrases that are apparently known or unknown to the system. As she intersperses known movement vocabulary with new accents, the AI agent is able to generate new movement material. On the screen a duet emerges between the figures in white and red, whose movements alternately overlap and deviate from each other.

The result is a complex experience for spectators. Rather than a performance per se, *Emergence* is presented as a demonstration based on artistic research into the interactive possibilities of the dancer and the AI agent. This is partially caused by the fact that each scene is preceded by a short text slide that gives an explanation of how the subsequent scene *works*. This explicit framing strongly directs the attention of the audience. It invites the spectators to interpret what is happening in front of them in accordance with the information they have been presented with. In this way, the following question becomes a force that structures the interpretation of this performance: How can spectators *match* their experience with the explanation they have just received? However, as the performance unfolds it becomes more and more evident that there is never going to be a clear-cut match. The spectators are confronted with the impossibility of 'solving' what they are perceiving. They are unable to interpret what they see in accordance with simple cause-and-effect relations. The stereoscopic imagery that pops out of the screen, displaying the improvised duet between the dancer and the AI agent, represents the only sensory reference point of what input the AI agent is receiving from the motion capture system. A comparison between the performer and her projected avatar is possible, a similarity in movements of the dancer on stage and on the screen can easily be perceived. At the same time, it is complicated to retrace the impact of the interaction with the AI agent on her performance. The dancer initiates movements that the AI agent captures and adapts into a new movement, which may subsequently be imitated again by the dancer. It becomes clear that the movement material that emerges from this interactive entanglement of bodies and technologies cannot be attributed exclusively to either the performer or the AI agent. This is where the impact of distributed cognition becomes tangible. New movement emerges here from an undefined and intangible

Figure 28. Steph Hutchison, *meta* (2014). Still from the performance recording (Hutchison 2014b).

source, an origin that is nowhere, a distinct 'in-between'. The new movement material that emerges – both in the projection and on stage – can be understood as a co-creation by the various human and non-human actors that constitute this setting.

4.9 *Meta*: an 'ex-quiry' of a motion-captured dancer

The performance of *Emergence* at the *Does it Matter?* conference in Ghent concluded with an adapted version of the performance *meta.*[81] The performance was made and performed by Hutchison, who collaborated with McCormick on the experimental process and the eventual performance of *Emergence.* She was inspired to create a performance based on her extensive experience as a dancer in a motion capture setting, and, more specifically, her experience with the AI agent that McCormick had created. Hutchison explains that she 'wanted to make explicit that [their] shared dance had deeply affected my body and my way of thinking about dancing' (Hutchison et al. 2015, 3). Her deep integration in the system significantly shaped her movement vocabulary. With the creation of *meta*, Hutchison took this motion capture-informed performance style out of the lab and onto the stage, to explore the specific characteristics and aesthetic qualities of this vocabulary.

Hutchison conceives of this exploration as an 'ex-quiry', a process that 'examines that which is extrinsic to the body, self and practice' (Hutchison 2014a). Dance history is full of examples of such ex-quiry. Ex-quiry is supported by external frameworks that help dancers to experiment and develop new movement aesthetics, which can be body techniques, scores,

[81] For a recording of *meta*, see Hutchison (2014b). Please note that this is not the recording of the performance of *meta* that was presented in Ghent.

other art forms, floor surfaces, equipment, artificial intelligence, or motion capture. Hutchison describes why McCormick's AI agent is valuable for her own ex-quiry as a dancer and choreographer as follows:

> the residual feedback of encounters with the Agent: its morphologies, textures, sense of weight, buoyancy, the tasks and games developed throughout its trading regime all can offer external frameworks or tasks from which to further develop [my] own work independently. (Hutchison 2014b, text displayed on screen at the end of this performance recording)

The performance, which can be watched online (Hutchison 2014b), bears no visible trace of a digitally enabled environment. In *meta*, Hutchison exchanges the motion capture suit for casual dance clothes (fig. 28). And yet, *meta*'s reference to motion capture is obvious to anyone with the slightest experience with performance in the MoCap studio. In accordance with its title, the performance offers a meta-view in which a dancer demonstrates how motion capture *makes her perform*. In this respect, Hutchison's performance can be understood to display a 'computational sensibility'. Computational sensibility is a notion introduced by Marc Downie (2004), who argued that there is a 'surprising common ground between recent choreographic practice and computer graphics (as well as computer science), so much, in fact, that one can identify a "computational sensibility" in the work of many prominent choreographers in the last half century' (Downie 2004, 5). Downie adds that 'choreographic practice is where such algorithmic concerns meet the realities, constraints, and meaning of the human body and the eyes of the audience' (2004, 5).

Meta represents an apt illustration of what happens in such an encounter. Through the displacement of the dancer's performance from the motion capture setting, the 'algorithmic concerns' and optical awareness that dominate this environment can be experienced through the choreography and performance style of the dancer. There are a number of stylistic aspects and movement qualities that stand out in the performance. Most strikingly, the choreography includes many movement sequences in which arms and legs are stretched out in full extension. As she seems to be reaching out as far as possible, it looks as if the dancer uses her limbs and her head as instruments to draw circular and linear patterns in the air. This results in an extreme sense of *unfolding* of the body, a maximum exposure of the body's surface. This movement vocabulary directly points to the dancer's awareness of the optical markers on her body's surface. Her experience with the system has endowed her with an

acute embodied awareness of the system's threshold. When the dancer does not articulate her movements clearly enough, the AI agent finds it difficult to discern certain movement phrases. 'One movement at a time,' the agent says, 'let me see the movements and nuance.' These movement phrases point to the main constraint of motion capture of dance, which has already been addressed earlier in this chapter: The dancer is not 'visible' for the system if the markers that are attached to the suit lack a direct connection to multiple cameras at the same time. Movements such as deep bows and rolling on the floor therefore tend to be avoided in choreographies in motion capture volumes because of the significant risk of marker occlusion and of the displacement or loss of markers attached to the suit, especially when movement data is streamed in real time and options to 'clean the data' — the phrasing that is commonly used for the editing of gaps in the data — are limited. In *meta*, the dancer shows an impressive command and consciousness of how she is *in touch* with the system through the interface that is created by the markers.

The motion capture system also has another effect. The optical markers have a way of compartmentalizing the dancer's body. The dancer ceases to be an indivisible whole. She becomes a sum of parts that each have a specific name and location. The dancer's incorporation of this dissecting partition results in the possibility to conceive of the markers as forming an ensemble in themselves. In this way, the dancer's body becomes multiple. I would argue that it is this acute awareness of the positions of the markers on her body that seems to encourage the play with sophisticated isolations that is another key characteristic of the choreography. A final aspect that is clearly visible in this choreography is the lack of movement *through* space, which reflects the considerable spatial limitations of most motion capture volumes.[82]

In addition to the specific movement vocabulary, another conspicuous feature of the performance of *meta* is the computer-generated voice-over that offers a commentary on the dancer's performance. It is a familiar voice. Indeed, it is one of the standard voices of the 'text-to-speech' feature that has been integrated in many word processors and internet browsers. This pre-scripted score/speech is based on the notes Hutchison made during the collaboration with McCormick on *Emergence.* The text describes the experience of her engagement with the AI agent and is written from the point of view of the agent. The following

[82] Deakin Motion.Lab (http://motionlab.deakin.edu.au/) should be considered as an exception here, because of the generous measures of their motion capture volume compared to other university-based motion capture studios. In contrast, the motion capture volume in which *Emergence* was performed at Ghent University offered a capturing volume of three meters in diameter.

quote gives a sense of how this score describes the interaction between the AI agent and the dancer:

> We meet in-between ourselves and although Steph's movement brings me to life, I have learnt to be independent and also provide Steph with an external frame work to work within, creating movement that she perhaps may otherwise not. (Hutchison, McCormick, and Vincs 2015, 4)

This excerpt demonstrates the strong self-reflective quality of *meta*'s textual score. Indeed, Hutchison says she was specifically interested in articulating in the text what she 'imagined happening for the Agent' (Hutchison et al. 2015, 3). This results in a text that is both poetic and ironic. The text also manages to reveal aspects of the experiential realm of the dancer's interaction with the agent, as the following excerpt illustrates:

> Fleetingly they appear as traces within this dance. Even if they only retain the trace of the concept I notice their presence before they disappear, before you move on. The slipperiness of my ability to decipher and relate to our shared understanding of these movements proves difficult without familiar landmarks and trajectories. I'm on a rollercoaster and I'm blindfolded. (Hutchison et al. 2015, 4)

To give the agent a voice is a compelling way of making present what is invisible for the audience, but rather tangible for the dancer: the way the dancer's interaction with the agent's ANN affects her physicality and movement choices. Also note that the automated human voice suggests that the dancer has an anthropomorphic view of the agent.

Another layer of meaning is added by the fact that the spoken commentary is enunciated by a male voice. Whereas the text represents the 'voice of the Agent', it was written by the (female) dancer. This draws attention to the fact that long-established gender roles have not failed to impact the motion capture lab as an environment, according to which dancers are *female* and technology and technicians are *male*.[83] But this gender discrepancy can also be understood as yet another way to convey the alienation that characterizes the experience of the dancer in her interaction with the agent to the audience. There is an analogy here with the confusion that the dancer experiences in *Emergence*: a sensory confusion and a confu-

[83] The oil paintings series *Motion Capture Studio* (2011-2014) by Chicago painter Andrew S. Conklin also addresses this topic, by displaying the interaction of female dancers and male technicians in the motion capture studio (fig. 48). A more in-depth analysis of gender roles in contemporary motion capture practices would be a rewarding subject for further study.

sion about identity, about the borders of her 'self'. This is clearly reflected in the score, in which the mix-up between personal pronouns and points of view resist a clear distinction between 'I' and 'you', as in the following sentence: 'I can see myself, as you feel traces of me lingering.' In *Emergence,* distributed cognition between dancer and agent results in an alienating encounter of the dancer with traces of her own movement. This is where *meta* displays an analogy to *Emergence*: it stages a dancer that is spoken to with words that are her own, but that are uttered by a voice that does not belong to her.

4.10 Conclusion

Performance capture artists in film studios have similar experiences as dancers that perform in a motion capture volume. To perform effectively in this setting, both these performers need to learn specific techniques, they need to *integrate in the system*. This observation is in contrast with the view that motion capture tracks the body in the volume without exerting any influence on it. The practices I analyzed in this chapter clearly contradict such a simplistic model of transmission. Motion capture constitutes a complex external framework that requires performers to develop a new awareness of their own body and its movement as a tool or corporeal strategy. I therefore argue that the performer in a motion capture volume should be approached as a *performance capture artist*, who does not exactly perform *for* motion capture, but rather masters the art of performing *with* motion capture.

In the film and game industries, motion capture is used to animate believable characters on the screen. The thriving 'making-of' genre displays the making process next to the end results so that the viewer can establish a causal connection between one and the other. Although this genre helps to validate the achievements of performance capture artists, the complicated mixture of virtual and real that these animated characters consist of thwarts simple disentanglement.

Whereas in the film and game industry the goal of motion capture-based creation processes is the production of a life-like animation, experiments in the dance field have used motion capture as a tool to support dance practice itself. The encounter between the dancer and a virtual avatar, or the relationship between the dancer and a digitally enabled environment represent key topics in artistic research into the employment of motion capture in dance performance. By sustaining the presence of the dancer's body, spectators are invited to consider the stage as a networked setting that works through an assemblage of human and non-human actors. It is a setting that defies clear-cut cause-and-effect relations. In this

setting dancers are emphatically just one of the ‘actors’, their performance only acquires meaning in the relation with their environment.

Chapter 5

Kinesthetic Renderings: The bodily basis of digital traces of dance

> Exercise: Imagine a writing instrument located at the top of your head, at the soft spot where the bones of the skull meet. Imagine you can draw with this instrument as a sky writing plane draws in space. The space around you is a three dimensional canvas.
> — John Gamble, "On Contact Improvisation" (1977)

In this chapter, I examine in more detail several art projects in which dance movement data are rendered into a specific type of visual imagery. All of these projects are singular examples of a specific tendency that has characterized motion capture-based renderings of dance from the beginning, namely to animate movement data in the shape of graphic lines and traces. These may outline the movement path of the dancer or they may take on an increasingly abstract form, expanding into two-dimensional shapes and three-dimensional objects. With myriad possibilities of rendering movement data, it is worth questioning why these basic graphic animations of dance continue to be such an attractive way to visualize dance. I argue that this type of visualization is not accidental, but firmly rooted in the history of Western choreographic practices, and enabled by a basic embodied experience.

'If there really were a writing instrument on the top of the head', Ann Cooper Albright remarks on the dance improvisation exercise cited above, 'it would probably draw something like a hieroglyph' (1989, 42). Cooper Albright refers to the handwritten hieroglyphs by Nancy Stark Smith that were inspired by her practice of contact improvisation. Stark Smith's hieroglyph-writing practice is one of many examples of singular writing and drawing practices that have emerged in the course of Western dance history. The dance traces that have emerged from these practices display an extensive range of functions. For one, these traces may support the memory of a dance. Such traces may be extremely subjective when they are created by a particular dancer or choreographer as a personal mnemonic aid. Other dance traces

may be consistent with a dance or movement notation system, such as Labanotation, one of the most in-depth systems for describing human movement. Dance notations of this type may be shared, read and interpreted by anyone who has studied the meaning that has been attributed to these symbolic signs. All types of dance traces offer different possibilities for the communication of dance knowledge. Whereas some examples of symbolic dance traces may act as well-versed guides in a reconstruction of a dance from the past, other traces — such as the singular glyphs that are the result of Stark Smith's hieroglyph practice — may convey important clues about specific choreographic concepts or movement qualities by appealing to the kinesthetic imagination of the dancer. Consider for instance the drawings of Trisha Brown, who deemed Labanotation insufficient to describe the movements she wanted to make. Instead, as Peter Eleey describes, Brown 'used drawing more often as a form of focused mental exercise, or to depict a continuity or accrual of movement that she sought in her performers' (Eleey 2014). The central role of her body in the creation of her drawings is illustrated by the following observation by Brown: 'My entire body becomes the agency of visual traces, vestige [sic] of the body's energy in motion' (Eleey 2014). Like many other singular traces of dance, Brown's drawings are both an indexical trace and an alternative, pictorial expression of the dancing body.

Because of the ability of motion capture to record the three-dimensional contours of the body of the performer, the motion data of a dancer's body have now become a prominent source for dance traces in a digital mode. Drawing a line with the top of the head on a three-dimensional canvas is no longer a mere exercise of the imagination. In fact, *Motion Bank*'s digital score *Using the Sky* (2013), based on Deborah Hay's choreography *No Time To Fly,* does just that: 'Travel paths' that trace the movement of dancers were digitally drawn through markerless movement capture, enabling the viewer to distinguish individual differences between the dancer's movement patterns.

These and other abstract graphic visualizations rely on a metaphorical understanding of the dancing body as a drawing instrument that leaves linear traces, marking out patterns and figures as it moves over surfaces and through the air. In this chapter, I examine the contemporary phenomenon of such motion capture-based renderings of dance, in an inquiry that is in line with Nicolás Salazar Sutil's recent assessment that 'the drawing of movement via motion capture technology invites a radically different modality of representation, one no longer divorced from a source body and no longer caught in a static representation of movement as pure symbol' (2015, 139). In an attempt to further substantiate and expand on this state-

ment, I draw a comparison between analogue and digital traces of dance that rely on principles of capture instead of following a symbolic notation system.

Because Stark Smith's hieroglyphs are created by an ink pen and *Motion Bank*'s digital score *Using the Sky* by a digital apparatus, there are clearly fundamental differences in the ontological basis of these images. At the same time, these examples display a striking similarity. This imagery invites the viewer to imagine the dancing body as an instrument that draws traces *while moving*. I argue that these graphic animations mark more than just the body's spatial trajectory: They also have a pronounced haptic dimension and affective impact that appeal to the kinesthetic imagination of a viewer. I interpret this way of using motion capture as a development that is informed by the metaphorical mental imagery that dancers use to learn and create. Motion-capture generated imagery can function as an externalized representation of such mental imagery in a different mode. The abstract quality of these graphic traces seems to be an advantage in promoting the kinesthetic imagination that dancers are looking for in these processes.

In addition to the connection with mental dance imagery, I argue that these data visualizations can be understood as an understandable product of the cultural heritage of Western dance history. Making use of the metaphor theory of Lakoff and Johnson (1980), I propose to interpret this imagery as a visual manifestation of a conceptual body metaphor that can be recognized throughout the history of choreography: The dancing body as a drawing instrument that leaves traces and demarcates space. As Franko has shown as part of his theorization of Western theatrical dance — which evaluates 'dance as text' as one of its main concerns —, this way of understanding the dancing body can already be recognized in the geometrical dance of the 16th century. Franko writes: 'At the dawn of theatrical dance in France, choreography was frequently likened to, and indeed contrived to suggest, a written text. One genre in particular — geometrical dance — pushed the conceit of a bodily writing to its ultimate visual consequences' (Franko 1993, 15). This dance genre featured geometrical and symbolic patterns that were formed by constellations of dancers, designed to be seen from above as if they were horizontal or flat on a page. 'One can say, without being overly metaphoric, that one of choreography's goals was to *inscribe* dance in theatrical space (…) The actions performed before the eyes of an audience were those of constructing and dissolving hieroglyphs' (Franko 2003, 26; 30).

This approach of 'dance as text' was carried on by practices of dance notation that promoted the idea of dance as a phenomenon that can be rendered in a *legible* form, open-

ing up possibilities for communication, transmission and reconstruction. Published in 1700, and based on a pre-existing system by Beauchamp, Feuillet notation gained much popularity in the 18th century, and, as Foster says, reflected the installment of a new corporeality. Dance notation systems 'took the dancing out of the body, away from body-to-body contact, and placed it in circulation as a codified symbolic system (Foster 2011, 33). Although the horizontal trajectories that dancers traversed over the floor were still recognizable in Feuillet notation, this system and subsequent dance notation systems marked a shift in the signs that were used to describe dance. Instead of previous attempts to document dance that more resembled dancer's footprints and could thus be understood as indexical signs of a spatial trajectory, dance notation systems such as Feuillet notation introduced signs with a much more distinct symbolic nature. As Salazar Sutil puts it: 'These dance notation systems take a step beyond natural odography [feet writing], in order to introduce orthographic symbolism and arbitrary meaning' (2015, 219). It was precisely by offering the possibility of writing and reading dances in symbolic signs that dance notation was valued as a way to elevate dance as an art form. Foster describes this development as follows: '[T]he invention of Feuillet notation at the beginning of the eighteenth century imbued dance with a composed permanence and newfound clarity, creating a parity with dance's sister-arts of painting and poetry, and also an opportunity for dances to travel around the world' (2011, 31).

Fast-forwarding three centuries, the contemporary digital realm now seems to invite a renaissance of traces that stress an indexical rather than a symbolic relation to the dancing body. Or, in Salazar Sutil's quote above, as a mode of representation 'no longer divorced from a source body and no longer caught in a static representation of movement as pure symbol' (2015, 139). The dancing body as drawing instrument resurfaces in the digital realm of motion capture, where it marks out two-dimensional surfaces and three-dimensional volumes. Digital animation of these planes and objects endows them with a vibrant quality and expressive force of their own that may highlight specific qualities and features of the dance performance they relate to. In this chapter I ask why it is that this figurative view of the dancing body that has played such a central role in choreographic history — a metaphor that I propose to term *the dancing-drawing body* — is thriving, stronger than ever it seems, in its current digital surroundings.

5.1 The dancing-drawing body

The dancing-drawing body, that is, the dancing body that leaves traces and marks out space, can be understood as a conceptual body metaphor as defined by the metaphor theory of linguist George Lakoff and philosopher Mark Johnson (1980). I argue that this body metaphor profoundly structures a common type of motion capture-based imagery consisting of lines and traces corresponding with dance movements. The dancing-drawing body metaphor is deeply engrained in the way dance is described, depicted and understood, so deeply, in fact, that it is difficult to always be conscious of its presence and the powerful influence it has on how the dancing body acquires meaning. After a more elaborate explanation of how the dancing-drawing body can be conceived as a conceptual metaphor, I will demonstrate how this insight can be operationalized in a series of cases that, each in their own way, rely on the dancing-drawing body in their representation and *re-realization* of dance.[84]

The notion of metaphor as a conceptual system that structures the way people think and act was first proposed by Lakoff and Johnson in *Metaphors We Live By* (1980). As part of their further development of this theory, based on recent findings in cognitive science, they argue that metaphor is a neural phenomenon that is related to how the mind works in embodied interaction.[85] They explain that '[b]ecause metaphorical maps are part of our brains, we will think and speak metaphorically whether we want to or not. (…) Further, since our brains are embodied, our metaphors will reflect our commonplace experiences in the world' (Lakoff and Johnson 2003, 257).

Lakoff and Johnson's research stresses that metaphors are not just linguistic phenomena; they are not just a matter of words. Rather, metaphors always represent concepts that shape understanding, and concurrently, shape what people believe to be true. All thought

[84] 'Re-realization' is a notion that was introduced by Andy Lavender (2015) in a paper on the development of motion capture applications. Lavender distinguished three phases, which can be put into chronological order, although they may still coincide and overlap: 1) analysis, 2) representation, 3) re-realization ('to make it *differently* real').

[85] Lakoff and Johnson's research has been influenced by various fields of study, including linguistics, philosophy, anthropology and psychology. Both researchers have published several other studies on this subject. Johnson further explored the way in which bodily experience influences people's understanding of the world, most importantly in *The Body in the Mind: The Bodily basis of Meaning, Imagination, and Reason* (Chicago: University of Chicago Press, 1987). The second book that Lakoff and Johnson wrote together was *Philosophy in the Flesh. The Embodied Mind and its Challenge to Western Thought* (New York: Basic Books, 1999). A second edition of *Metaphors We Live By* (2003) included a reflection on the impact of the book in a wide range of research disciplines and presented an overview of how research performed since the first edition had further substantiated and expanded on their initial theory.

processes are largely metaphorical and people act in accordance with the meaning of these metaphorical concepts. Abstract or complex ideas start to make sense once people find a way to grasp them in accordance with concepts we understand in clearer terms. Lakoff and Johnson explain:

> The heart of metaphor is inference. Conceptual metaphor allows inferences in sensory motor domains (e.g., domains of space and objects) to be used to draw inferences about other domains (e.g., domains of subjective judgment, with concepts like intimacy, emotions, justice, and so on). Because we reason in terms of metaphor, the metaphors we use determine a great deal about how we live our lives. (Lakoff and Johnson 2003, 244)

The use of metaphor thus not only changes the way in which people think about an object, but also alters the way in which they conceive of this object in reality: '*The essence of metaphor is understanding and experiencing one kind of thing in terms of another'* (Lakoff and Johnson 2003, 5; italics in original). An instructive example is the metaphor 'time is money, which is expressed in the phrase 'Don't waste my time'. Other examples of metaphors are 'the mind is a machine' (expression: 'These ideas may be difficult to process'); 'labor is a resource' (expression: 'That company is low on manpower').

Note that these metaphors are not based on similarity per se, even though the fact that one conceptual domain (the mind) is understood in terms of another conceptual domain (a machine) may well give rise to perceived similarities within these two domains, in this case the ability of both mind and machine 'to get stuck' or 'to be in need of fuel'. 'Labor is a resource' is an example of a culturally grounded metaphor that foregrounds labor as a commodity. This particular way of understanding labor may hide the human dimension of labor. When labor is primarily understood as a commodity, an expression such as 'a virtually inexhaustible supply of cheap labor' is 'a neutral-sounding economic statement that hides the reality of human degradation' (Lakoff and Johnson 2003, 237). 'Labor as resource' is thus a powerful example of ways in which metaphor can shape experience and can have a real impact on people's lives.

As is true for all perceived phenomena, there are many metaphors that shape the experience of dance. However, in my studies of a broad range of examples of visualizations of motion data of dancers, I was struck by one particular metaphor that seemed to surface

again and again, namely 'dancing is drawing' and 'the dancing body is a drawing instrument'. I call this metaphor the *dancing-drawing body*.

In terms of Lakoff and Johnson's conceptual metaphor theory, the source domains for this metaphor — the domains in which the metaphorical language has a literal meaning — are the act of *drawing* and *a drawing instrument*. Think of a pen or a paintbrush. The target domains are *dancing* and *the dancing body*. What this metaphor highlights is that in drawing, a trace is created through a *deliberate gesture* that establishes physical contact between a drawing instrument and a suitable, material surface. This drawing may simply function as an index of the spatial trajectory the gesture has followed, but it may also emphasize the affective quality with which it has done so. Either way, the dancing-drawing body emphasizes drawing as an indexical sign of bodily gesture.

To understand the specific allure of this metaphor, it is first of all important to acknowledge an obvious dissimilarity between dancing and drawing. The characterizing feature of drawing is that it produces or traces lines and marks on a surface. Dance and other types of performance, on the other hand, have often been defined and problematized by their ephemerality and disappearance, their incapability of leaving a trace (Phelan 1993; Reason 2006). The metaphorical view of 'dancing is drawing', then, invites a conception of ways in which dance may endure beyond its performance, of how it can 'live on' by *imagining* it in a different mode or materiality. Considering the efforts that are put into the description of dance and the communication of dance knowledge to others, it is no surprise that the drawing-dancing body, a metaphor that lifts dance's ephemerality and turns dance into a visible trace, has been followed and applied by so many.

Yet, although they may display striking differences, the opposition between dancing and drawing as one between ephemerality and endurance is not that strict. Just like drawing, dancing is an activity that may very well leave marks on a surface. Indeed, a chief appeal of this metaphor can be explained by the fact that it is rooted in a fundamental embodied experience: the fact that when one moves through the world one leaves behind physical traces. Footprints are the most obvious example here. Gravity is pulling one down, and the main interface of one's body that impresses the surfaces one walks over are the soles of one's feet. Walks along the beach result in a trail of footprints until they are washed away in the surf or by the tide. Indeed, the bipedal upright posture of the human body is a model that deeply influences how people make sense of their being in the world. This is shown by frequent metaphorical references to the feet in everyday language when speaking about the impact

people have on the environment. Consider for example the term 'carbon footprint' that is used to indicate an individual or entity's contribution to carbon emissions that cause environmental pollution and climate change. Similarly, 'making an impression' and 'making a mark' are metaphors that use this fundamental basic human activity of *treading the earth* as a source domain. It is understandable, then, that the dancing-drawing body metaphor may draw extra attention to the feet, because they are so often understood as the primary interface of a body and the earth.

By using a drawing instrument as a source domain in thinking of the dancing body, attention is not only drawn to the feet, but also to the hands. A similarity between hands and feet is that they are both associated with human interaction with the environment. But it usually is the hand that holds and *manipulates* the pen or brush. The association with the feet invites an experience of dance as a spatial trajectory, as leaving a mark on a surface. The same association can be made in relation to the hand, because a drawing may in the first place be regarded as an index of the drawing gesture itself, the movement of a brush across a canvas. However, far more so than is the case with feet, the understanding of hands and fingers is charged with associations linked to a deeply personal domain. These associations have an explicit bodily basis. Fingertips are very sensitive, due to a high density of nerve ends under the skin. Fingers can also develop exceptional motor functions, which is apparent in the skill of playing musical instruments. However, fingers are not only associated with sensitivity and dexterity per se. They are also understood as an instrument of expression, to bring what is thought or felt to the surface. As Igor Stravinsky noted: 'Fingers are not to be despised: they are great inspirers and, in contact with a musical instrument, often give birth to subconscious ideas which might otherwise never come to life' (Jordan 2007, 94). Fingers are closely associated with a unique identity. A fingerprint, the mark that is made on a surface by a unique pattern of whorls and lines on a fingertip, is used as a source domain when describing a distinctive identifying characteristic of something ('the faint chemical fingerprint of plastic explosives'). A similar inference occurs in the expression 'a personal touch' ('each of the rooms in the hotel has a personal touch to make you feel at home'). Consider in this respect also the figurative use of the term 'signature' to describe a distinctive pattern, product or characteristic by which someone or something can be identified. These associations with hands and fingers are an important element of the dancing-drawing body metaphor, because they provoke a consideration of dance traces not merely as evidence of a covered trajectory,

but also as pointing to a deeper layer of meaning by revealing a specific quality, or even, perhaps, by unmasking an inner, personal truth.[86]

I have paid special attention here to the role that feet and hands play, because these are the parts of the body that gain specific attention as part of the dancing-drawing body. Indeed, the influence of this metaphor extends throughout the history of dance notation practices in the Western dance tradition. As part of this tradition, the feet have habitually been linked with the pathways and trajectories of the dancers, while the hands have mostly been attributed the role of the instrument with which to compose or notate dance, in other words, the instrument of *choreography*.

In the past decade, the boom of touchscreen technology has opened up new ways in which hands can be used to write, draw and interact with others. It has also led to possibilities of redirecting the senses to the contact of the feet with the ground, for example through the use of floor sensors.[87] Motion capture technology, too, affords a digital augmentation of the dancing-drawing body. In a similar way as fingertips making a drawing on a touch screen, a reflecting optical marker attached to the dancing body produces a virtual drawing on a flowing stream of data. Here, the marker becomes the *hotspot* of the body, it becomes the tip of the pen from which the ink is flowing. Another similarity with touchscreen technology is that the experience of motion capture also works in accordance with haptic logic. Think of the example that was discussed in Chapter 4, in which a dancer likened her experience in the motion capture volume to contact improvisation, the improvisational practice in which new movement is generated through an ongoing exploration of ways in which multiple bodies may touch (Hutchison and Vincs 2013). I argue that the haptic experience in the motion capture volume *without the dancer being in actual physical contact with another body*, is stimu-

[86] Isa Wortelkamp is an example of a dance scholar who has often reflected on parallels between movement and writing, dancing and drawing. She is interested in the question what impetus dance movement gives to academic writing. In her dissertation *Sehen mit dem Stift in der Hand: Die Aufführung im Schriftzug der Aufzeichnung* (*Seeing with pen in hand. The performance in writing the record* [Wortelkamp's suggested translation], 2006) Wortelkamp pays attention to the role of the hand in describing dance and draws attention to the corporeality of the dance scholar. Another relevant volume in this context, edited by Wortelkamp, is *Bewegung Lesen. Bewegung Schreiben* (*Reading Movement. Writing Movement*, 2012).

[87] The popular music video game series *Dance Dance Revolution*, for example, is a dance game in which the whole body is involved, but which basically relies on eye-foot coordination through a combination of pressure sensors incorporated in tiles on the floor and a screen that presents the player with a life-fed score. First released in Japan in 1998 (where it was developed and produced by Konani), players stand on a 'dance platform' or stage and hit colored arrows laid out in a cross with their feet to musical and visual cues. Players are judged by how well they time their dance to the patterns presented to them.

lated by the dancer's sensory access to movement data visualizations, designed to support and augment the dancing-drawing body, a metaphor that conjures up the physical contact of pen on paper.

The haptic experience of a dancer involved in the virtual dancing-drawing body that emerges in a motion capture volume also further substantiates Mary Ann Doane's assessment of touch as the 'hidden operative force buried behind the digital image' (Vermy 2014, 68). The way in which dance movement is rendered in motion capture-based imagery, then, especially the imagery that consists of graphic traces and lines, is a design choice that makes sense. I will further illustrate this by a discussion of case studies that, each in their own way, rely on the dancing-drawing body. The powerful way in which this type of animation appeals to the kinesthetic imagination of dancers is unmistakable.

5.2 *Traces* and *E-Traces* by Lesia Trubat

An artistic research project that provides an arresting example of the dancing-drawing body is the diptych *Traces: Memories of Dance* and *Electronic Traces: Memories of Dance* (*Traces* and *E-Traces*), created by Catalan designer Lesia Trubat (2014). For *E-Traces*, Trubat incorporated pressure sensors in pointe shoes (fig. 29). A short demonstration video of the project shows a ballet dancer who puts on her shoes and starts to dance. Superimposed on the video image, black-brushed traces start to appear that correspond to her feet touching the ground. When the sole of the dancer's foot moves over the floor slowly and with a lot of

Figure 29. Lesia Trubat, *E-Traces* (2014).

Figure 30. Lesia Trubat, *E-Traces* (2014).

pressure, the virtual stroke of the black brush increases in density. Alternatively, a swift and light touch of the sole on the ground generates a thinner and more delicate trace. Trubat writes that '[t]he concept of *Electronic Traces* is based on capturing dance movements and transforming them into visual sensations through the use of new technologies' (Trubat 2014). These visual sensations, triggered by the graphical brush-stroke imagery, do more than appeal to the visual senses exclusively. It is possible for dancers to view their moves in video format, or to save and print them as images (fig. 30). Trubat suggests that these annotations may have value as a means of support for the reflection of dancers on their own work and that of others:

> Dancers can interpret their own movements and correct them or compare them with the movements of other dancers, as graphs created with motion may be the same or different depending on the type of movements executed and the correction of the steps and body position (Trubat 2014).

The other project displayed on Trubat's website, simply called *Traces: Memories of Dance* (2013), holds clues as to how the concept for *E-Traces* evolved. In fact, *Traces* can be considered to be the analogue counterpart of *E-Traces*. With *Traces*, Trubat aims to turn dance movements into 'haptics, visual and tactile sensations' by combining them 'with materials used in the construction sector, introduced into a mould, which is then converted into tiles containing the memory of dance.' In the accompanying video, we see a dancer in ballet shoes steps into a wooden grid on the floor that holds a dark, semi-solid liquid, a mortar of

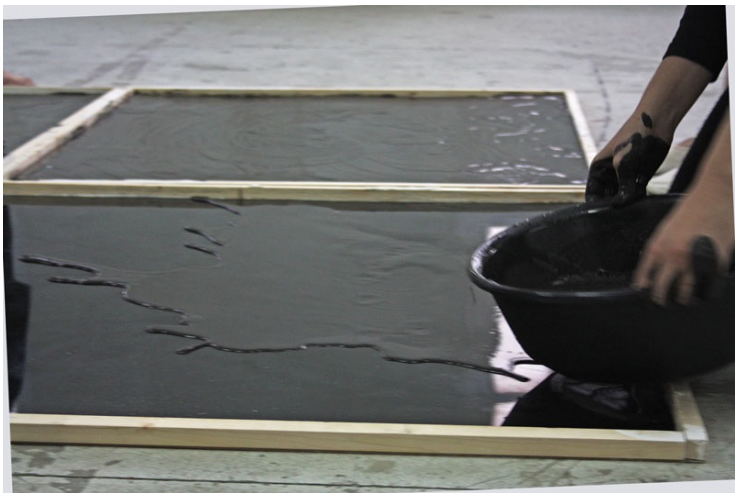


Figure 31. Lesia Trubat, *Traces: Memories of Dance* (2013)

Figure 32. Lesia Trubat, *Traces: Memories of Dance* (2013)

Figure 33. Lesia Trubat, *Traces: Memories of Dance* (2013)

some kind (fig. 31). As she dances, she slowly traces her feet through the liquid, crossing over from one mortar-filled rectangle to the other, while leaving behind a trail of points, and curved and linear traces (fig. 32). The dancer is *scoring* the mortar, in the carving sense of the word. Because of the specific quality of the material she is moving through, it is a process that is simultaneously messy and delicate. The splotches of dark mortar contrast with the impeccable appearance of the ballet dancer. This contrast draws attention to what happens when making contact; the dancer marks the surface and the surface marks the dancer too. After the grooves have hardened over time, liquid plaster is poured into the grooves, which is left to dry and then pulled out. What results are rectangular plaster-casted tiles that show the trajectory of the dancer's feet, thus transforming the dance into a striking mode of representation: a *physical cast* of the dance (fig. 33).

Trubat's projects show how the view of the dancing body as *impressing* the surface can be translated through the application of digital media. In the case of *E-Traces*, this happens through the incorporation of the pressure sensors in the shoes that register contact with the floor. The abstract graphical shape of the resulting imagery is relatable, because of the way in which it corresponds to the proprioception of how feet touch the ground when walking. At the same time, it becomes apparent that the sensors single out the feet as the primary locus *where the dance happens*. In both *Traces* and *E*-Traces, the feet are transformed into hotspots, the tip of the pen with which the dance trace is drawn. Arguably, these feet-drawn traces represent a very limited impression of the phenomenological reality of the dance as a whole. Nevertheless, Trubat's projects invite the viewer to do precisely this: To imagine the dance as performance through virtual imagery and morticed tiles, scored by a dancer's feet.

5.3 Phenomenal dance images: Nancy Stark Smith's hieroglyphs

In another practice of dance drawing, the dance traces are not directly sourced from the dancing body itself, as is the case in Trubat's work, but rather evolve from the perception or proprioception of a dancer. Writing with a black ink pen, Nancy Stark Smith started to make quick and expressive drawings as a reflection on her own dancing, or while watching others dance (fig. 34). Stark Smith was interested in 'what happens *between* an experience and the telling of it, the translation from one medium to another' (1982, 45). Stark Smith's hieroglyphs were open to interpretation and never aimed to describe a concrete movement phrase: 'A squiggly line could as well be a pathway on the floor as an S curving through the body' (Cooper Albright 1989, 42). In her attempt to avoid fixating dance as it occurs in symbolic movement notation, Stark Smith found that this type of dance writing managed to both embody the subjectivity of the writer and to convey the fluidity of dance as creative practice at the same time.

Continuing a dance writing practice she has taught for more than three decades, Stark Smith, while still a prominent figure in the field of contact improvisation, continues to teach the drawing of hieroglyphs as part of her workshops. An excerpt of a recent online video tutorial shows that her instruction of this practice has remained virtually unchanged since the beginning of the 1980s:

Figure 34. Nancy Stark Smith writing hieroglyphs. Video by Meta-academy@Bates 2013: Minded Motion Lab (Marlon Barrios Solano et al 2013). Video editor and camera: Rachel Boggia.

> You allow a bit of body energy to move on the page in an area. They're individual units of movement, you could say. I call these 'glyphs': an extension of the energy of your body that comes out in the space. It's almost a little conversation with yourself as you go from glyph to glyph. It's not so much thinking about it as it is reconnecting to the body and extending out into the page and moving. (…) [After you have finished a page,] put your pen down and look at what you wrote. You might have your favourite or there might be something about the movement that feels balanced or unbalanced, amusing or confusing. (Stark Smith 2013)

The online availability of the tutorial enables participants to share their thoughts on the process and pictures of their own glyphs (Stark Smith 2013). One participant comments: 'Fascinating...my sense of orientation to the paper vis-a-vis my inner body – amazing in what is felt vs what is drawn – I'm calling the drawing my 'TKG' – tensile kinetic graphic' (Batson 2013). Rather than functioning as a score or document, then, the glyphs fulfill the aim of reflecting on dance improvisation sessions without describing *too* much. Stark Smith observes: 'An inspiring dance can be quickly flattened when the mind closes in around it trying too quickly to define and enclose the experience. The point, it seems, is to bring something forward, not to close it in' (Stark Smith 1982, 45). The hieroglyphs are part of what Stark Smith calls 'harvest', a reflection of the performer after an improvisation session. Glyph writing offers the performer an opportunity to reflect on what happened during the session, which seems to function as a valuable tool to sharpen the proprioceptive abilities of the dancer.

Stark Smith's drawing of hieroglyphs recall somebody writing their signature. The glyphs flow out of her pen in a way that seems impulsive and deliberate at the same time. As opposed to a signature, though, these movement signatures are all unique, although they tend to share a recognizable 'style'. Stark Smith, who calls them 'self-styled symbols', has noticed the similarity with her handwriting. These 'unique insignias of a moving body', as Cooper Albright called them, are quite different from Egyptian hieroglyphics, as they are not part of an established symbolic writing system. The choice of the term 'hieroglyphs' can be explained from a different angle. As opposed to alphabetic language, Egyptian hieroglyphics often display a visual connection to what they represent, as do Chinese characters and Mayan glyphs (Rotman 2008, 124).[88] The dance glyphs also connect to the dance, through a connection that is both visual and experiential. By transposing the dance into written marks, the glyphs produce a kinesthetic expression of the dance that enables the dancer to reflect on her experience.

Moreover, this reflection is not merely of an intellectual nature, but involves an embodied response. This observation is further clarified by Nigel Stewart (1998), who argues that Stark Smith's hieroglyphs can be understood as 'phenomenal dance images'. Stewart defines phenomenal dance images as expressive figures that convey the 'forcetimespace' of dance, a term Sheets-Johnstone has used to describe the 'indivisible wholeness' of dance (1979, 14). The effect of these hieroglyphs indeed goes beyond a visual depiction of the movement. As Stewart observes:

> They mark the very manner in which the object is kinaesthetically perceived by, and danced from, the subject's consciousness. So, from one point of view, these forms of notation embody a unity prized by phenomenology - between the daning subject and the object that is danced. (…) [T]hese expressive figures then elicit in me an aesthetic response, which re-enacts the aesthetic response to [dance] movement (…) whether I am reader, spectator, notator, or dancer, 'I' (the subject) have to embody 'It (the object) by becoming kinaesthetically conscious of the object. (Stewart 1998, 49)

[88] Note that the iconicity of Chinese characters is contested. For instance, Schwan (2015) notes that: '[Not every] mark in Chinese writing originates from visual representations of bodily figures, as is often and wrongly stated, probably in an attempt to reduce the vast incomprehensibility of Chinese writing to any non-trained eye. Some signs may historically derive from depictions of human or animal bodies, yet the majority of signs have a primarily abstract character' (Schwan 2015, 140).

The use of the term 're-enact' is vital here for Stewart's argument. He points out that these images not only express the kinesthetic perception of the dancer, but also trigger an aesthetic response in others by inviting them to 'embody it', by becoming 'kinesthetically conscious of the object.' Another angle from which the imaginative potential of the glyphs can be acknowledged is by considering the extensively theorized idea of immersion in the study of Chinese calligraphy (fig. 35-36). In his analysis of the analogy that is often drawn between calligraphy and dancing, Alexander Schwan observes that

> as spectators of dancing and calligraphy, we actively take part in what we see and what we construct in our imagination. Not only are we set in motion on a mere bodily level – by moving our eyes in saccades while reading, and by responding to dancing bodies with our own kinaesthetic resonances – but we attempt to bridge the gap between us and the unfolding figuration of ink or bodies. (Schwan 2015, 139)

Schwan points to a parallel in how dance and calligraphy are perceived. Both of these perception processes invite an immersion of the viewer. Through their calligraphy of dance, the glyphs seize on this resemblance and thus offer an opportunity to re-enact the experience of the dance in a different mode, allowing us, as Stark Smith puts it, to see 'what happens be-

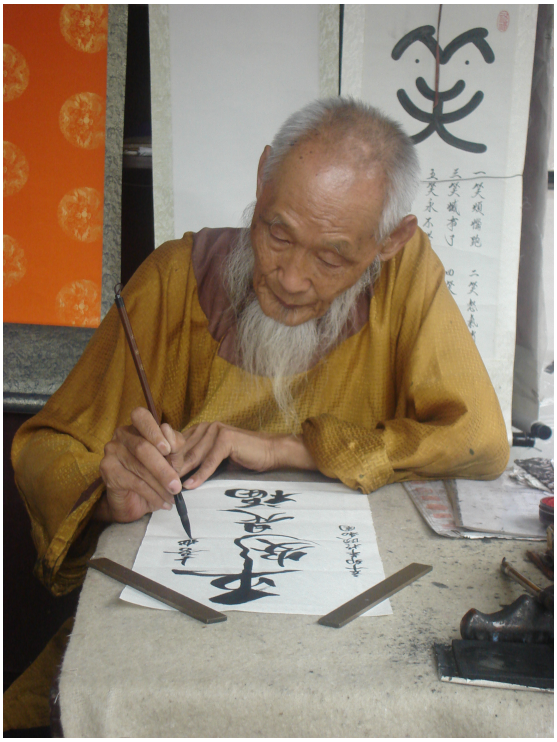


Figure 35. Chinese ink calligraphy. Beijing. Photo Laura Karreman.

Figure 36. Chinese water calligraphy. Beijing. Photo Laura Karreman.

tween an experience and the telling of it.' The glyph prompts dancers with the question: if this image corresponds to my experience of the dance, how does that reveal aspects of that experience that I had not previously been sensitive to or conscious of? The glyph thus inevitably invites dancers to add another layer of reflection to their perception of the dance, which may deepen their practice.

5.4 Travel paths in *Using the Sky* by Deborah Hay and Motion Bank

The pictorial and expressive quality of the motion capture-based travel paths in the digital score *Using the Sky* (Hay and Motion Bank 2013) bears a resemblance to Stark Smith's hieroglyphs. Both travel paths and hieroglyphs can be recognized as a type of non-symbolic dance writing that is first and foremost shaped by the idiosyncrasy of its source: a dancing body. Although the dancing-drawing body is present in both *Motion Bank*'s travel paths and Stark Smith's hieroglyphs, a comparison of these images also shows fundamental differences. These differences revolve around *what* the written trace depicts and *who* is involved in the writing.

Consider what the digital trace depicts in *Using the Sky*. The travel paths in *Using the Sky* are based on the movement trajectory of the (approximate) center of the body of three different performers of Hay's score *No Time To Fly*, who have been captured through markerless motion capture, enabled by the use of Kinect cameras (Kahn et al. 2012). The digital score's interface allows for a simultaneous view of multimodal sources. The score is structured in accordance with a division of Deborah Hay's score in 25 parts. For each part, the travel path images can be viewed, as well as Hay's written score and the dancer's account of her insights on performing the score. A video capture of the performance is also available. For example, when Hay's score in section 12 reads 'I move across the stage in a straight line while erasing my destination', next to it performer Jeanine Durning comments:

> I always am aware of this diagonal but I'm trying to erase it at the same time, I don't want to give away that I'm travelling in this direction, so in this way I'm also constantly in negotiation with the audience and trying to maybe understand how they're perceiving this pathway and trying to trick them to not see it any more. (Hay and Motion Bank 2013)

The blue travel path that corresponds to Durning's movement clearly follows a diagonal across the stage, but instead of a 'straight line' it shows an erratic sequence of tiny detours

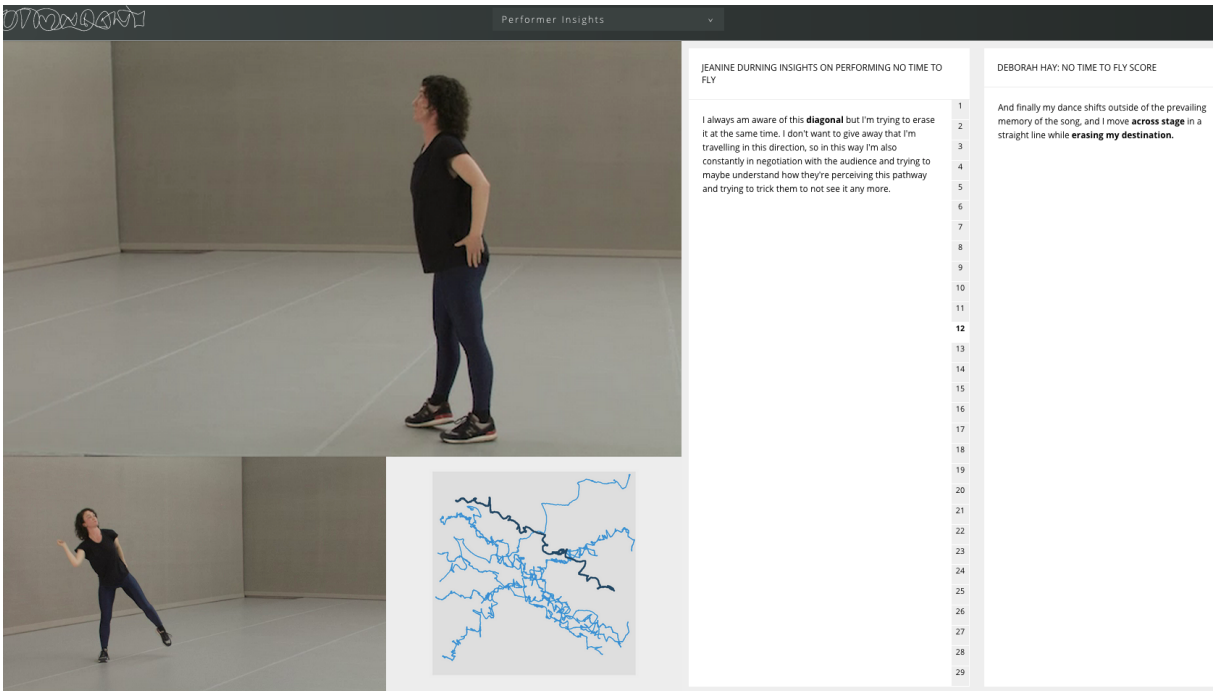


Figure 37. *Using the Sky* (2013). An exploration of Deborah Hay's solo *No Time To Fly* by *Motion Bank*. This excerpt shows (from left to right) video recordings of the performance, the travel paths of performer Jeanine Durning, Durning's insights, the section number of the score and the text of Deborah Hay's score belonging to this section. Screenshot by Laura Karreman.

and divergences (fig. 37). The messy diagonal perceived in the travel path starts to make sense when making the connection with the attempt to 'trick the audience', which is Durning's interpretation of the instruction in Hay's score to 'erase her destination.' Rather than just a messily drawn diagonal, other features now become recognizable in the image, related to the interpretation of the score, such as hesitance, negotiation, or playfulness. The juxtaposition of these different sources has the effect that the travel path image becomes more than a display of a movement trajectory; it also acquires the expressive force that Stewart associates with the 'phenomenal dance image'. The image invites one to 'step inside', to imagine the experiential perspective of the performer.

Even though both travel paths and hieroglyphs can be considered as phenomenal dance images, the linear traces they consist of are the result of different processes. Cooper Albright may comment that a writing instrument on the top of the head 'would probably draw something like a hieroglyph' (see chapter introduction), but from Stark Smith's description of the practice, as well as from examples of glyphs, it becomes clear that the spatial description of dance is but one of the aspects reflected in the drawing. Rather than being about the outward appearance of the dance, the glyphs capture the internal, proprioceptive experience of the dancer. By only capturing the spatial trajectory of the body's contours in space,

the motion capture apparatus radically abstracts dance movements. Its inability to capture anything else except for the movement of bodies from a to b results in what I would call the 'spatial bias' of motion capture-based dance renderings: a tendency to give preference to dance with a 'large movement amplitude', be it in the body itself — think of the extension of legs and arms — or distributed in trajectories across the stage.[89] The representational logic of *Using the Sky*'s travel paths also recalls the association with the geometrical dances from the 16th century, which were designed to be seen from above as if they were horizontal or flat on a page. Mapping dance onto a two-dimensional plane, then, is another tried and tested method of the transmission of dance knowledge that is in accordance with the dancing-drawing body.

5.5 Hand-drawn spaces: *Ghostcatching* by OpenEndedGroup

The belief that drawing might be a key feature of the design of compelling digital renderings of human movement stands at the core of the work of Paul Kaiser and the digital artist collective OpenEndedGroup. Choosing his words in a way that is faithful to the dancing-drawing body, Kaiser recognized the activity of drawing in 'the technology of motion capture, where instead of a crayon it is a body inscribing itself not on a static piece of paper but on a flowing stream of data' (Kaiser 2003, n.p.). Active in different collaborative constellations before taking on its official name in 2001, OpenEndedGroup's work can be broadly characterized as artistic research into digital design. The question of how human movement and performance may be designed and drawn in the digital realm represents a special interest in their creative work.

In 1999, OpenEndedGroup and Merce Cunningham collaborated for the creation of BIPED, the dance performance that featured a juxtaposition of live dancers and motion capture-based projections of dancers. On a par with *BIPED*, the video installation *Ghostcatching* (1999) has acquired nothing less than canonical fame as the turn-of-the-century performance that used motion capture data of dancers as its basis. The 7-minute video installation has become a prominent point of reference in the discourse on dance capture and has not

[89] *Capturing Stillness: Visualisations of Dance through Motion Capture Technologies* (2010-2013) by Ruth Gibson and Bruno Martelli is a relevant example of an artistic research project that challenged this spatial bias by aiming to map dance movements emerging from the somatic practice of Skinner Releasing Technique. One of the key questions of this project was 'whether stillness remains invisible when no motion can be tracked or whether stillness becomes replete with life as the visualisation process gives life to the dancing avatar' (Whatley 2011, 274). The project *Capturing Stillness* is discussed in Section 5.6.

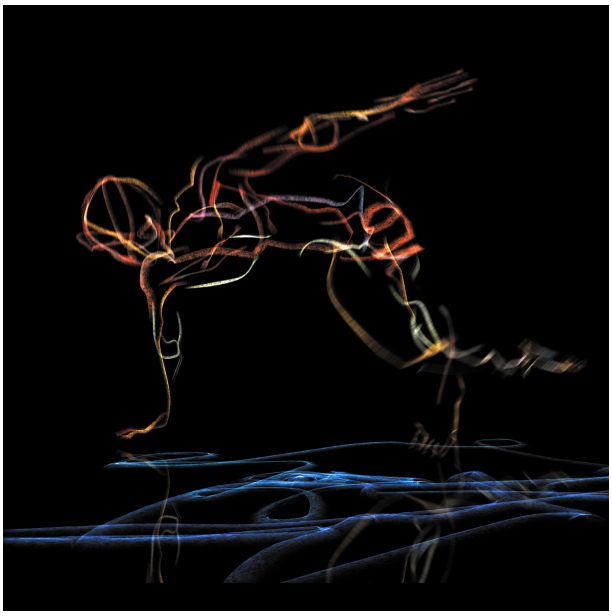


Figure 38. *Ghostcatching* (1999) by Bill T. Jones, Paul Kaiser, and Shelley Eshkar.

lost its appeal up until today (Barber 2015; Dils 2002; Franko 2011; Portanova 2013).

Ghostcatching was created by OpenEndedGroup members Paul Kaiser and Shelley Eshkar in collaboration with dancer Bill T. Jones. Kaiser and Eshkar used optical motion capture to record the singular movement material that Jones had created while improvising. This motion data was rendered into an avatar that consisted of colorful dynamic lines, their texture resembling that of charcoal drawings (fig. 38). The imagery was created by an inventive mix of technologies and materials, combining analogue drawing, computer graphics and motion data. Kaiser explains: 'Sampled charcoal and other scans were texture-mapped to the splines of the new body [that evolved from the motion capture data], so that when rendered it looked like a gesture drawing – but a gesture drawing inhabiting a 3D space and moving to Jones' dance' (Kaiser et al. 2003, n.p.). A multi-layered soundtrack enhanced the kinesthetic feel of this imagery by including sounds that intimately evoked the living presence of a body, such as footsteps, humming and breathing.[90] As Ann Dils observed: 'The sound of footsteps keeps him present and adds weight, force, and a sense of direction to the movement' (Dils 2002, 98). The sensation of these movements is further amplified by audiovisual effects that accompany the body's trajectories through space. For example, a wide,

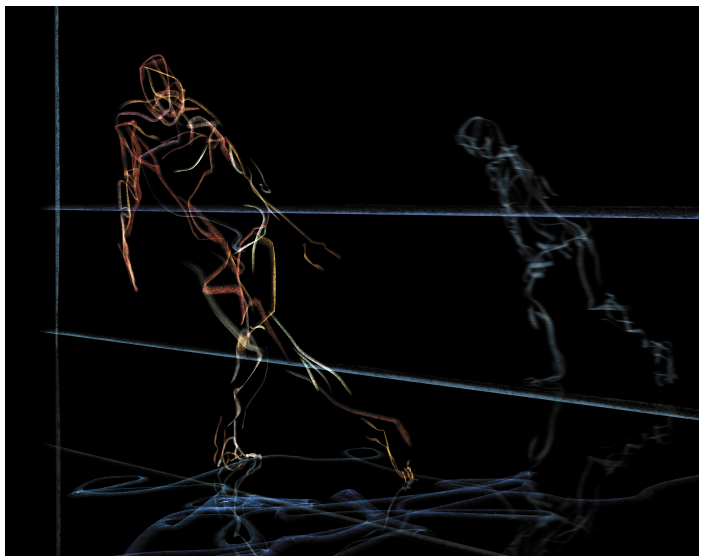


Figure 39. *Ghostcatching* (1999) by Bill T. Jones, Paul Kaiser, and Shelley Eshkar.

[90] Jones is also heard singing an American folk song and recites text that has an autobiographical nature, including 'a spoken exchange between a mother and a child about cornbread, a re-telling of one of his maternal grandmother's "story-songs",' which Tiffany Barber relates to the specific identification processes that arise from this work (Barber 2015, 50).

sweeping movement of the arm, part of the starting sequence of the work, is made more explicit by leaving a graphic trace of the hand's spatial trajectory, accompanied by the sound of chalk on a blackboard. In *Ghostcatching,* Jones's avatar can be seen escaping from a drawn box. Later on the avatar sees a reflection of himself in a mirror, which adds another layer to the idea of a digital double (fig. 39). At the end of the film, Jones's movement data is multiplied into a group of dancers, a further demonstration of the potential of manipulation of movement data.

Ghostcatching is thus more than an aesthetically pleasing animation of motion data. It is a work that invites the viewer to think about motion capture as a topic in itself. It is an artistic inquiry into the affordances of motion capture to render dance performance.[91] This meta perspective becomes already evident from the questions that were presented as part of the artists' statement that accompanied the work: 'What is human movement in the absence of the body? Can the drawn line carry the rhythm, weight and intent of physical movement? What kind of dance do we conceive in this ghostly place, where enclosures, entanglements, and reflections vie with the will to break free?' (Jones et al. 1999).

The roots of OpenEndedGroup can already be found in the 1980s and are specifically tied up with Kaiser's professional background, which Johannes Birringer describes as follows:

> Paul Kaiser's background is in experimental filmmaking; throughout the 1980s he taught students with severe learning disabilities, with whom he collaborated on making multimedia depictions of their own minds. From this work, he derived the key ideas — *mental space* and *drawing as performance* — which became points of departure for the digital artworks he has been making since the mid-90s (…). (Birringer 2008, 17)

Indeed, texts by Kaiser that document the creative development of *Ghostcatchin*g confirm that he had already been contemplating issues that are at the core of the project for a while

[91] The recent article "Ghostcatching and after Ghostcatching, Dances in the Dark" (2015) by Tiffany Barber addresses another relevant topic with regard to this work by asking the question how *Ghostcatching* performs racial identity. Barber argues that the blackness of Bill T. Jones may be made 'invisible' in the motion capture imagery, but that it still is a work about race, 'operating within a political imaginary that is what Toni Morrison calls race-free yet race-specific, a way to "enunciate race while depriving it of its legal cling" (1997, 5).

(Kaiser 1999; Kaiser 2002).[92] As Birringer writes, Kaiser's first thoughts on this topic emerged when he became interested in the way children draw while teaching children's classes in 1986. Rather than concentrating on the finished drawings, Kaiser observed that the most compelling part of their drawing was the practice itself, the drawing *as performance*. He observed the gestures and sounds of children while they were drawing and came to see the final drawings as cumulative traces of this performance that engaged the whole body. Kaiser started thinking of ways to open up this process to an audience. Inspired by the recent invention of computer multimedia, Kaiser figured that he could animate these drawings using computer graphics, in order to 'stretch them out in time'. He was amazed by the expressiveness of the result, which he described as a 'cinematic record of a child's mind in action' (Kaiser 1999). This recognition of the drawing as 'the mind in action' would prove to be a fundamental observation for Kaiser's subsequent research. He went on to explore the idea of the animation of drawings for revealing a mental space. The following two questions lay at the basis of these explorations: 'Might it be possible to enter a drawing as if entering a 3D space? To move around inside it as if within the mind of the creator?' (Kaiser 1999). Kaiser called the particular space he envisioned with this idea a 'hand-drawn space'.

Kaiser intuited that such a hand-drawn space would require a design that was radically different from the conventions of computer graphics of the early 1990s, which he characterized as follows: 'The more 'realistic' the 3D rendering, the more synthetic its feeling. With its too-logical forms and lights and reflections, it left no room to think or to breathe' (Kaiser 1999). Things began to fall into place when Kaiser started collaborating with computer programmers Susan Amkraut and Michael Girard, who provided ideas on how to go about prototyping the hand-drawn spaces he imagined. Amkraut and Girard had been working on creating software for choreographers — Merce Cunningham among others — so they were able to animate moving figures. They turned their attention to motion capture once they realized that sampling real movement data would take away an important flaw of their software: the movement imagery was too synthetic, the figures 'moved too well.' By capturing the movements of actual dancers as raw data for the software to operate on, Amkraut and Girard

[92] A strength of OpenEndedGroup is their self-reflective writing, which is available on their website. These texts are mainly written by Paul Kaiser. The following texts provide a rich inside look into the thinking process and inspirational basis fundamental to the creation of *Ghostcatching* and other motion capture-based works by OpenEndedGroup. The strength of these articles lies in the fact that they not only describe details about the process of making the work, but simultaneously propose ways of thinking about these processes. See "Steps" (Kaiser 1999), "On Motion-Mapping" (Kaiser 2003) and "Frequently pondered questions" (Kaiser 2002), available on the website of OpenEndedGroup.

aimed to incorporate those features that give movements their individual character, in order to make the generated animations more credible.

Building on this idea, Kaiser started to collaborate with Shelley Eshkar, who had studied drawing, photography, sculpture and computer graphics at Cooper Union. By combining these talents, Eshkar developed a way of drawing animations based on motion data. The dancers' motion was thus transposed to rather abstract figures made up of dynamic lines of colorful chalk. Kaiser and Eshkar recognized the extremely well-developed human sensitivity to human movement and found that the abstraction of animated figures could actually play a role in magnifying the kinesthetic experience of the audience. 'Strip the visible signs of movement to the barest of minimums, and not only will you still distinguish the walk or the run or the leap or the tumble, but you will even still sense something of the size, the weight, the age, and the intention of the body behind it' (Kaiser et al. 2003).[93] The great expressive force of this design would become the basis of the imagery of *Ghostcatching* (1999) and *BIPED* (1999).

Ghostcatching is an early example of a work that demonstrates the capacity of motion capture to reveal the spatial trajectory and the three-dimensional contours of a dance. Additionally, OpenEndedGroup also paid specific attention to how these traces could be rendered as a hand-drawn space. The hand-drawn space of *Ghostcatching* not only represents the outer surface of the dancing body of Bill T. Jones, but it was designed in such a way that it convincingly expressed qualities that were related to a mental space, thereby externalizing an inner world.

5.6 Haptic interfaces: *Capturing Stillness* by Gibson/Martelli

Another artistic formation that has been researching the affordance of motion capture technologies since they became more widely available in the 1990s is the visual art partnership

[93] The idea of hand-drawn space has remained a key artistic concept in the work of OpenEndedGroup and found perhaps its most literal and glorious translation in *Loops* (the first version was developed in 2001, commissioned by the M.I.T. Media Lab for the "ID/Entity" show), which features an emergent, perpetual audiovisual flow based on motion capture data of Merce Cunningham's improvisational dance solo *Loops*, first performed in 1971. Cunningham, who never taught the choreographic principles of the performance to anybody else, called *Loops* his signature solo. Once arthritis restricted his motion range, Cunningham came to perform *Loops* with his hands alone. After reiterating *Loops* in different versions, OpenEndedGroup eventually resolved to release the code for the 2008 implementation of *Loops* and the programming environment Field as open source, to enable others to study the work and its underlying code but also to 'allow future (and even contemporaneous) programmers to update the work as well as to create their own derivative artworks.' See Paul Kaiser (2017).

Gibson/Martelli (formerly known as igloo), consisting of choreographer and performer Ruth Gibson and programmer Bruno Martelli. Key questions that motivate their work are: How does digital technology enable performance work that, instead of taking place within the frame of the proscenium arch, could be played with and interacted with? How can the audience be let *into* the space where performance might take place?[94] From the onset of Gibson and Martelli's collaboration, motion capture technology has played a central role in how they envisioned and designed work that relates to these questions. Especially motion capture's potential to bring into visibility the dancer's own body and the bodies of others from all angles held a promise for the new spaces of performance that they aspire to create. Rather than conducting analytical calculations on the basis of motion capture data, Gibson and Martelli are interested in experimenting with various ways in which these motion data can be brought back to life. Their animations do not always take the realistic shape of a humanoid figure, but have often taken the form of abstract shapes and virtual landscapes.

The work of Gibson/Martelli makes clear that their artistic research relates to a central set of questions that characterizes the contemporary effort to comprehend the extensive developments in HCI. How do humans engage with the world through digitally enabled interfaces? How do they orient themselves in environments that are created by these interfaces, which intertwine real and virtual spaces? How do they make sense of these mediated environments through an embodied experience? How is what they learn about themselves by engaging with these interfaces affected by the corporeal computation that is inherent in them?

In the early stages of their collaboration, motion capture also provided a specific advantage. In their project *dotdotdot* (2002), igloo used:

> motion capture, web tools, animation, games engine technology and custom built software, combined with sound and live movement, to generate a series of animated dancers (…) inviting the internet *flâneur* to 'manipulate' the dancers 'in terms of speed, sound, rotation, movement and angle of view.' (With which the viewer [could] interact online (…)). (Birringer 2007, 41)

Gibson and Martelli used Shockwave 3D web technology to put these motion capture sequences, which lasted about seven minutes, online. At the time, video did not have the re-

[94] For this section on the work of Gibson/Martelli, I draw on an interview I conducted with them (Gibson and Martelli 2015).

quired quality and these sequences were very heavy to upload. The three-dimensional data provided additional options to spin the image around, to see it from the top or from below, to zoom in or out, to slow it down or make it go backwards. Another advantage was that whereas when video is slowed down it shows the separate key frames, slowing down motion capture shows a very smooth curve, because the motion capture software interpolated between all points. To allow the viewer into this space, it seemed a natural progression to move from Shockwave 3D to using a computer game engine. In the subsequent SwanQuake series, including *SwanQuake: House* (2007), Gibson and Martelli experimented with interfaces that allowed the audience to move around in environments that combined motion-captured performance with computer game aesthetics (Popat 2012).

Gibson seized the opportunity to research in more depth how motion capture could act as a tool for imagining dance performance by initiating the Capturing Stillness project (Gibson 2011; Whatley 2011). Gibson took a specific somatic technique as her point of departure: Skinner releasing technique (SRT). This technique was developed by Joan Skinner in the early 1960s and has had a significant influence on dance training and performance; it continues to be taught all over the world.

Because the Capturing Stillness project is specifically aimed at rethinking ways of transmitting SRT, I provide a concise introduction of how this technique emerged and what it focuses on. Joan Skinner had built an impressive professional dance career in the 1960s, having danced in the companies of both Martha Graham and Merce Cunningham. Influenced by her experience with Alexander Technique, another somatic technique that is frequently used by dancers, Skinner discovered that the use of imagery was a powerful means to convey kinesthetic information in movement training. In an article from the late 1970s that describes SRT as an innovative approach to dance training, SRT is defined as ‘a system of kinesthetic training which refines the perception and performance of movement through the use of imagery' (Skinner et al. 1979, 8).

The advantage of using mental imagery in dance practice is that it fosters an intuitive rather than an analytic response, which is helpful because much of the mechanics of movement is not directly subject to the control of the analytical mind.[95] Indeed, research suggests

[95] Skinner designates four principles of releasing: ‘multi-directional alignment’, ‘multi-directional balancing’, ‘autonomy’ and ‘economy’. Excess tension often stands in the way of realizing these principles. Through the use of imagery in exercises, students become aware of their own patterns of tension. Skinner distinguishes two levels of imagery: specific and totality imagery.

that imagined movement is an effective means for educating the neuromuscular system.[96] An example of what Skinner calls 'specific imagery' is the 'knee string image' in which students, while lying down on their back, imagine a string attached to the center of each knee extending toward the ceiling and supporting the weight of each leg. The strings open each knee, one at a time. 'With practice, the legs are freed from the pelvis, facilitating turnout and greater flexibility in the hip socket' (1979, 9). 'Totality imagery' evokes a feeling state that can be experienced as an immersion or complete identification with the imagery. 'For instance,' Skinner explains, 'by working within an imagined state of weightlessness where there is no problem with the pull of gravity, a dancer can let go of muscles usually gripped as if necessary to hold one's balance' (Skinner et al. 1979, 11). By practicing in accordance with these releasing principles, students discover new movements and also acquire more power, speed and intensity of movement. Skinner describes the effect of SRT training on the appearance of dancers as follows:

> Ideally, movement seems to be more skeletal than muscular. The muscles appear to be lengthened and wrapped around the bones rather than contracted or gripped. The joints give the appearance of having space in them and the limbs of being unbound though belonging to the torso. There is a suspended relationship to gravity which can be likened to the suspension of a dust particle in a shaft of sunlight. (Skinner et al. 1979, 11)

The metaphorical language that Skinner uses in this description already gives some important clues as to why Gibson, herself a practitioner of SRT, would be interested in investigating how to convey SRT principles through motion capture. The difficulty of representing muscles and body weight in motion capture-based dance visualizations is often perceived as a problematic aspect. However, because concepts like weightlessness, transparency and suspension from gravity play a central role in the imagery that is used in the performance of SRT principles, motion capture may have a special potential to highlight these features. The particular expression of the point cloud, the most basic visual rendering of the dancing body in optical motion capture, is easily associated with the 'suspension of a dust particle in a shaft of sunlight' to which Joan Skinner likens the appearance of the dancer using SRT technique.

[96] Skinner et al. (1979) cite Lulu E. Sweigard (1949), who worked at the Dance Department at the Julliard School of Music in New York City at the time. In the past two decades, there has been an increasing interest in the topic of dance and cognition, in which the working of 'mirror neurons' in the process of learning dance continues to attract much attention, see for example Birringer and Fenger (2006) and Bläsing, Puttke and Schack (2010).

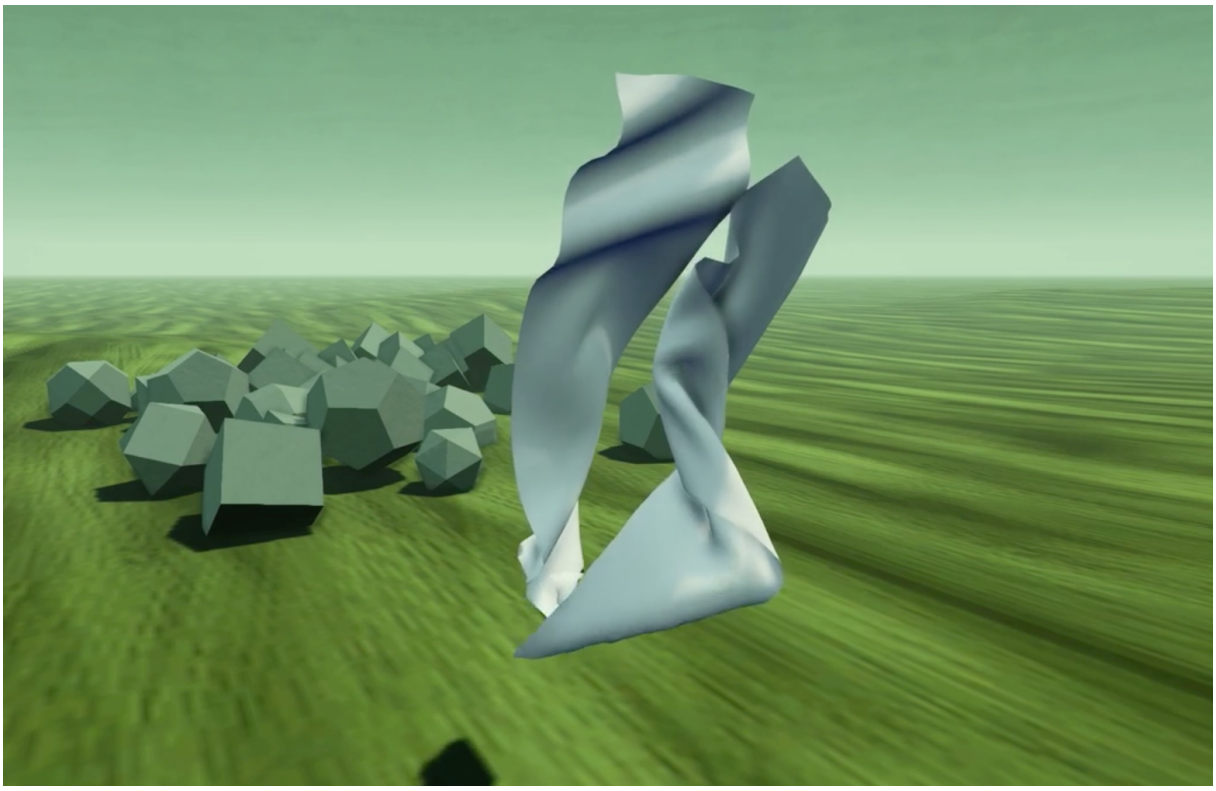


Figure 40. Gibson/Martelli, *Falling Upwards* (2013). Screenshot of realtime virtual environment made for first-person navigation via CAVE technology.

For the Capturing Stillness project, Gibson and Martelli collaborated with the Skinner Releasing Institute, where they recorded SRT classes with experienced dancers through optical motion capture. At various stages of this process, Gibson collected feedback from the dancers, including responses to the initial imagery that came out of the project. Gibson and Martelli also developed the 'MocApp' as part of the project, an application that allows a user to view motion data clips on a smartphone or tablet. By enabling the augmented reality function in this application, it is possible to project movement data in the shape of a moving stick figure as a layer onto one's immediate surroundings (Gibson/Martelli 2013).[97]

The final outcomes of the Capturing Stillness project had not been fully developed, nor officially published when I was conducting my research for this thesis. Gibson and Martelli were still processing and experimenting with ways to present their findings as part of the Capturing Stillness Project when I interviewed them. The various ways in which the project had nurtured and folded into their ongoing artistic work had already become very

[97] For a video demonstration of the app, see dancetechtv (2013).

clear to them at this point.[98] One work that evolved from the Capturing Stillness project is *Falling Upwards* (2013), a real-time virtual environment that is made for first-person navigation via Cave Automatic Virtual Environment (CAVE) technology. *Falling Upwards* presents the viewer with a simple, abstract landscape, a green surface suggesting a grassland. In the middle of the field, there is a small cluster of dark rocks, which provides the viewer with a sense of orientation in the otherwise vast and nondescript green plain (fig. 40). The whole attention of the viewer is directed to two, vertically aligned, rippling planes floating above the ground. These two grey strokes move in close relation to each other. At first sight, these moving surfaces lack any anthropomorphic features. And yet, the way the strokes move and ripple, the sensuous flow in which they first move in sync and then separate in gentle counterpoint, recalls the ever-shifting balance of two dancing bodies involved in contact improvisation. In contrast with the dancing body, though, the strokes float in continuous suspension. Although they never completely touch the ground, their movement is dynamic rather than static. Their bodies are alternately carried up and down by an intangible force.

Falling Upwards expresses kinesthetic features that are at the core of Skinner's principles, such as weightlessness, floating, suspension and flow. The animation compellingly evokes Skinner's imagery, which invites qualities of effortlessness and weightlessness in movement: 'Tumbling in an imaginary weightless chamber; legs, arms, skull all are floating, buoyant. There is no up, no down. There are only inwardness and outwardness. Movement is effortless even as the dancers balloon off the walls of their weightless environment' (Skinner et al. 1979, 9). CAVE technology allows the viewer to take in the dance animation in from all sides, from close by and from further away. *Falling Upwards* thus explores what happens when the mental images that are at the core of SRT are visualized in an environment that is subject to the physical navigation of the viewer. Furthermore, *Falling Upwards* demonstrates that it is not necessary for animations to be anthropomorphic for them to convey kinesthetic information. This suggests that the artistic computation of motion data may also support the education of the neuromuscular system. This virtual imagery is based on a similar principle, but presented in a different mode, from the mental imagery that is used in SRT.

[98] In their installation *VISITOR,* for example, in which half of a rowing boat is set up in a small wooden house constructed on site, the visitor can navigate through a virtual lake by using the oars of the rowing boat. Gibson speaks about the experience of a Skinner Release dancer who participated in the Capturing Stillness project, who described the experience of being inside *VISITOR* as 'floating in a Skinner image' (Gibson 2014). Although the lake environment did not feature any recognizable human shapes, the movement of the mist particles above the water was created by using motion data from the Capturing Stillness project.

The Capturing Stillness Project gave Gibson/Martelli new perspectives on one of the fundamental questions in their research: How can the audience be let *into* the space of performance through the use of digital media? It added to their awareness of the power of imagery to convey kinesthetic information. Gibson emphasizes that the imagery they created is 'as much about what you *see* and what you *feel* while watching' (2015). Indeed, the Capturing Stillness Project was never about a direct mapping of the motion data of the dancers. To create a virtual environment that an audience can engage with, it is necessary, according to Gibson and Martelli, to think about the SRT principles in consideration with HCI. For them, it is a continuous learning experience to see how audiences move and orient themselves in the virtual environments they create. Although they do not research these engagements in a very deliberate way, they does represent a constant focus of their attention. As Gibson explains: 'We're not statistically looking at how audiences behave in these spaces, but there is a gentle awareness of looking at that' (2015).

By putting effort into testing how the visualization of motion data may spark kinesthetic imagination, Gibson and Martelli have further developed their artistic ideas on interfaces. Whereas the ultimate goal of HCI for contemporary companies appears to be a seamless interface that is very easy to control, as exemplified by the fast development of the self-driving car, Gibson and Martelli have deliberately gone in the opposite direction by creating interfaces that are complex. They believe that making their interfaces difficult to navigate enhances a sense of immersion for participants. Gibson and Martelli describe their interfaces as 'physical' rather than 'gestural', because the audience has to physically engage with an object to relate to the surrounding virtual environment. In *VISITOR-Vermillion Lake* (2011), the navigational instruments that connect the audience to the virtual landscape are the oars of a rowing boat. *80º N* (2014), a project inspired by the discovery journeys to the arctic, presents the audience with a steering wheel, a pause rope and an accelerate rope, and an ascending and descending lever. The programming that underlies these interfaces prevents an easy command over the navigation; instead, it evokes sensations of resistance in the user. Gibson explains: 'You could say there is a sense of buoyancy about it, but things are a little subtler than that. 'Delay' is not quite the right way to describe it either…I suppose it's more related to the difference between 'pause' and 'stop'' (2015). The work deliberately plays with the sense of 'being in control' that is so strongly associated with the interaction with computer interfaces. As Martelli explains, in *80º N*:

> You can only navigate against the wind. You have influence through the rope, which really feels like a proper rope, which is important for your proprioception. But you're essentially out of control. We're thinking of making even more haptic interfaces that make you even less in control. (Gibson and Martelli 2015)

By showing the destabilizing effects of the loss of control, Gibson and Martelli's work draws attention to the sense of mastery and control that characterizes the interaction with computer interfaces. Although it often feels like one can smoothly interact with computers, this does not mean that one can fully grasp what is going on inside of them, unless one has a deep knowledge of programming languages. As Wendy Hui Kyong Chun observes: '[The computer] does not simply relay what is on the other side: it computes. In order to become transparent, the fact that computers always *generate* text and images rather than merely represent or reproduce what exists elsewhere must be forgotten' (2011, 17).

Chun also introduces the notion of 'causal pleasure' to describe her experience that '[her] typing and clicking seem[s] to have corresponding actions on the screen' (Hui Kyong Chun 2005, 45). Chun refers to Brenda Laurel's study *Computers as Theatre* (1991), in which Laurel has argued, as part of her comparison of computer interfaces and theater, that direct engagement is predominantly established by clear causality. Chun summarizes Laurel's argument as follows: 'Causality, she claims, ensures universality, ensures that the users will willingly suspend their disbelief' (Hui Kyong Chun 2005, 41). Causal pleasure also typically involves what Manovich (2001) designates as 'user amplification', the tendency of computer programs to amplify a single action, such as pressing a key, for example by expanding it into a narrative sequence, as happens in computer games. Chun views causal pleasure and user amplification as phenomena that are central to the power of programming.

Gibson and Martelli explicitly play with these notions of causal pleasure and user amplification, albeit not in a straightforward way: the interfaces they create typically resist an immediate response to the actions of the user. Both in *VISITOR-Vermillion Lake* and *80º N*, the audience can navigate within a landscape, but the installations do not prescribe what the ultimate goal of this navigation should be, nor does the audience seem to be able to gain control of where they are going. In this way, these works do not just display, but intentionally foreground the 'rhetoric of interactivity' (Manovich 2002), which holds that people become convinced not just by 'listening/watching a prepared message' (Manovich 2002), but by actively working and engaging with the interface that is presented to them. Causality and user amplification are suggested and draw the audience in. However, at the same time these prin-

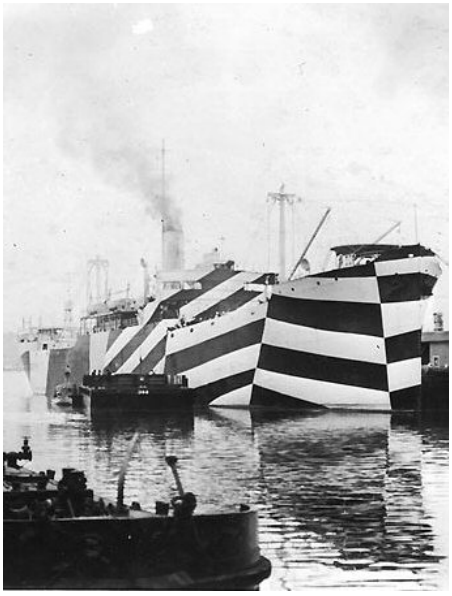


Figure 41. Dazzle camouflage in the First World War (1918).

ciples of interactivity are thwarted by never allowing the audience a full sense of control. This results in an ongoing negotiation and adjustment of the audience's orientation in space and creates an acute awareness about the longing for immediacy and transparency that these interfaces trigger. As Chun points out: 'Our interactions with software have disciplined us, created certain expectations about cause and effect, offered us pleasure and power that we believe should be transferable elsewhere' (Chun 2004, 47).

Both *VISITOR* and *80 degrees North* are projects that can also be related to the phenomenon of 'remote sensing'. In his article "Remotely sensing affective afterlives: The spectral geographies of material remains", human geographer Derek P. McCormack discusses what he calls the 'spectral logics' of remote sensing, the fact that remote sensing is always haunted by the prospect of that which cannot be sensed. McCormack's evocation of 'the spectral' is related to the term 'hauntology', which Jacques Derrida used to problematize the ontology of presence (Derrida 1994, 202). McCormack: 'For Derrida, the spectral is the necessary impossibility of the fullness of presence, without which materiality would be implosively inert' (McCormack 2010, 643). Taking the 1897 Balloon Expedition to the North Pole led by Salamon August Andrée as his case study, McCormack argues that various interpretative strategies that deal with the material remains that constitute the afterlife of this famous arctic expedition can be understood as a modified kind of remote sensing that is 'a kind of technique of sensing spectrality rather than a project of techno-scientific mastery' (McCormack 2010, 650). McCormack's critical evaluation of remote sensing offers several parallels with the skepticism with regard to the re-appearance of the dancing body in motion capture. Motion capture can in fact be understood as a type of 'remote sensing' in accordance with the suggestion of Lintz and Simonett (1976, 1) to define remote sensing as 'the acquisition of physical data of an object without touch or contact' (McCormack 2010, 641).

I also recognize this spectral effect of motion capture as a type of 'remote sensing' in the most recent work that has emerged from the Capturing Stillness project, with which I conclude my discussion of the work by Gibson/Martelli: the installation *MAN A* (2014). *MAN*

Figure 42. Gibson/Martelli, *Big Bob* (2015).

A plays with the tension between concealment and visibility by inviting audiences to step into a particular space of performance in an overwhelmingly public environment; a major shopping street in London. *MAN A* was set up as an installation in a shopping window of the department store Selfridges at Oxford Street. At first sight, the work appears as a large, two-dimensional surface that displays abstract, irregularly shaped black and white graphics. The first association of anyone who is slightly media-savvy would probably be the distinctive scrambled black and white pattern of a giant QR code. Yet, the design was primarily inspired by 'dazzle camouflage', a type of military ship camouflage, first and famously used in the First World War (fig. 41). The principal objective of dazzle camouflage was not to conceal, but rather to mislead the enemy about a target's range, speed and heading. In *MAN A*, Gibson and Martelli play with the tension between concealment and visibility by subtly inviting passers-by to download a mobile application. This application opens up an augmented reality layer that superimposes three-dimensional imagery of dance performance into the live camera view. The dancers are perfectly camouflaged within the prints. Having the app makes them to break cover. The motion capture sequences that were used for *MAN A* also come from the recordings of Skinner Release dancers. The fact that all these performances are improvisatory seems to invite the audience to explore different viewing perspectives of these performances. How does a different angle and distance change what they see? In a different version of *MAN A* in Slovenia, Gibson and Martelli constructed *Big Bob*, a two meter-high

dazzle sculpture in a gallery space that created yet another space of performance by enabling the audience to walk around the sculpture and watch the dancers appear through augmented reality (fig. 42).[99] Gibson: '*MAN A* is a reminder of how we understand ourselves in this world we're now in. When it comes to new performance spaces in the digital era, I think we are now coming into a space where we are constantly assembling and re-assembling ourselves, within a *MAN A* exhibition I think this is the experience' (Gibson 2014).

The work of Gibson/Martelli represents a continuing creative inquiry into ways in which our proprioception is impacted by extending bodily movement into virtual environments. For the Capturing Stillness Project, Gibson and Martelli have explicitly taken on mental imagery as it is used in dance technique as a model for the design of a human-computer interface that may support the imagination of new movement material. By deliberately moving away from recognizable humanoid shapes in their renderings of motion data, they experiment with the limits of abstraction that participants are able to handle in their perception of human movement.

5.7 Rightness of rendering

Motion capture now offers what key players in the history of Western dance notation may have considered to be the ultimate opportunity: The visualization of movement in a navigable, three-dimensional space and – even more radically – the possibility to map the movement of one body onto other bodies. Each of these renderings highlights different aspects of dance and offers the opportunity to ask questions about dance that have not been asked before.[100] If anything, however, the manipulation of dance motion data confronts one on an even deeper level with the impossibility of creating signs that match the phenomenal nature of dance. As Laurence Louppe wondered in *Traces of Dance* (1993), in response to early computer-generated choreography by Cunningham in the 1980s:

> Are we not, perhaps like dance masters of the fifteenth century, still far from inventing true signs, finding ourselves stuck in the old pursuit of corporeal truth,

[99] The sculpture was presented in 2014 at the You/Me/It Institut Jozef Sefan in Ljubljana, Slovenia. It has since been presented at various exhibitions worldwide. See http://gibsonmartelli.com/BigBob1.html.

[100] For example, as became clear in Chapter 3, the variability in the execution of a dance phrase can now be closely analyzed (Vincs and Barbour 2013), and the same applies to other features of dance performance that have hardly been studied yet, such as micro movements, repetitive patterns, timing, speed and acceleration.

> where signs, regardless of their nature, merely serve as intermediate means to render this truth in a new form? (Louppe 1993, 143).

The event of dance capture can be regarded as adding yet another aesthetic form to the 'pursuit of corporeal truth' that Louppe places at the core of the history of dance notation. Could contemporary motion capture-based visualizations, such as the colorful travel paths in *Using the Sky*, be conceived of as 'true signs'?

I suggest it is more helpful to continue to ask whether a motion capture-based image is *rightly designed*. I derive the distinction between truth and rightness from Nelson Goodman's *Ways of Worldmaking* (1978), in which he proposes that both scientific theories and works of art continuously create worlds, and that each have their own specific ways of knowing and understanding. In the section 'On Rightness of Rendering', Goodman argues that in the evaluation of renderings of a world, 'the distinction between true and false falls far short of marking the general distinction between right and wrong versions' (1978, 109). The rightness of design, Goodman emphasizes, is always relative to a system:

> Whether a picture is rightly designed or a statement correctly describes is tested by examination and reexamination of the picture or statement and what it refers to in one way or another, by trying its fit in varied applications and with other patterns and statements. (Goodman 1978, 39)

The projects that have been discussed in this chapter provide an insight into the diversity of digital modes of motion data that are used to *describe* dance. However, it is difficult to evaluate whether this imagery *correctly* describes dance.

The uses of motion capture in the projects described in this chapter underline the fact that exacting reconstructions are often not helpful as input for dancers involved in creative processes, or for staging phenomenal qualities of dance for spectators. Although this imagery may indeed present new opportunities for sensorimotor imagination, it should also be noted that its *legibility* is distinctly ambiguous. Through its lack of fixed meaning, it presents new questions about dance literacy and the transmission of dance knowledge.

In this chapter, I have shown the parallels that are apparent between motion capture and other scoring and writing practices that choreographers and dancers have used, such as dance notation systems and, more often, singular varieties of dance notes, writings with a personal dimension, which may function as a mnemonic device or as a tool for reflection.

The shape of the linear trace that these graphic animations take can be interpreted as a re-mediation of these practices, but can also be understood as closely linked to the revelation of an inner, mental space, as shown by Kaiser's intimation that walking around in one's drawing compares to walking around in one's mind.

The case studies I have discussed in this chapter are all compelling examples of how motion capture-based renderings of dance movement data tend to be rooted in a fundamentally embodied experience: the fact that when moving through the world one leaves physical traces behind. While considering these projects, a question that comes up again and again is how to 'read' this body that is drawn on a flowing stream of data. One perspective that could be helpful in considering this question is to interpret these objects and imagery as instances of 'corporeal or gesturo-haptic writing', a notion that I introduced in Chapter 3 (Rotman 2002; 2008). According to Rotman, motion capture is an example *par excellence* of a gesturo-haptic medium because of its ability to position human movement in the 'orbit of writing'. In contrast to symbol-based writing systems, Rotman observes that capturing technologies such as motion capture offer the advantage of a 'continuous topological model', which allows for an easier retainment of the affective quality of the movement. Taking a similar stance as Rotman, Salazar Sutil notes that

> the turn toward a graphic notation points to a changing paradigm in the culture of representation and mediation, one in which writing is not static but in fact moves, in which the markings of a recorded movement score are no longer fixed symbols on staves but animated ideographs that express movement qua movement. (Salazar Sutil 2015, 139)

To view motion capture as a gesturo-haptic medium also resonates with Stewart's notion of phenomenal dance images, which he used to characterize Stark Smith's hieroglyphs.

How can these motion capture-based dance traces be assessed? It seems that the foremost value of these traces is that they can be 'read' not by first interpreting symbols, but through kinesthetic imagination. This is also supported by the comparison of dancing and calligraphy made by Schwan (2015), who stressed the kinesthetic impact of the perception of linear traces in both arts: 'With particular regard to linearity, we can state that in calligraphy and dancing we not only look at lines drawn permanently on paper or ephemerally in space, but take part in the unfolding lineament we perceive' (2015, 139). Visualizations of motion data invite the viewer to perform or 're-enact' the gesture on display. In this regard, the ex-

perimental artistic projects that have been discussed in this chapter also support the assertion of Dee Reynolds that:

> [D]igital technologies may extend the boundaries of kinaesthetic imagination (…). Where such work has a visceral impact and heightens kinesthetic awareness, I argue that it resists and critiques the de-corporealising effects frequently attributed to digital technologies. New technologies can thereby enhance the reflexivity of kinesthetic imagination, on which its critical resistive potential depends. (Reynolds 2007, 18)

In addition to their kinesthetic appeal, the movement imagery that is featured in these projects is compelling because it suggests a direct relation with a dancing body: the body that sourced the motion data. Whereas notation systems rely on a symbolic representation of dance, the visualizations of movement data that have been discussed in this chapter can be understood as indexical and iconic, in accordance with Peirce's idea of the triadic sign, as was observed in Chapter 3. Even though the proof for such a direct relation may not always be evident to a viewer – this is certainly the case in the abstract renderings of Gibson/ Martelli –, the fact that this relation is suggested adds to the believability of these images. In a similar way to contemporary practices in the film industry (Chapter 4), where the 'making-of' genre functions as a supporting genre for performance capture-based films, the suggestion that actual dance movement data lies at the basis of this imagery increases not only the *believability*, but also the *legitimacy* of these images. This is striking, especially because the case studies in this chapter have made clear that the kinesthetic information that is conveyed through this imagery often seems to play a more important role than an accurate representation of a spatial trajectory would. These traces describe, but not necessarily *pre-scribe*, pathways across the stage. In the creation of this graphic movement imagery, then, a balance is typically sought between the representation of an empirical trace of the dancing body and the expression of the quality and intention it embodies.

One clear aim of movement data renderings is that, in order to remain believable, they should not appear to be too synthetic or too perfect. First, artists with in-depth experience with motion capture and dance projects argue that they prefer using motion capture data in renderings of human movement, because computer-generated animation cannot yield the same expression. It is thus undesirable for the rendering *to outperform* the dance in this way. There is a delicate balance here, however, because it is equally undesirable for

these renderings to *underperform* the dance. I introduce the coupled terms 'outperforming' and 'underperforming' to stress the ultimate unattainability of a decisive 'rightness of rendering' (Goodman 1978). Second, digital renderings of dance are appreciated more if an indexical relationship can be established between a data visualization and the dance or dancer as a *source* of such a rendering. Indeed, a shared quality of many contemporary mediations of dance seems to be that they, in one way or another, usually aim to re-create elements of the phenomenological experience of dance.

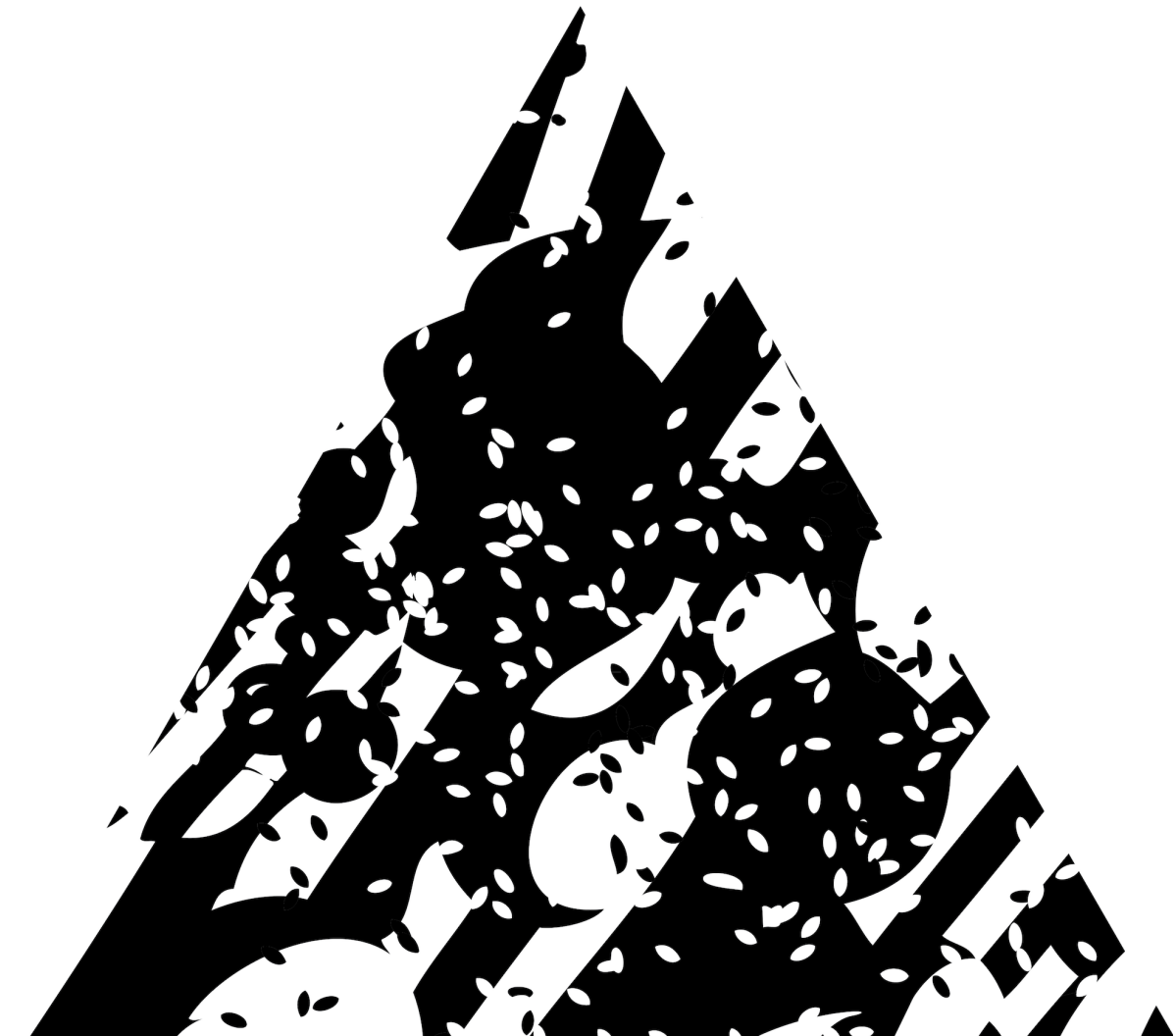
5.8 Conclusion

In a process similar to that when video was introduced into the dance field, contemporary audiences are currently learning new ways to 'read' motion-captured images of dance effectively. By grounding *the dancing-drawing body* in the metaphor theory of Lakoff and Johnson, I have demonstrated that the reasons this imagery is so appealing may to a significant extent be explained by its compelling correspondence to our proprioceptive awareness of moving through the world.

In the artistic projects described in this chapter, I illuminated the powerful metaphor at work that has permeated choreographic and notational practices, a metaphor I propose to call the *dancing-drawing body*. This metaphor uses a drawing instrument that traces and marks out space as the source domain to make explicit a view of the dancing body as something that is both able to draw and to leave traces behind. Designed in accordance with this metaphor, digital renderings of dance confront one with the cultural heritage of the history of Western dance notation. The aesthetics of the linear traces of dance that can now be navigated in two-dimensional planes and three-dimensional space still recall the dance notation Feuillet created in the 17th century, which displayed floor pathways of dancers in combination with a music bar at the top of the page. While these first notational practices planted one of the first seeds, it was in response to the motion capture experiments at the end of the 19th century by pioneers such as Eadweard Muybridge and Etienne-Jules Marey that the belief that empirically based movement capture would hold the key to an ultimate truth about the nature of human movement started to gain ground.

A closer look at contemporary dance capturing practices still reveals glimpses of this idea as a supporting belief. And indeed, even if many features of dance get lost in translation, motion capture offers opportunities to create new worlds through which one may start to know dance differently: artistically, by creating new phenomenal images of dance; analytical-

ly, by gaining insight into spatial and rhythmical patterns; and gesturo-haptically, by offering the radical opportunity to re-enact movement through mapping it onto other bodies.



Chapter 6

Breathing Matters: Breath as a vital feature of dance knowledge

> For the breath is the mysterious great master who reigns unknown and unnamed behind all and everything — who silently commands the function of muscles and joints — who knows how to fire with passions and to relax, how to whip up and restrain — who puts the breaks in the rhythmic structure and dictates the phrasing of the flowing passages — who above all this regulates the temper of expression in its interplay with the colourfulness of rhythm and melody.
> — Mary Wigman, *The Language of Dance* (1966)[101]

This chapter directs attention to the opportunities that lie in acknowledging and articulating embodied and 'tacit knowledge',[102] in order to conduct new research that responds to the interest and curiosity in dance in areas dealing with corporeal computation and the digitally enabled re-realization of movement. In the foregoing I have contextualized and evaluated the implications that motion capture technologies have for the mediation and transmission of dance performance. In this sixth and final chapter, I substantiate my claim that digital capturing technologies *stimulate* an expansion of what is considered as dance knowledge by turning the spotlights on the performative knowledge of dancers — in which a specific role is being reserved for the *breath*.

Over the past three decades, the emergence of dance studies as an autonomous field of research has coincided with critical turns that have firmly directed the attention to practice, embodiment and (kinesthetic) experience.[103] Often referred to as 'the body as archive',

[101] Quoted in Louppe (2010, 54).

[102] The term tacit knowledge was introduced by Michael Polanyi (1958). Polanyi further elaborated his use of the term in *The Tacit Dimension* (1966). See Chapter 2 for a discussion of Polanyi.

[103] Three examples of relevant recent publications in this area are Foster (2011), Reynolds and Reason (2011) and Spatz (2015).

the embodied, mnemonic role of the dancer's body has received significant attention in dance studies.[104] At the same time, many features of the 'procedural' or 'performative' expertise of the dancer continue to receive scant attention.

How technological design affects corporealities is a topic that is gaining relevance in the current cultural moment, which can in part be defined by the widespread use of digital capturing tools that enable 'lifelogging' and 'quantified selves',[105] such as smartphones, laptops and other devices. This development has sparked a multitude of practices, so much so that it has become impossible to imagine everyday life without them. While they are primarily concerned with capturing and measuring physical and physiological features, these practices also inevitably restructure ways of seeing and understanding dance.

The critical evaluation of the abstraction and reduction of the dancing body that are part of its digital transfer into data, has as yet gained little notice. I have made clear in Chapters 3, 4 and 5 that this topic requires further inquiry. In fact, I believe that questions emerging in this research area will represent some of the most pressing tasks for the field of dance studies in years to come. In this chapter, I zoom in on this topic from a specific angle. In doing so I specifically build on observations I have made in Chapter 1 on dancers' experiences with transmission practices. I argue that, in response to digital capturing technologies and the specific challenge they generate to 'make data speak', breath is emerging as a particular topic of interest because of its potential to relate physical movement to intentions, emotions and other layers in the semantic realm of performance.

In this chapter I open up a new line of inquiry that I consider to be an exciting avenue for future research in this area. Research into the role of breath in dance performance not only leads to deeper insight in the performative knowledge in dancers. The study of breath may also be instrumental to strengthen bridges between research areas such as dance studies and computer science. In order to set the stage for such a future inquiry, I draw on a wide range of sources that are concerned with *the relationship between performance and respiration*. I take my inspiration from Luce Irigaray's philosophy of breath, draw on breath studies in dance and somatic practices and examine relevant case studies in the interrelated realms of dance, performance, film and HCI design.

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[104] Three examples of the many publications in this area are Baxmann (2007), Lepecki (2010) and Stalpaert (2011).

[105] For a comprehensive overview of lifelogging that covers its research history, current technologies and applications, see Cathal Gurrin, Alan F. Smeaton, and Aiden R. Doherty (2014).

6.1 *The Forgetting of Air*

Breath has become a key topic in the work of Belgian philosopher and cultural theorist Luce Irigaray, the influential author of writings on ethics and sexual difference. The beginning of Irigaray's philosophical exploration of breath is marked by *L'Oubli de L'Air chez Martin Heidegger* (1983), translated as *The Forgetting of Air in Martin Heidegger* (1999), part of a series that was devoted to the elements water, earth and air. 'It was only with Heidegger's and Irigaray's theories,' Slovenian philosopher Lenart Škof reflects on the book's importance, 'that we started to be fully and radically aware of the meaning of our being oblivious to the notions of being and breath in our history' (2015, 3). By pointing out the importance of breath, Irigaray aims to draw awareness back to the body. By redirecting the attention to embodied experience, Irigaray joins in the often-expressed critique of the logocentric bias of Western thinking. However, rather than merely articulating this critique, Irigaray has come to conceptualize breath as essential for an embodied ethics of difference. Awareness of breath, Irigaray says, offers the possibility 'to attend to our own bodies and the bodies of others, to animals, nature, other cultures, oppressed minorities, and the other of sexual difference' (Bloomsbury 2013). Breath is vital for human existence and is in constant flux. At birth, a baby is given breath, is given inspiration, but at the same time people can never hold on to breath, it cannot be appropriated and kept to oneself. Breath is necessarily shared with others. Irigaray recognizes this 'giving-sharing one's breath' as an ethical gesture that offers a fundamental possibility for compassion and understanding. In her essay "A Breath that Touches in Words" (1996), Irigaray considers the relation between breathing and speech. She identifies speech as a phenomenon that, in Western society, is favored over listening and silence. Speech represses breath and draws the attention away from the embodied reality of beings. Irigaray argues that this actually puts lives at risk:

> Speech, instead of bearing breath, takes its place, replaces it, which invariably stifles and preoccupies the place for silence. People who pay no heed to respiration, who breathe poorly, who are short of air, often cannot stop speaking, and are thus unable to listen. (…) It is, therefore, important to reflect upon the fact that a language, spirituality or religion that is founded on speech, yet pays no need to the silence and breath making it possible, might well lead to a lack of respect for life; for one's own life, for the other's life, for others' lives. (Irigaray 1996, 122)

To incite a reflection on the potential of silence and breath, Irigaray has proclaimed *le temps du souffle* ('the age of the breath'), which can be understood as 'a spiritual shift in human awareness to the needs of the other figured through breathing' (Bloomsbury 2013; Irigaray 2004). The age of the breath means a commitment to the body and the senses and involves 'a process of accepting and sharing vital energies of the cosmos' (Škof 2015, 148).

When Irigaray's thought is considered from the perspective of dance studies, the dancer would seem the incontestable heroine of the age of the breath. Irigaray's philosophy certainly destabilizes the established prejudice about the dancer, namely that being a *non-speaking* performer represents a challenge rather than an advantage. Following Irigaray, a radically different perspective on dance performance becomes apparent. In this view of dance it is precisely the absence of speech that inspires mutual respect, an appreciation of the body and the senses, and a 'giving-sharing' of vital energies. Breath, then, is foregrounded as a powerful aspect of the exchange between dancer and audience. In appreciating the core of Irigaray's writings, the fundamental possibility that is offered by this exchange is nothing less than a cultivation of humanity, or, perhaps more comprehensively put, a cultivation of *being*.

6.2 Why does breath matter in dance?

Despite its crucial role in dance performance, breath has relatively seldom been considered a principal topic within dance studies. This is remarkable, because breath has various functions in dance and often figures as the foundational element of specific techniques and practices. Following Irigaray's notion of 'the forgetting of air', the under-acknowledgment of breath can be understood as a result of the problematic position of bodily practices in Western academia, which has long been permeated by logocentrism. This deep-rooted focus on the expression of speech and written language has concealed the strength of the body as a meaning-producing force. This focus has also been apparent in traditional dance studies, as has been observed by Susan Foster.[106] The dominance of propositional ways of knowing in scholarly research has not been conducive to the study of the corporeal-experiential realm of the dancer, including the ways in which breath functions in performance. The following overview should by no means be understood as exhaustive, but serves to provide principal reference points for further research in this area. It gives an impression of the chief insights into the question: Why does breath matter in dance?

[106] See for instance Foster (1995, 15; 2011, 7).

In many long-established bodily practices, breath takes a central position. In hatha yoga, breathing exercises (*pranayama*) are of equal importance to the practice of postures (*asana*). The rising and falling sensation of the breath is the primary focus of Buddhist meditation. In Eastern martial arts and related practices, such as Aikido, Kendo, Wushu and Chi Kung, breath is used to create a correct state of mind and body, to focus strength. The continuous flow of breath is used as an instrument that supports the anticipation of the opponent by facilitating a *moving together with* an opponent. In Japanese performance traditions, such as Noh performance, but also in the more recent Butoh, specific breathing techniques are used. Indeed, Sreenath Nair notes in his book *Restoration of Breath* that the 'fundamental approach to breath in relation to the psycho-physical energy level of the body is the basic method found in many systems of actor training available in some of the traditional performance forms like Kathakali, Kudiyattam and Noh' (2007, 63). Louppe points to the influence the 'pneumatic thought of the East' has had on Western dance practice: '[I]n all phases of its history contemporary dance has, in a reflexive or remedial way, called upon the great Eastern or Mediterranean techniques in which breathing represents, physically and metaphorically, the source of any search for the self' (2010, 57).

This notion of the 'pneumatic body' was also present in the work of Antonin Artaud, whose systematic reflection on the actor's use of breath is one of the most prominent examples of the acknowledgment of breath as a vital element of physical knowledge within Western performing arts traditions.[107] 'Thus with the wetted edge of the breath the actor carves out his character,' writes Artaud in *The Theatre and its Double*, conjuring up a metaphorical image of the breath as a weapon of combat ([1938] 1958, 137). An important clue that explains the meaning of Artaud's breath-oriented body emerges from the analogy he draws between the lungs and the brain. Both of these organs, says Artaud, either act unconsciously or can be directed by the will:

> We can keep ourselves from breathing or from thinking, can speed up our respiration, give it any rhythm we choose, make it conscious or unconscious at will, introduce a balance between two kinds of breathing: the automatic, which is under the direct control of the sympathetic nervous system, and the other, which is subject to those reflexes of the brain which have once again become conscious. (Artaud [1938] 1958, 21).

[107] See in particular the sections "Theatre and the Plague" and "An Affective Athleticism" in Artaud ([1938] 1958).

The analogy of the working of the brain and lungs is a compelling way of empowering performers, because it makes them aware that they are in charge and have the capacity to unleash their bodily potential through their breath. The lasting influence of Artaud's work remains visible in recent work on the subject of the role of breath in expression, such as Brandon LaBelle's *Lexicon of the Mouth* (2014), which describes how gasping, grunting and sighing give shape to expression and are created by breath: 'Controlled breathing allows for directing intensities, and grunting appears as a sonic register of this, where the energy of breath is held in the lungs until the optimal moment of release and attack' (78).

As many dancers will answer when asked: In dance, *the breath is everything*. In Chapter 1, I discussed the interviews I conducted with dancers of the Rosas dance company on their practices of performance and transmission. These interviews illustrated the various ways in which dancers use breath: as a means to sustain rhythm and strength, to support synchronicity and communication between dancers, as an instrument to shape movement qualities, to avoid mechanical repetition of dance phrases, and to give 'color' to their movement.

Indeed, the work of many prominent choreographers is entangled with a specific understanding of the use of the breath. In Martha Graham's work, the key principle of contraction and release in dance phrases relates to the inhaling and exhaling of breath (Freedman 1998, 56). Russell Freedman notes that Graham's approach 'has much in common with the Eastern way of thinking about the body' (1998, 123). Freedman quotes choreographer Willy Tsao, founder of Hong Kong's pioneering City Contemporary Dance Company, who observes that

> 'a Graham contraction is similar to the Chinese *chi-gong*, or breath-exercise, which is the foundation of the Chinese martial arts and also comes from deep inside the gut. The Chinese practice of *chi* is more internalized and less dramatic than a Graham contraction (…) but they are both ways of harnessing a person's inner energy.' (Freedman 1998, 122-123)

Breath is also a central element in the teaching of modern dance icons such as Mary Wigman and Doris Humphrey.[108] Sally Banes notes that for Humphrey: 'the breath pulled the body

[108] The quote at the beginning of this chapter gives a taste of Wigman's eloquent writing on the subject.

out of two possible kinetic and symbolic "deaths" — the stable positions of standing upright and lying down — into fall and recovery, creating an asymmetric arc' (1987, 4). In Limón technique, breath is emphasized as a motivating force. Suzanne Youngerman explains how this emphasis distinguishes Limón from ballet as a dance technique: '[A] leg extension to the side, for instance, might be done in ballet with the goal of reaching as high a point as possible, whereas for the Limón dancer the intent would be for the leg to travel only as far as the forceful impulse of the breath would send it' (Youngerman 1984, 117). Laban's design for a comprehensive movement analysis system recognized breath as a connective force that supports the connection between the physiological and expressive qualities of the body. Laban believed that 'motion and emotion, form and content, body and mind, are inseparably united' (Laban 1974, vii in Youngerman 1984, 117).

In the exchange between choreographers and dancers, the breath is often used in a sense that is simultaneously physical and metaphorical. For instance, dancers are invited to 'breathe life' into their movement phrases, a metaphor that emphasizes the entwinement of the meaning-making and life-giving qualities associated with breathing. At other times, breath plays a role in more complex metaphorical images, which may help dancers to imagine and explore movement beyond their familiar range of motion. This breath-imbued imagery is abundantly present in many somatic practices and movement techniques that are used to support dance practice, such as Alexander technique, Skinner releasing technique and Feldenkrais.[109] In these and other somatic practices and techniques, breath has also often been identified as an essential connecting force between inside and outside. The dynamic connection between inward and outward experience that is associated with breathing also characterizes the work of breathing therapist Ilse Middendorf,[110] who wrote: 'Breath is a connecting force. It creates a bodily equilibrium and balance and helps us to make inner and outer impressions interchangeable. It connects the human being with the outside world and the outside world with his inner world' (Middendorf 1995, 77).

[109] For an outline of the historical development of somatic movement practices, specifically as they relate to dance, dancers and dance education, see Eddy (2009).

[110] Ilse Middendorf founded an Institute for Breathing Therapy in 1935. Middendorf was particularly influenced by Mastanang, a Tibetan movement system that aims to interrelate body state and mind through specific breathing exercises. For an interview with Middendorf see Beringer (1995).

6.3 *My Breathing is my Dancing*

An example of a performance by Rosas that explicitly positions breath at the core of dance performance is the recent piece *My Breathing is My Dancing* (2015). The piece was created during a nine-week residency that ran parallel to the exhibition *Work/Travail/Arbeid* at the gallery space WIELS in Brussels in spring 2015.[111] Aptly described by Rosas' website as 'an elegant study on motion from breath to space', the piece is performed by a flutist and a dancer (Rosas 2015) (fig. 43-44). Breath is rendered audible by a flutist, who performs parts of *Opera per flauto* by Salvatore Sciarrino.[112] The dancer — De Keersmaeker herself — dances 'in the steps of the flutist's breath' (Rosas 2015).[113]

As in the large-scale performance exhibition *Work/Travail/Arbeid*, which ran parallel to the creation process of this piece, in *My Breathing is My Dancing* the audience could move around freely in the gallery space. There were no seats for the audience, nor was there any indication of the position the audience was supposed to take. Indeed, when I went to see the performance, members of the audience often stood or sat in close proximity to the flutist and dancer. There was no guarantee that spectators would not eventually end up in De Keersmaeker's trajectory, and in fact this happened quite frequently.

A result of this proximity and shared space was that the conventional spectator-performer divide of 'watching and being watched' was blurred. This divide seemed to be partially lifted and transformed into a shared complicity. As Marie Pons remarks in her review of the performance: '[C]'est là la vraie force de cette proposition, à faire place à l'humain, aux sourires, à la proximité physique. Une connivence s'établit avec les spectateurs, non sans cabotinage'[114] (Pons 2015). This complicity (*connivence*) among the spectators is induced by De Keersmaeker who subtly yet deliberately changes course, at times physically confronting and provoking audience members. Will they move out of her way or not? And if not, what

[111] The primary piece that was made and performed in the WIELS gallery in this period was *Work/Arbeid/Travail* (2015), a performance based on the choreography of the much-lauded *Vortex Temporum* (2013). The performance exhibition *Work/Travail/Arbeid* ran in WIELS from 20 March to 17 May 2015.

[112] The works that were performed by the flutist as part of the performance were: Salvatore Sciarriono, *Opera per flauto* ('Immagine fenicia' and 'All'aure in una lontananza') and Johann Sebastian Bach, *Partita for flute* ('Allemande').

[113] The flutist was Chryssi Dimitriou. No recording of the performance *My Breathing Is My Dancing* was available for consultation at the Rosas dance company as of May 2016.

[114] 'To create space for the human, for a smile and for physical proximity is the true strength of this proposal. A complicity is established among the spectators, not without a sense of drama.' Translation by LK.

Figure 43. Rosas, *My Breathing is My Dancing* (2015). Dancer: Anne Teresa De Keersmaeker. Flutist: Chryssi Dimitriou. Photo: Anne van Aerschot.

Figure 44. Rosas, *My Breathing is My Dancing* (2015). Dancer: Anne Teresa De Keersmaeker. Flutist: Chryssi Dimitriou. Photo: Anne van Aerschot.

will their encounter look like? Pons observes on one such encounter: '[De Keersmaeker] ne manque pas de pousser gentiment du passage une spectatrice qui persiste à se trouver systématiquement sur son trajet, en écartant les bras en signe de protestation'[115] (2015). In this way the dancer-choreographer continues to test the invisible limits of the space of the dance. How much space does this dance occupy? And how much distance does a spectator need to watch the dance? The performance revealed — perhaps not surprisingly, but still spectacularly — that this space had to be continuously re-negotiated. Spectators responded in different ways. Some remained standing right next to De Keersmaeker as she danced in one spot. Her flowing pants revealed one bare leg; a leg that is slender as well as compactly muscled. Other spectators gave her ample room, quickly moving away as soon as she started heading in their direction. This prompted a heightened physical awareness of the spectators, who became very conscious of their own attitude. Spectators of *My Breathing,* then, could never 'merely watch', they could not escape from performing, from dancing along *themselves*.

In *My Breathing is My Dancing*, De Keersmaeker employs her idea of a 'stepping phrase', which is a 'phrase that literally transposes, step by step/ note by note, the rhythmic aspect of the music with which it appears. It is a way to "walk" or "step" the music, rendering it visible or inscribed on the floor by movement' (De Keersmaeker et al. 2013, 186). *My Breathing* thus revisits the piece *En Atendant* (2010) which abounded in the use of the stepping phrase. It also returns to the coupled principle of 'Mickey-Mousing' in Rosas. Mickey-Mousing is described as 'the principle of literal transposition of music into dance (…) it indicates whichever way of maintaining a correspondence between what the spectators can hear in music and see in movement (De Keersmaeker et al. 2013, 186). In *My Breathing*, the tones of the flute have a clear relationship to the breath of the flutist. The swirling sounds of the flute performance of Sciarrino — which varies greatly in color, frequency and amplitude — work as a focalizer for the audience to read the phrasing of De Keersmaeker's dance.

When the flute stops, the musician comes to a standstill. De Keersmaeker continues her dance in silence. This moment in *My Breathing* mirrors a device also employed in *Partita 2* (2013). *Partita 2* starts with a magnificent violin solo in a completely dark auditorium and then, when the stage lights come on, it continues with a duet in silence (by De Keersmaeker and Boris Charmatz). Like in *Partita 2*, in *My Breathing* the memory of the music — its

[115] '[De Keersmaeker] does not shy away from gently pushing aside a female spectator who persists in systematically placing herself in her trajectory, spreading out her arms in protest.' Translation by LK.

melody, its color, its energy — continues to linger in the space and in the ears of the spectators. This temporal juxtaposition of dance and music invites the spectators to sharpen their senses and share in the focus of the dancer. When the flute stops and the silence arrives, De Keersmaeker continues to dance: Tentatively at first, as if trying to pick up on the breath that still reverberates in the space, but no longer carries the music. Then her dancing becomes more energetic. The Rosas' vocabulary is unmistakable. There is the running, the walking, the jumping. There are the extended arms and legs swinging in the air. But, as always, De Keersmaeker's dancing stays far from becoming completely airborne. While there is definitely elegance, focus, precision and refinement, it is never the detached ethereality associated with ballet. A Rosas dance makes a connection with the ground that is at the same time dynamic and firm. It is a connection that is perhaps best exemplified by a signature element of Rosas' dance technique: When dancers make a step, it is never the toe that first touches the ground, it's *the heel of the foot* that is firmly *planted into the ground*. In fact, this is an element that many dancers new to Rosas technique have to learn to get used to (Van Wissen 2014). This focus on the heel is the element in Rosas' technique that can be understood as fundamental to the principle 'my walking is my dancing.' Moreover, the planting of the heel in the ground is also a movement that symbolizes the headstrong quality of Rosas' aesthetics.

'My walking is my dancing', 'my breathing is my dancing', 'my talking is my dancing', 'my watching is my dancing': These are all examples of choreographic principles in the shape of maxims that have, over the years, surfaced in different articulations in De Keersmaeker's work. She has been effective in making use of these short but powerful sentences in which verbs stand as nouns (gerunds) in an is-sentence, which triggers an aphoristic effect. In these brief, equative clauses one gerund functions as subject ('walking') and the other as complement ('dancing'). The repetition of the possessive pronoun 'my' emphasizes the personal dimension of the phrase. The repetition of the 'my + gerund' construction in an equative clause provokes reflection: Can one imagine a correspondence between *dancing* and *walking*?[116]

[116] I derive the linguistic terminology I use here from Virginia Tufte's book *Artful Sentences: Syntax as style* (2006). In her explanation of the effect that short sentences can trigger, Tufte notes that equative clauses that follow a *be*-pattern ['is-sentences'] can have an aphoristic effect (12). Tufte also points out that '*Ing* verbs that hold down nominal slots, the very useful gerunds, retain also some of their action-giving, verb-like qualities' (71). Both these observations support the explanation of the powerful effect of De Keersmaeker's phrases such as 'My walking is my dancing'.

Perhaps these sentences are best called *choreographic vignettes*, as they draw attention to the core concepts of De Keersmaeker's perspective as a choreographer. For example, she has used 'my walking is my dancing' to explain that the basic choreographic principle that underlies the movement material in *Fase* (1982) is walking. She introduced 'my watching is my dancing' to explain the importance of dancers watching others dance. The intensity that this principle adds to the expressive force of a performance was first noticeable in *Elena's Aria* (1984). However, De Keersmaeker has never before elevated such a choreographic vignette to the title of a piece, as with *My Breathing is My Dancing*. This underlines the importance De Keersmaeker attributes to the breath as a core element of dancing. It also points to the position of this work as an example of De Keersmaeker's ongoing reflection on choreography, on dancing and on the relationship between music and performance. Indeed, if anything, artistic inquiry is a fundamental aspect of the piece. In this regard it recalls *Violin Phase*, the piece that was developed by De Keersmaeker during her studies at the Tisch School of the Arts in New York in 1981. *Violin Phase*, which would later become part of *Fase*, has been described by De Keersmaeker as the piece in which she taught herself to dance (De Keersmaeker and Cvejić 2012). If anything, *My Breathing* demonstrates that this process has never ceased, but only expanded. By continuing to teach herself to dance, De Keersmaeker teaches others.

As a result of its minimal yet powerful setup, *My Breathing is My Dancing* triggers an intimate awareness of the breath as a reverberating, vital energy that binds and attunes performers to audience members. The performance is imbued with a deep sense of sharing, which sparks a *respirational empathy*.[117] De Keersmaeker transforms the pure joy she emanates when dancing into a generous gesture towards spectators. It is a gesture that seems to say: 'Look, this is how movement is turned into dance. Do you think it looks simple from up close? I assure you, *it is not*.' *My Breathing is My Dancing* thus takes the spectators along in a sense of wonder about what emerges when De Keersmaeker's minimal conditions *for dance to happen* are there: Walking, watching, talking and breathing.

6.4 Mediating breath

As has become clear throughout this thesis, motion capture currently plays a pivotal role in supporting a wide range of animation processes, as well as the design of HCI applications in thriving industries such as robotics, films and games. A central pursuit in this rapidly develop-

[117] I am indebted to Janice Ross for suggesting this term after reading an earlier draft of this chapter.

ing area of research is simulating or re-creating life-like movement. Although motion data may still be understood as an indexical trace of captured performance, processes of corporeal computation necessarily entail a radical abstraction of the complex embodied phenomenon of a moving performer. When motion data are used to make other bodies — both virtual and real — move, the challenge is to render motion data in an effective and convincing way. Movement that is re-created in this way is ideally expressive and *believable*. This complicated pursuit has triggered a novel interest in the nature of expressive movement. Computer scientists, engineers, animators, digital artists and others involved in these creative industries express much interest in the body of knowledge that is harbored by dance and performance traditions. Computer scientist Michael Neff has explained the main reasoning behind this interest as follows:

> The performance literature defines what issues the computer animation research community must pay attention to if it wants to create effective tools for producing engaging, rich, nuanced expressive characters. Simply put, the performance literature defines the problem we as computer science researchers are trying to solve and provides part of the solution. (Neff 2005, 51)

The urgent demand for such meaning-making frames is also evidenced by the widespread — and sometimes haphazard[118] — appropriation of Laban Movement Analysis and Labanotation as conceptual frameworks to support the analysis, recognition and re-creation of gestures, emotion and movement qualities.[119]

In order to grasp the implications of motion capture and wearable physiological sensors as capturing tools for dance, it is important to differentiate between the ways in which various media conceptualize dance. How can an embodied dance feature such as breath be

[118] A Laban movement analyst and HCI-expert relates in an interview: 'I know that a lot of people who work with the Laban framework are not necessarily knowledgeable with the framework. So they sometimes take big simplifications and they actually don't measure what they are supposed to be measuring. So they mistake the categories. In a way they actually don't know what they're dealing with. A lot of computer scientists are trying to deal with movement that they do not have experience of or understanding of, so it becomes a big simplification or becomes misleading. I read so many papers that state that they measure the Laban effort, but what they measure is not the effort' (Fdili Alaoui 2015).

[119] The Moving Stories Research Partnership, for which Simon Fraser University acts as a host institution, is an example of ongoing collaborative research in which renowned Laban movement analysts and experts in the area of HCI design from the US and Canada have joined to research bridges between movement experience and digital technology design ("Moving Stories: Digital Tools for Movement, Meaning and Interaction" 2012).

mediated by these technologies? Video, the most-established capturing tool in the dance field, can make breath visible and audible, and thus, to a certain degree, provide useful insights into the kinesthetic basis of a live performance.[120] When researching how the subtle body movements of a performer in standstill may be used in an interactive dance/music performance, musicologists working at the *fourMs* motion capture laboratories at the University of Oslo found that '[m]icro-movements can be felt by the performer, can to some extent be seen by an observer, and can easily be picked up by a motion capture system' (Jensenius and Vadstensvik Bjerkestrand 2012, 7). Indeed, motion capture and wearable sensors are able to track breathing movements and transfer these movements into three-dimensional data trajectories. This yields a range of options to adapt and render these data into visualizations or to map these data onto other bodies or entities.

When considering the relationship between breath data and meaningful constructs of dance, such as movement qualities and other expressive features, breath data can be a source through which different types of 'inside movement knowledge' can be brought to the surface.[121] Such an approach would be in line with existing research, in which qualitative inferences are made based on motion data of the performer's gestures. Indeed, in experimental setups of interaction between performer and performance systems, the computation of breathing sounds has been used to facilitate the interaction of performers with generative performance systems. For example, HCI researcher Gregory Corness explored how by incorporating breath as part of a system's feedback, the interaction design could leverage the performer's sense of intuition, allowing for an expanded sense of connection and understanding towards the system, leading to synchronization, collaboration and trust during their interaction with the system (2013, 5).

Another example of the computation of breathing sounds in an interactive performance system can be found in research performed at the IRCAM institute in Paris. Bevilacqua made use of the breath as part of the 'gesture follower', which was discussed in Chapter 3: An interactive system that was designed to provide real-time feedback to dancers when they are performing a dance phrase (Bevilacqua 2007). A central motivation for a focus on breath

[120] For a research project that looks at dancers' experiences with watching video recordings of their own performance, see Ehrenberg (2012).

[121] I borrow the term 'inside movement knowledge' from the interdisciplinary research project with the same name that is reported on in the volume *Capturing Intention* (2007), edited by deLahunta.

in HCI is that breath is a physiological feature that is not only measurable, but is also considered to be closely related to the affective and semantic layers of performance.

6.5 Making motion more alive

Gaining awareness of the importance of breath is also of great importance to digital artists who are working on the animation of films and games. Adding or amplifying breathing movements may have a decisive impact on rendering the performance of a character compelling and life-like. This has also become apparent in the research project "How to Make Human Motion More Alive" (2013), in which Dutch software developer, dancer and movement analyst Sandra Hooghwinkel analyzes the movement expression of human characters in film animation. Hooghwinkel observes that characters with a realistic outward appearance, but a flawed movement signature run the risk of evoking an uncanny response in the viewer.[122] With regard to the role of breath in 'making motion more alive', Hooghwinkel writes:

> We 'say' a great deal with our breath and we perceive much about another person's mood and/or intentions by how they are breathing. Breath defines many things, for example life, emotion, phrasing and intent. (…) However, in most of the animated characters, breath is almost never shown. (…) Especially in motion capture movies I was amazed that so little breath is conveyed in the characters (…). (Hoogwinkel 54-55)

This observation is substantiated by Hooghwinkel's movement analysis of the character Jake Sully in James Cameron's celebrated movie *Avatar* (2009). As part of this analysis, Hooghwinkel uses the notion of breath support, 'which underlies and informs every part of human movement' in accordance with Laban movement analysis (Bradley 2009, 71). Jake comes across as a distant character. Even though his upper body is uncovered, he can hardly be seen to be breathing. However, eventually, a close-up shows him taking one deep breath (fig. 45). Hooghwinkel observes: 'This is almost a relief for me, since I then feel I can allow myself to release my own breath, which I tend to hold when watching Jake. This one breath suddenly

[122] Hooghwinkel supports the explanation of her findings with the notion of 'the uncanny valley', originally introduced by Japanese robot maker Masahiro Mori. In his article "The Uncanny Valley" ([1970] 2012), Mori describes the awkward feeling experienced when one is confronted with a perfect-but-not-quite-right looking animated character. Mori presents a model to explain the pronounced dip or 'valley' that appears when visualizing the relation between the human likeness of an entity against the perceiver's affinity or familiarity (*shinwakan)* for it.

Figure 45. Jake in *Avatar* (Cameron 2009). A close-up of the character during the scene where the viewer can see him take one deep breath.

makes Jake alive, too!' (40). Whether or not animated characters in films and games are allowed to take a breath, then, is a matter of design. The choices that directors and designers make will likely have a significant impact on the degree of empathy, sympathy and identification the viewer experiences in response to the character.

6.6 Breath and body states

The emergence of digital capturing technologies has also triggered a heightened interest in breath as a meaning-making dimension in dance practice. Recent experimental approaches of this topic have taken place in an area that combines input from arts and sciences. Breath sensors have become more available, affordable and less intrusive to wear. These sensors have been used in performances that explore the use of 'wearable technologies' to transpose the breath into visual and audiovisual output.[123]

An example of such a project is the wearable technology art piece *exhale* (2003-2005), which was part of the movement research project "breath between bodies" conducted at Simon Fraser University (Schiphorst and Kozel 2016). A central question of this project was: how can movement research based in performance and somatics be applied to design strategies for digital interfaces? In *exhale*, participants wear garments with an inte-

[123] For the use of breath sensors and other measurements of physiological parameters in interactive performance systems, see for instance Bevilacqua, Schnell and Fdili Alaoui (2010).

Figure 46. Breath sensing technology integrated in costumes for the performance *exhale*. Left. LED array embedded within fabric to display continuous breath data. Right: exhale breathband measures breath, while RFID tag enables breath exchange.

grated breath-sensor waistband (fig. 46). When several participants breathe simultaneously, the color and rhythm of the lights that are attached to their garments change accordingly.[124] Explicitly considering breath as a feature of performance, the researchers tried to relate specific tools of performance analysis, such as Laban Effort/Shape analysis to embodied computing and HCI. In this way, the project specifically searched for meaningful ways to transpose breath to a digital network set up through wearable technologies. Thecla Schiphorst points out how the work of neurophysiologist Antonio Damasio (2003) on the relationship between feelings and body states helps to grasp what is happening in *exhale*:

> [Damasio's] research suggests that these 'feeling' body-states are an interconnected set of feeling, thought, emotion and physiological functioning: each of these being present and affecting the other. He asserts that the induction of a body-state can be brought about through attention to *any* one of the interconnected patterns: so that attention to physiological patterning (for example breath) can induce a body state, or conversely, attention to other associated patterns, such as the occurrence of certain thought patterns can also induce the body state. (Schiphorst 2006, 178)

[124] Another example is the work of Myriam Gourfink who has used breath sensors and gyroscope sensors in the performance *This is my house* (2005), a collaboration with Frédéric Bevilacqua (Gourfink 2013).

The interconnectedness that is suggested by Damasio gives an important clue as to why breath is such an interesting phenomenon to focus on in technologically based exchanges. Because breath corresponds with physical movement, it can be captured and transposed into data by wearable sensors or motion capture technology. Furthermore, Damasio's notion of interconnectedness points to the possibility that these data may hold a bigger potential than merely capturing breathing aspects as part of a physiological state. Because breath is an element that is part of the interconnected set of feeling, thought and emotion, breath data may well be understood as indexical traces of these elements, which together constitute a body state.

A notable example of a performance work that can be understood as an almost clinical experiment in staging this interconnectedness is Antonia Baehr's performance *Un après-midi* (2003). The title and the performance itself cannot escape reference to the ballet *L'Après-midi d'un faune* (1912), the famous avant-garde piece by Vaslav Nijinsky, but this work is not officially listed as source of inspiration.[125] For each staging of *Un après-midi*, Baehr invites four performers who are not yet familiar with the performance. Without any form of rehearsal, they are given the task to go on stage in two couples and perform, as precisely as possible, pre-recorded directions that they listen to via earbuds. This audible score consists of detailed movement instructions.[126] Many of these cues direct the frequency and quality of the breath. Baehr's score essentially scripts physiological features that are linked to basic emotions. The effect of this setup is decidedly uncanny. Because of their focus on the score, it is challenging for performers to become aware of the specific emotions they are conveying. Audience members may therefore be quicker to recognize specific body states than the performers themselves. Anger, joy, surprise, fear and excitement all affect the dramatic situation unfolding between the two couples on stage. I read *Un après-midi* as a playful reflection on the 'modern aesthetic' that is attributed to the work of Nijinsky, which, as Susan Foster says, 'treated the body's movement as a kind of material substance, capable of being shaped and manipulated, even as [it] attributed this corporeal reality to a manifestation of the psyche' (Foster 1995, 13). It is precisely through the artificial disconnection of the

[125] For an overview of sources of inspiration and background information on the various stagings of *Un après-midi* (17 in the period of 2003-2013), see Make up productions/ Antonia Baehr (2013).

[126] Throughout the performance, the audience only now and then catches fragments of what the performers are hearing, which is enough to get a sense of the 'type' of instructions they get, but not enough to be distracted by a constant comparison between the score and the ways it is interpreted.

intention of the performer and the expressed emotion that *Un après-midi* so aptly demonstrates the inevitable entanglement of both.

6.7 Breathing machines

The interconnectedness that lies at the basis of body states also helps to understand why breath is such a rewarding lead in the continuing endeavor to design intuitive ways to relate to a continually expanding technological realm. This is shown by many examples of technological design that tap into the sensitivity to the perception of breathing movements, even when such movements are clearly mapped onto inanimate objects. An everyday example of such design is the way in which breath is suggested by the 'sleep mode' of a Mac laptop. The gently increasing and dimming of the LED light on the laptop imitates the rising and falling sensation of the breath. The even, rhythmical pattern of the light not only invokes a relaxed and calm body state. It also subtly invites users to embrace the computer as a *living being*, and accept it as an intelligent partner, which may function as an extension of themselves.

In another striking example, breathing movements are mapped onto a machine to suggest intelligence and trigger fear. The opening scene of Ridley Scott's *Blade Runner* (1982) features the Voight-Kampff machine, a polygraph-like machine and 'replicant' detector (fig. 47).[127] Replicants are genetically engineered creatures composed entirely of organic substance designed to look and act human. In *Blade Runner*, replicants are perceived as a dangerous threat and are hunted down by special human agents called 'blade runners'. Standing on the table that separates interrogator and suspect, the Voight-Kampff machine has bellows

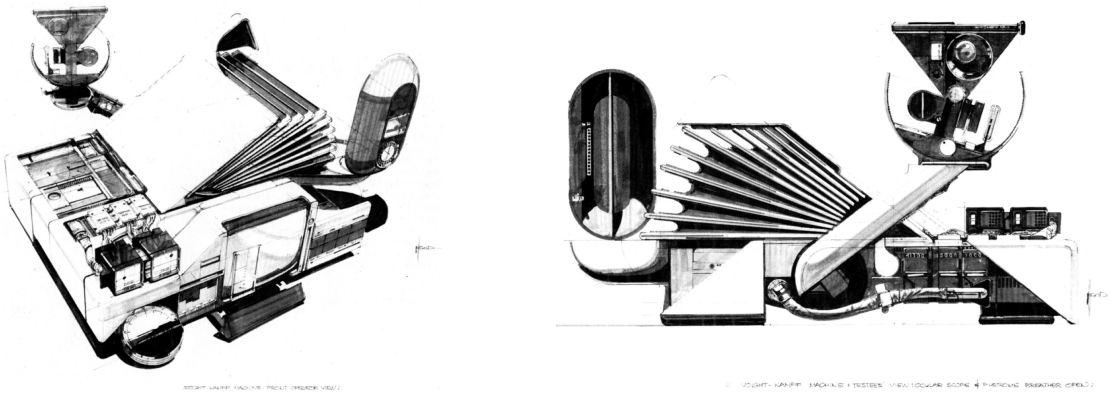

Figure 47. Design sketches for Voight-Kampff machine in *Blade Runner* (Ridley Scott 1982). From Blade Runner Sketchbook (Scroggy 1982).

[127] The Voight-Kampff machine was first introduced in Philip K. Dick's story *Do Androids Dream of Electric Sheep?* ([1968] 1996), on which *Blade Runner* was based.

that move in a breathing rhythm. The machine is able to sniff air samples to detect if a subject is nervous in support of its task to determine if a suspect is truly human. A publication of the sketchbook with the original production artwork for the film notes that 'Ridley Scott specifically wanted the unit to appear to breathe, hence the bellows. . . . This added to the "life-like" features of the machine, while underscoring its threatening nature' (Scroggy 1982, 51). Through its breathing bellows, the machine conveys the message to both humans and replicants that it is not to be provoked.[128] The Voight-Kampff machine can be interpreted as a cultural artifact that quite accurately premediates[129] the current interest of creative industries in the business of re-creating movement based on bodily expression.

6.8 Conclusion

The renowned breathing therapist Ilse Middendorf states that: 'Breathing is an original unceasing movement and therefore actual life' (Middendorf 1995, 77). It seems to be particularly this conceptualization of breath — breath as movement — that provides the main basis for emerging practices of breath capture and the re-creation of breath. In these practices, breath is mapped onto virtual, animate and inanimate bodies. These practices take advantage of humans' highly-developed sensitivity to perceiving bodily expression through the principle of interconnectedness of feelings and body states. The emergence of digital capturing tools can be understood as a stimulating force that fosters interest in embodied experience in performance, and thus opposes the commonly held view that digital technologies ignore the corporeal and the material in favor of the virtual. This claim is in line with Dee Reynolds' argument, which holds that digital technologies may in fact extend the boundaries of kinesthetic imagination:

> Where such work has a visceral impact and heightens kinesthetic awareness, I argue that it resists and critiques the de-corporealising effects frequently attributed to digital technologies. New technologies can thereby enhance the reflexivity of kinesthetic imagination, on which its critical resistive potential depends. (Reynolds 2007, 18)

[128] Ironically, in the opening scene of *Blade Runner* the replicant outwits the machine long enough to shoot down the interrogator with a hidden gun.

[129] The notion of 'premediation' was introduced by Grusin (2010).

Making sense of the streams of data that are generated by these devices is a difficult task. But it is exactly this challenge that encourages new investigations of performance techniques and that presents opportunities to articulate the corporeality of dancers in different ways.

The pursuit of this research area to 'make motion data speak' adds a new urgency to the understanding of the role of breathing in dance, for instance because animations of motion data are found to be more compelling when breathing movements are added or amplified. One reason for the focus on breath as a dance feature in HCI research is that breath, even though it is rather complex, is a physiological feature that is considered to be closely related to the affective quality of a performance. It seems that a sensory highlight of breath — be it auditory, visual or tactile — makes motion capture-based visualizations of dance performance easier to interpret. This observation can be confirmed when looking at an analysis of motion capture-based films in which explicit visualization of the breath increases the lifelike appearance of its characters.

This final chapter thus signals a fundamental shift in attention in dance studies, which may be boldly phrased by the following question: How can danced be imagined *from the outside in*, instead of *from the inside out*? The hypothetical image of the dancer as the uncontested heroine of the age of the breath – conjured up at the beginning of this chapter in response to Luce Irigaray's philosophy of breath – then acquires a new meaning and potential. In tandem with the search for intuitive technological design that is more and more attuned to corporeality, current artistic and scientific research invites a new appreciation and articulation of breathing as the key to intentions and intensities at the core of the dancer's expression.

Conclusion

The Motion Capture Imaginary

The event of the dancer's entrance in the motion capture setting gives rise to the central question of this thesis: How does motion capture invite us to know dance differently? Despite the growth of practices in this area and their significance for the contemporary debate on the impact of corporeal computation on the arts, sciences and society at large, this phenomenon has not yet been thoroughly investigated from the perspective of dance research and practice. My approach to this question is a discourse analysis that investigates the meaning of what I call 'the motion capture imaginary'. A media taxonomy enables me to address the complexity of this imaginary. This method allows me to perform a critical analysis of recent artistic and analytic experiments with the corporeal computation of dance. These experiments propose new ways of *making motion data speak*.

Motion capture practices in the dance field are not a mainstream phenomenon. However, the experimental work that is being done in this area spans an impressive range of purposes. Experimental research in this area opens up new views on art research, performance analysis, notation, pedagogy, documentation and the archive. I claim that the cultural significance of this phenomenon should not be judged merely by its size. Its impact stretches beyond its disciplinary boundaries. These practices connect with developments that are taking place in society on a much larger scale, such as the ever-growing sophistication of motion recognition and gait analysis; touchscreens and other haptic technologies; and finally, the analysis, visualization and application of big data. What these developments have in common is that they produce a type of knowledge that is not primarily based on *what people say or write*, but on *how people move through the world*. This is why I approach this topic from the perspective of dance. Dance offers a particularly valuable perspective on this topic because the development of strategies to deal with the interpretation and transmission of the dancing body in performance stand at the heart of dance practice.

In the introduction I briefly retrace the origins of the contemporary use of the term 'the imaginary' in cultural analysis to the areas of psychoanalytic theory (Lacan), phenomenological philosophy (Sartre) and social theory (Castoriadis). I then perform a discourse analysis of a wide range of texts and practices to analyze what meanings are produced by a specific cultural imaginary that informs the encounter of motion capture and dance.

A selective genealogy of dance knowledge underpins an identification of larger cultural-historical phenomena and contemporary strategies in which the emergence of these practices should be situated. The emergence of prototypes for sharing dance knowledge and the interest in performing arts coming from other research areas concerned with corporeal computation are two main developments that have occurred in the past decades. I argue that digitally enabled dance archives indeed benefit from a discussion of choreographic ideas, but that it is also rewarding to incorporate bodily strategies of dancers in relation to the choreography.

I show that efforts made in the area of dance heritage throughout dance history have laid an important basis for an epistemological approach of dance. I recognize such efforts in the work of Ann Hutchinson Guest and other experts in dance notation, but also in the development of dance studies as an independent academic discipline. I observe that William Forsythe's choreographic objects and digital scores can be recognized as a way to create a 'sustained reading' of dance. I point out that efforts that recognize the potential of digital technology in this endeavor share visual strategies that were already at work in A. Michael Noll's experiments at the Bell Labs in the 1960s and the LifeForms software which Merce Cunningham used as a choreographic tool in the 1980s and early 1990s.

I retrace important roots of this cultural imaginary by revisiting the photographic experiments of Muybridge in the late 19th century, pointing out that one of its basic features is an idea of movement associated with modernity: the idea that movement can be known by fixating it in time. The motion capture imaginary also promotes an understanding of the body through its reflection, which recalls Lacan's mirror stage. However, the three-dimensional basis of the motion capture image differs from a mirror reflection in that it provides an option that was long deemed utopian in the historical, pre-digital motion capture imaginary, namely to view the body not just from one perspective, but from a multitude of perspectives at the same time. Indeed, one of the key challenges in contemporary experiments with dance and motion capture lies in grasping the consequences of the simultaneous availability of these multiple perspectives. This all-encompassing scrutiny goes against the grain of a

conventional feature of the spatial organization of spectatorship in performance, namely: *frontality*. The absence of such a primary orientation through the three-dimensional gaze that characterizes the many-eyed apparatus of motion capture has an impact on the physical awareness of dancers, who report feelings of vulnerability and a heightened sense of performance once they enter the motion capture volume.

The motion capture imaginary informs a broad range of cultural phenomena. As I discuss in Chapter 6, this observation potentially opens up new avenues of research, both in dance studies and in areas that are concerned with HCI-related inquiries. The curiosity about dance knowledge from other fields that deal with questions related to 'corporeal computation' — such as film, gaming and robotics — gives rise to an impulse to articulate different features of dance knowledge. I argue that in addition to an articulation of choreographic knowledge, practices of corporeal computation invite a *conjoined* articulation of both choreographic and performative knowledge in dance.

Research into the possibilities of digital technologies such as motion capture allows one to ask new questions about dance. In order to present this data in a meaningful frame, such research will always require a correspondence between (quantitative) motion data and (qualitative) dance knowledge. Dancers point to the strong relationship between the breath and the expression of dance features. They *breathe with intention*. One of the Rosas dancers articulated the relationship of breath with her performance as follows: 'The breath communicates it is more than movement' (Penkova 2013b). Breath is clearly a key instrument for the dancer to express choreographic intention in physical movement. I mark breath studies as a promising research area for the design of intuitive technology that is attuned to corporeality.

One of the different modes of seeing and knowing dance which emerging digital dance prototypes entail concerns the paradoxical notion of knowing the dance from the 'outside in'. For a deeper understanding of emerging dance capture applications, and to anticipate paths they may be taking in future, I argue that we should take on new perspectives when reconsidering actual practices of dance transmission. What are the central issues that characterize these practices? What roles do media play as part of these practices? The fact that dance performance is usually not scripted or strictly tied to *one source only* —be it material or personal —, but rather conveyed and authenticated by multiple actors is a central issue at stake in such practices. These actors can be choreographers, dancers, rehearsal directors, producers, audience members, critics, etc. The role of the actor can also be played by various materials and media, such as dance notes, scores, interviews, video recordings,

films, photographs, publication material, etc. Each of these actors *performs* the dance in different ways, thus giving prominence to different features of the dance.

The impact of computational sensibility can be discerned in situations in which dancers and choreographers have themselves refrained from articulating any explicit interest in connecting dance with the digital realm. In other words, technologies also have an impact in places where they, at first glance, seem to be absent. There are several reasons for this. The increasing presence of motion capture technologies and other gesturo-haptic media has contributed to a shift in established notions of what is considered to constitute the core of dance knowledge. 'Making motion data speak' is in no way a challenge that is limited to experimental applications in the dance field; it is a central concern of human-computer interaction research in various commercial sectors. Industries such as film and games, motion recognition, security, surveillance and robotics are seeking to capitalize on the wealth of information and other opportunities that are present in the motion capture of bodies.

The re-realization of elements of the phenomenological experience of dance is a shared quality of many contemporary mediations of dance. Corporeal computation of dance can thus be said to be designed to a human measure. Indeed, I argue that the way in which people engage with motion capture technology is thoroughly rooted in and modeled by an embodied experience and embodied cognition. What people want from this technology, it seems, are two contradictory things: recognition and newness. Motion capture may provide an externalization of knowledge, a sensory referent of something people are already deeply acquainted with, but which they have never been able to contemplate in a representational mode existing separately of the mind-body. The experimental works I discuss are aiming to find the right mode, the right *rendering* to fit the experience of dance as a phenomenon. On the one hand, people look for something that *clicks into place* when they see it. On the other hand, these projects also seek newness. They aim to mediate dance in a way that people recognize, but also in a way that brings novel insights. Nevertheless, the body-to-body transmission process, which has been *the* model for sharing and passing on dance since time immemorial, will continue to serve as an important model for experimental motion capture applications. I believe that we will learn to read and interact with motion capture-based mediations of dance in increasingly different shapes and forms.

These developments in turn have triggered an interest in the specific knowledge about bodily expression that is present in performing arts practices, and in dance in particular. In dance, the body *is* the archive. Body-to-body communication in the studio is the un-

challenged 'golden standard' of dance transmission. A new task for dance research, as part of the larger project advocated by *A Choreographer's Score* to 'take dance seriously', may be found in the further investigation of the craftsmanship and 'dance knowledge' of the performer. Because of academic discourse's reputation of discarding the study of the corporeal-experiential realms that escape written description, this is not an unproblematic endeavor. Indeed, a core belief in dance practice is that the complexity of the combination of oral and kinesthetic communication cannot and perhaps *should* not be captured in writing. While writing may indeed be counter-productive as a tool in dance practice and may undoubtedly fall short in capturing complexities of performative knowledge, this should not make dance researchers refrain from further investigating the 'corporeal enunciation' of choreographic ideas. The embodied nature of this knowledge does not imply that it is wholly beyond the reach of the dancer's declarative abilities. Nor does the idiosyncrasy of the dancer's experiences necessarily result in an incoherent collection of subjective findings. However, if the explicit aim is to share and validate dance expertise with other areas of research — both in the arts and in the sciences —, it seems that it is especially this connection that could generate new insights. The recognition of the value of this dance knowledge *outside* the dance field, in its turn, has prompted an increasing awareness of the need to articulate performative knowledge at the heart of dance practice. Unlike choreographic knowledge, the 'know-how' or tacit knowledge lying at the center of this practice often remains under-represented in dance literature. In the dance field's efforts to make dance knowledge public, the important connection between choreographic ideas and performative knowledge can be a blind spot precisely because it is so self-evident to practitioners.

Another effect of the rise of gesturo-haptic media, in addition to a growing appreciation and theorization of performative knowledge, is a shift in how dance is imagined. This brings the dancer's breath into focus, because the breath essentially connects external movement with inner intention. The dancer's use of breath is an example of practical knowledge that is of vital importance for dance performance but that has been under-represented not only in dance scholarship, but also in computational and digital media for capturing movement. I attribute this phenomenon to the logocentric focus of its discursive tradition. This finally results in a question that I believe will be at the core of investigations in this area in the near future: How can dance be imagined from the *outside in* instead of *from the inside out?*

A promising avenue for future investigations in this area is a closer study of the motion capture imaginary as an explicit topic in contemporary art. It is striking that the entrance of the dancer into the motion capture volume can be identified as a recurring trope in works of recent years. An analysis of these works would provide more insights into the complex web of meanings associated with this imaginary. A striking example can be found in the oil-on-linen *Motion Capture Studio* painting series (2011-2014) by the Chicago painter Andrew S. Conklin, which portrays dancers and technicians in the grey cube of the motion capture volume (fig. 48). Since the motion capture studio is usually understood as a space that has the status of a *backstage,* there is a palpable friction between taking this *backstage* environment as a main subject and the status of the medium of oil painting in Western art history, which is associated with the depiction of grand scenery and dramatic events. Conklin's paintings present an intriguing analogy between the strategies of staging demanded by motion capture and the tradition of composition in Western figurative art. They draw attention to the particular arrangement of bodies and objects in an environment that primarily supports the production of digital motion data and animation in virtual realms. The incongruity between this subject and the medium of oil painting — the digital data endlessly manipulable, the oil painting unalterable, permanent — forcefully highlights the material reality of this environment.

Figure 48. Andrew S. Conklin, *Motion Capture Studio 03* (2013). Oil on linen, 36 x 48 in.

Figure 49. Leos Carax, *Holy Motors* (2012).

The trope of the dancer in a motion capture volume is increasingly present in film and related media. For instance, the film *Holy Motors* (2012) by Leos Carax stresses the absurdity, isolation and detachment of motion capture processes by introducing an actor who performs martial arts moves in a dark motion capture studio devoid of any other human presence, and in which only the point cloud of the optical markers on his suit illuminates the space (fig. 49). The rhetoric of these works often verges on the techno-apocalyptic, as is the case in the video installation *Factory of the Sun*, which was presented at the Venice Biennial in 2015 (fig. 50). *Factory of the Sun* shows a motion capture volume in which actors perform in the creation process of a video game in slave-like conditions. Their shiny, tight-fitting golden suits are at the same time spectacular and claustrophobic. However, the atmosphere shifts when the actors start to dance: 'the act of dancing represents the most playful form of resistance

Figure 50. Hito Steyerl, *Factory of the Sun* (2015). Contribution to the German Pavilion at the Venice Biennale.

for the young protagonists in their struggle against the supremacy of their invisible opponents' (Steyerl 2015).

This image of *dance as a site of resistance* against the fixation associated with motion capture offers another clue as to why it is helpful to approach the critical evaluation of these practices from the perspective of dance. The theme of dance as a performance of resistance is also present in the music video *Wide Open* (2016), a showpiece of the possibilities of contemporary visual effects and technologies such as photogrammetry, computer-generated imaging and motion capture (fig. 51). Set in a garage-like space, its concrete floor covered with blistering paint, the video presents a solo performance of a dancer whose body – to her own astonishment – transitions to a transparent, mesh-like structure (fig. 52). In one striking scene, the dancer observes herself in a mirror that not only shows her reflection – half-body, half-mesh –, but also reveals a double of her former 'whole' self behind her that is still intact. This second self briefly meets her gaze in the mirror, only to then vanish mysteriously. *Wide Open* ends on a less hopeful note than *Factory of the Sun*, as the dancer's disembodied body is rendered completely transparent and is frozen into standstill. The body in transition reconfirms the inevitable entanglement of body and technology and the impossibility to clearly distinguish between one and the other. It is impossible to determine where the one stops

Figure 51. The Xsens suit used in the creation process of *Wide Open* (2016). Xsens MVN (or MOVEN) is a full-body, camera-less motion capture solution that detects body movements via inertial sensors attached to the suit. It is a flexible system that can be used indoors or outdoors (on-set).

Figure 52. *Wide Open* (2016). Music video that resulted from a creative collaboration by the Chemical Brothers (music), Beck (lyrics), choreographer Wayne McGregor and dancer Sonoya Mizumo, the British visual effects studio The Mill London and the directing duo Dom&Nic.

and the other begins, or to tell exactly who is moving who. The indeterminacies encountered in an attempt to make sense of these processes trigger feelings of anxiety and wonder.

Inherently multi-layered, multi-modal and multi-authored, the entrance of the dancer into the motion capture studio constitutes a complex, but highly interesting cultural phenomenon at a time when motion recognition and haptic technology increasingly affect society at large. As this practice is located at the crossroads of so many divergent worlds, worlds created and supported by the arts, sciences and technology, it is no wonder that consensus on the 'rightness' of digital renderings of dance knowledge shifts — and will continue to shift — in accordance with the different beliefs and points of view that these worlds afford. Tantalizingly close, but always just out of reach, digital traces of dance shapeshift upon closer approach. Inevitably, as we set our eyes on these flickering motion traces, we continue to grapple with how they present the absence of the dancing body.

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Summary

The Motion Capture Imaginary: Digital renderings of dance knowledge

This thesis examines practices in which motion capture is used to record and visualize dance. It demonstrates that motion capture opens up new ways of seeing and understanding dance by taking the dancer's body as its main point of reference.

Optical motion capture is a technology that translates movement into digital motion data. Markers are attached to a tight-fitting motion capture suit or directly onto the skin. These markers reflect the infrared light emitted by cameras installed in a surrounding grid. The reflected light is transposed into digital motion data. The data describe the three-dimensional trajectory of the markers in submillimeter detail. Movement data can be modeled and navigated in a three-dimensional space. They can also become the source the movement of other bodies, both virtual and real. The quantitative aspect of motion capture data allows for detailed calculations that map how the body moves, thus providing the basis for fast-developing research areas such as robotics and motion recognition.

Motion capture practices in the dance field are not a mainstream phenomenon. However, the experimental work in this area spans an impressive range of purposes. I claim that the cultural significance of this phenomenon stretches beyond dance's disciplinary boundaries. These practices connect with other developments in society, such as the ever-growing sophistication of motion recognition and gait analysis; touch screens and other haptic technologies; and finally, the analysis, visualization and application of big data.

The recent shift towards taking choreographic ideas beyond the studio walls through the development of digital applications and environments has triggered many questions. A central question is produced by the complex design processes that are aimed at providing access to dance knowledge in digital formats: How to make motion data speak? Although

motion capture offers many creative and analytical opportunities, the technology produces specific constraints when it comes to the representation of the dancing body. Motion capture cannot but fixate an image of the dancing body. It radically reduces the complexity of its phenomenological wholeness. Despite this critique, movement data lying at the basis of highly complex calculations or phenomenological representations of dance may well generate new insights into the dancing body or expand habits of seeing and knowing.

This dissertation evaluates the implications of contemporary practices of digital dance capture. How is dance conceived of as a type of knowledge that can be transmitted? How does motion capture invite us to know dance differently? This dissertation introduces the notion of 'the motion capture imaginary' as a conceptual framework that interconnects various characteristics associated with ways of seeing and knowing dance through motion capture. The methodology consists of a discourse analysis of recent artistic and analytic experiments with the corporeal computation of dance. These experiments suggest new ways of making motion data speak. This analysis is supported by an interdisciplinary frame of reference, drawing on sources from dance practice, dance studies, performance studies, philosophy, film studies and computer science. The study uses a media taxonomy, which emphasizes that media do not exist in a technological realm separate from social and cultural practices, but that they are deeply entangled in these practices, and grow and develop in tandem with them. I describe my own research identity as that of a dramaturg-researcher. I analyze and communicate how meaning is produced in dance as performance practice, and thus support the larger endeavor of explaining the importance of such practices.

I argue that an inquiry into the recent emergence of notions of dance as knowledge is vital for understanding the encounter between dance and motion capture technology. What habits of seeing and knowing are embedded in contemporary practices of movement capture? What are the consequences of relying on these technologies to produce new bodies of dance knowledge? What dance features are highlighted and what features escape notice as a result of these mediations?

In Chapter 1, I examine the culture of transmission of the choreography *Rosas danst Rosas* (1983) by the Belgian dance company Rosas. The transmission practice is studied through in-depth interviews with dancers, recordings of the performance, the film version of the performance by Thierry de Mey, and various literatures. Specific attention is paid to the multimodal publication *A Choreographer's Score* (Cvejić and De Keersmaeker 2012). The

chapter provides an insight into key issues in dance transmission practice and thereby informs the discussion in subsequent chapters, in which related issues resurface.

In Chapter 2, I position the encounter between motion capture and dance in the current discourse around 'dance knowledge', which is a recurring notion in recent dance documentation projects. Contemporary dance practice is increasingly recognized as a 'knowledge-producing endeavor' (Leach 2013). I examine William Forsythe's notion and application of 'choreographic objects' to understand this trend. I trace the roots of this development back to the work of Michael Polanyi, who introduced the notion of the 'tacit dimension', the unarticulated dimension of intelligence that shapes speech, writing and the approach to science.

Chapter 3 presents an overview of practices that employ motion capture in dance research and practice. It maps the main issues and concerns in the debate on motion capture and dance. I discern two characteristics of motion capture as apparatus in these practices: its remediation of video and its indexical referentiality. The chapter includes analyses of the digital tools *Noh Composer* (Oshita et al. 2013) and *TWO* (Hauert, Miller and Motion Bank 2013), a digital score of the improvisation strategies of Thomas Hauert/ ZOO company.

Chapter 4 shows how the experiences with performance capture in the film and game industries can be made productive in the analysis of contemporary practices of dance capture. It includes a comparative analysis of actors and dancers in the motion capture volume. I analyze the motion capture-based dance performance *Emergence* (McCormick and Hutchison 2014) and the solo dance performance *meta* (2014), which is a reflection on a dancer's experience of performing *with* motion capture.

Chapter 5 investigates the origins of the convention to visualize dance motion data in graphic, linear traces. This imagery invites the viewer to imagine the dancing body as an instrument that draws lines while moving. I approach this as a conceptual metaphor (Lakoff and Johnson 1980; 2003), which I call the *dancing-drawing body*. I analyze works by Lesia Trubat, Nancy Stark Smith, Motion Bank and Deborah Hay, OpenEndedGroup and Gibson/ Martelli. Each of these examples provides a different perspective on how knowledge about the bodily basis of cognition can be digitalized.

In Chapter 6 I argue that the study of breath in performance can 'make motion data speak'. I return to the work of Rosas when I discuss the performance *My Breathing Is My Dancing* (2015). I examine various case studies that deliberately incorporate breath as movement to affect specific body states. Inspired by Luce Irigaray's philosophy of breath, I

argue that breath is a rewarding lead in the continuing endeavor to design intuitive ways to transmit dance knowledge in the expanding realm of corporeal computation.

This thesis demonstrates that motion capture-based renderings of dance are characterized by ongoing efforts to articulate less-explored dimensions of dance knowledge. I argue that these practices foster an interest in embodied experience in performance and I oppose the view that digital technologies ignore the corporeal and the material in favor of the virtual. People's engagement with motion capture technology is deeply rooted in and modeled by an embodied experience and embodied cognition. I demonstrate that motion capture can provide an externalization of knowledge, a sensory referent of something people are already deeply acquainted with, but which they have not been able to contemplate in a representational mode that exists separately of the mind-body. The process of making sense of motion data streams encourages new investigations of technique and knowledge transmission in performance and presents opportunities to articulate the corporeality of dancers in different ways.

In addition to a growing appreciation and theorization of performative knowledge, another effect of experiments with motion capture in the dance field is a shift in how dance is imagined. This brings the dancer's breath into focus, because the breath essentially connects external movement with inner intention. The dancer's use of breath is an example of practical knowledge that is of vital importance for dance performance but that has been underrepresented in dance scholarship and computational and digital media for capturing movement. I attribute this phenomenon to the logocentric focus of its discursive tradition. This results in a question that I believe will be at the core of investigations in this area in the near future: How can dance be imagined from the *outside in* instead of *from the inside out?*

Dutch Summary

De Motion Capture Verbeelding: Digitale representaties van danskennis

In dit proefschrift onderzoek ik praktijken waarin motion capture gebruikt wordt om dans te registreren en te visualiseren. Dit onderzoek toont aan dat motion capture nieuwe manieren biedt om dans te zien en te begrijpen, doordat deze technologie het lichaam van de danser als belangrijkste ijkpunt neemt.

Optische motion capture is een technologie die beweging vertaalt naar digitale bewegingsdata. Reflecterende markers worden aangebracht op een strak motion capture pak of direct op de huid. Deze markers reflecteren het infrarode licht dat wordt uitgezonden door camera's die er omheen geplaatst zijn op een grid. Het weerspiegelde licht wordt omgezet naar digitale bewegingsdata. Deze data beschrijven tot op de submillimeter nauwkeurig het driedimensionale traject van de markers. Op deze manier kunnen bewegingsdata worden gemodelleerd en bekeken in een driedimensionale ruimte. Deze data kunnen ook de bron vormen van de beweging van zowel virtuele als echte lichamen. Het kwantitatieve aspect van motion capture data maakt precieze berekeningen mogelijk die laten zien hoe het lichaam beweegt. Daardoor vormt deze technologie de basis voor snelgroeiende onderzoeksgebieden zoals bewegingsherkenning en robotica.

In de hedendaagse danspraktijk en het onderzoek naar dans is het gebruik van motion capture geen regulier fenomeen. Het experimentele werk op dit gebied laat echter een indrukwekkend spectrum van toepassingen zien. In dit proefschrift beargumenteer ik dat het culturele belang van dit fenomeen de grenzen van het dansvakgebied overschrijdt. Deze praktijken zijn verbonden met andere ontwikkelingen in de maatschappij, zoals de steeds toenemende complexiteit van bewegingsonderzoek en 'gait analysis' (loopanalyse), touchscreens en andere haptische technologie, en tenslotte, de analyse, visualisering en toepas-

sing van 'big data'. De recente overgang naar het gebruik van choreografische ideeën buiten de muren van de dansstudio door de ontwikkeling van digitale toepassingen en omgevingen heeft veel vragen opgeroepen. Een van de belangrijkste vragen komt voort uit de complexe ontwerpprocessen die toegang kunnen bieden tot danskennis in digitale vormen: hoe kunnen motion capture data op een betekenisvolle manier gepresenteerd worden? Hoewel motion capture veel creatieve en analytische mogelijkheden biedt, kent de technologie ook specifieke beperkingen met betrekking tot de weergave van het dansende lichaam. Motion capture kan een drastische vermindering veroorzaken van de complexiteit van de ervaring van dans. Desondanks is het zeker mogelijk dat de bewegingsdata die aan de basis liggen van zeer complexe berekeningen of fenomenologische weergaven van dans nieuwe inzichten kunnen bieden in het dansende lichaam. Daarnaast kunnen bewegingsdata de manieren verruimen waarop dans gewoonlijk gezien en begrepen wordt.

Dit proefschrift evalueert de implicaties van hedendaagse praktijken waarin dans digitaal geregistreerd wordt. Hoe wordt dans gezien als een vorm van kennis die kan worden overgedragen? Hoe nodigt motion capture ons uit om dans anders te kennen? In dit proefschrift introduceer ik het begrip *de motion capture verbeelding* als een conceptueel kader dat verschillende kenmerken met elkaar verbindt die te maken hebben met het zien en begrijpen van dans door motion capture. De methodologie bestaat uit een discoursanalyse van recente artistieke en analytische experimenten met de lichamelijke digitalisering van dans. Deze experimenten stellen nieuwe manieren voor om bewegingsdata te presenteren. Deze analyse past in een interdisciplinair referentiekader dat bestaat uit bronnen uit de danspraktijk, danswetenschappen, performance studies, filosofie, filmwetenschappen en computerwetenschappen. In het onderzoek wordt gebruik gemaakt van een media-taxonomie, een methode die benadrukt dat media zich niet in een technologisch vacuüm bevinden, onafhankelijk van sociale en culturele praktijken, maar dat media juist verstrengeld zijn met deze praktijken, en dat ze hiermee parallel groeien en zich ontwikkelen. Ik introduceer het begrip dramaturg-onderzoeker om mijn onderzoeksidentiteit te beschrijven. Ik analyseer en communiceer hoe betekenis tot stand komt in de danspraktijk, waarmee ik een bijdrage lever aan de onderbouwing van het belang van dit soort praktijken.

Ik betoog dat een onderzoek naar de recente opkomst van ideeën over dans als kennis essentieel is voor het begrijpen van de ontmoeting tussen dans en motion capture technologie. Welke gewoontes van zien en kennen liggen verankerd in hedendaagse methoden om beweging te registreren? Wat zijn de gevolgen van het vertrouwen dat in deze technolo-

gieën gesteld wordt om nieuwe kennis te produceren? Welke kenmerken van dans worden benadrukt als gevolg van dit soort vertalingen en welke kenmerken verdwijnen juist uit zicht?

In hoofdstuk 1 bestudeer ik de overdrachtscultuur van de choreografie *Rosas danst Rosas* (1983) van het Belgische dansgezelschap Rosas aan de hand van uitgebreide interviews met dansers, voorstellingsregistraties, de filmversie van de voorstelling door Thierry de Mey en diverse literatuur. Ik besteed specifieke aandacht aan de multimodale uitgave *A Choreographer's Score* (Cvejić en De Keersmaeker 2012). Het hoofdstuk biedt inzicht in de kernpunten van de methoden van dansoverdracht en onderbouwt op deze manier de discussie van de volgende hoofdstukken waarin aanverwante punten naar voren komen.

In hoofdstuk 2 plaats ik de ontmoeting tussen motion capture en dans in de context van het huidige debat over 'danskennis', wat een terugkerend begrip is in recente projecten op het gebied van dansdocumentatie. Dans wordt steeds meer gezien als een 'kennisproducerend streven' (Leach 2013, mijn vertaling). Om deze tendens te begrijpen onderzoek ik William Forsythe's begrip van 'choreografische objecten' en hun toepassingen. Ik breng deze ontwikkeling in verband met het werk van Michael Polanyi, die het begrip *the tacit dimension* introduceerde, de onuitgesproken dimensie van kennis die spraak, schrift en de benadering van de wetenschap vormgeeft.

Hoofdstuk 3 geeft een overzicht van recente praktijken die motion capture gebruiken in dansonderzoek en in de danspraktijk. Het brengt de voornaamste kwesties en problemen in de discussie over motion capture en dans in kaart. Ik onderscheid twee kenmerken van motion capture als apparatus in deze praktijken: de remediëring van video en de indexicale referentialiteit. Het hoofdstuk bevat analyses van het digitale programma *Noh Composer* (Oshita et al. 2013) en *TWO* (Hauert, Miller en Motion Bank 2013), een digitale notatie van de improvisatiestrategieën van Thomas Hauert/ZOO company.

Hoofdstuk 4 laat zien hoe de ervaringen met motion capture in de film- en game-industrie gebruikt kunnen worden in de analyse van hedendaagse methoden van dansregistratie. Het hoofdstuk bevat een vergelijkende analyse van acteurs en dansers in de motion capture setting. Ik analyseer de op motion capture gebaseerde dansvoorstelling *Emergence* (McCormick en Hutchison 2014) en de solo dansvoorstelling *meta* (2014), die een reflectie biedt op de ervaring van dansen *met* motion capture.

Hoofdstuk 5 onderzoekt het ontstaan van het gebruik om bewegingsdata van dans te visualiseren als getekende lijnen. Deze beeldvorming nodigt de kijker uit om zich het dansende lichaam in te beelden als een instrument dat lijnen tekent terwijl het beweegt. Ik

benader dit als een conceptuele metafoor (Lakoff en Johnson 1980; 2003), die ik het *dansende-tekenende lichaam* noem. Ik analyseer werken van Lesia Trubat, Nancy Stark Smith, Motion Bank en Deborah Hay, OpenEndedGroup en Gibson/Martelli. Elk van deze voorbeelden biedt een andere kijk op hoe kennis over de lichamelijke basis van cognitie kan worden gedigitaliseerd.

In hoofdstuk 6 beargumenteer ik dat het bestuderen van het gebruik van adem in dans een middel kan zijn om bewegingsdata op een betekeningsvolle manier weer te geven. Ik keer terug naar het werk van Rosas en bespreek de voorstelling *My Breathing Is My Dancing* (2015). Ik bekijk verschillende case studies waarin adem bewust als beweging gebruikt wordt om specifieke lichamelijke toestanden te creëren. Geïnspireerd door Luce Irigaray's filosofie van de adem beargumenteer ik dat adem een waardevolle leidraad is in het streven naar intuïtieve manieren om danskennis door te geven binnen het groeiende gebied van de digitalisering van het lichaam.

Dit proefschrift toont aan dat motion capture representaties van dans worden gekenmerkt door voortdurende inspanningen om minder bekende dimensies van danskennis te verwoorden. Ik stel dat deze methoden interesse kunnen oproepen in de belichaamde ervaring in de danspraktijk. Ik weerleg het idee dat digitale technologieën het lichamelijke en het materiële negeren ten gunste van het virtuele. De omgang met motion capture technologie is diep geworteld in belichaamde ervaring en belichaamde cognitie. Ik laat zien dat motion capture kan voorzien in een externalisering van kennis, een zintuiglijke verwijzing naar iets wat mensen al van binnenuit kennen, maar waar ze nog niet op hebben kunnen reflecteren aan de hand van een op zichzelf staande modus van representatie. Het toekennen van betekenis aan bewegingsdata bevordert nieuw onderzoek naar techniek en kennisoverdracht in voorstellingen en biedt mogelijkheden om de lichamelijkheid van dansers op andere manieren te benoemen.

Naast een groeiende waardering van en theorievorming over belichaamde danskennis is een ander effect van experimenten met motion capture op het gebied van dans een verschuiving in de manier waarop dans wordt verbeeld. Ik wijs in dit verband op het belang van de ademhaling van de danser, omdat de adem uiterlijke beweging verbindt met innerlijke intentie. De manier waarop dansers gebruik maken van adem is een voorbeeld van praktische kennis die van cruciaal belang is voor de uitvoering van dans, maar die ondervertegenwoordigd is in de danswetenschap en in digitale toepassingen voor het registreren van beweging. Ik schrijf dit fenomeen toe aan de logocentrische eigenschappen van de discur-

sieve traditie van dit onderzoeksgebied. Dit roept een vraag op waarvan ik geloof dat hij aan de basis zal liggen van onderzoek op dit gebied in de nabije toekomst: Hoe kan dans worden verbeeld *van buitenaf* in plaats van *van binnen-uit*?

List of Abbreviations

AI Agent	Artificial intelligent agent
ANN	Artificial neural networks
CGI	Computer-generated imagery
HCI	Human computer interaction
MoCap	Motion capture
PeCap	Performance capture
PerfCap	Performance capture
SOM	Self-organizing map
SRT	Skinner releasing technique

List of Figures

Previously published

Earlier versions of chapter sections of this thesis have appeared or will appear elsewhere:

Chapter 1

Karreman, Laura. 2015. “Repeating *Rosas danst Rosas*: On the Transmission of Dance Knowledge." *Performance Research* 20, no. 5: 98-107.

Chapter 2

Karreman, Laura. 2013. "The Dance without the Dancer: Writing Dance in Digital Scores." *Performance Research* 18, no. 5: 120-128.

Chapter 5

Karreman, Laura. 2015. "Worlds of MoCap: Writing Dance on a Three-Dimensional Canvas." *Performance Research* 20, no. 6: 35-42.

Chapter 6

Karreman, Laura. “Breathing Matters: Breath as a Vital Feature of Dance Knowledge.” Commissioned by Susan Manning, Janice Ross and Rebecca Schneider for inclusion in a volume with the provisional title *Futures of Dance Studies.* This volume documents the multi-school, multi-year project ‘Dance Studies in/and the Humanities’ (2012-2018), funded by the Andrew W. Mellon Foundation.