CHAPTER 8

DESIGNING FOR THE ACTIVE HUMAN BODY IN A DIGITAL MATERIAL WORLD

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Introduction

Recently, there has been a trend in using technology to support the active human body. This contrasts with the prevalent focus of technology supporting desk-based work that has characterized the history of the field. For example, where most prior work on the design of interactive systems focused on developing software for desk-based computer systems, with advances in miniaturization and sensor advances came a new breed of interactive technologies that support interactive experiences beyond the desktop. Such interactive experiences are often not only encompassing other locations than a desk environment, they are also offering completely new interaction experiences and techniques. Typical game systems within this genre are the Xbox Kinect and Nintendo Wii that enabled new forms of digital play. Such "exertion games" systems (Mueller, Agamanolis, & Picard, 2003) are offering exemplary interactive experiences that collectively have been assembled under the notion of the so called 3rd wave of human-computer interaction (Harrison, Tatar, & Sengers, 2007) that argues that our interactions with computers moved from mainframes where multiple people needed to share one computer, to individual desktops, to now many devices equipped with many sensors that support a more embodied-centric digital experience focus. Such a more embodied-centric digital experience focus originated from a view that the "body" of the computer matters more than originally assumed, for

example the shape and form of a laptop does not only allow computers to be moved from place to place, but they also afford new opportunities for interaction (Dourish, 2001). Typical examples arose through the field of tangible interfaces (Hornecker & Buur, 2006), these are new interfaces that highlight the physical form of the device people use to interact with when engaging with digital content. Extending this, new research emerged that not only considers the body of the computer, but also the body of the user, for example jogging apps on mobile phones support people being physically active as part of the digital interaction experience.

With these new opportunities to support the active human body comes an increased desire to understand how to design these new technologies to support interactions in which the human body actively engages with a world full of physical and digital materialities. Considering physical materialities is important as the human body never acts in isolation or independent from its environment and social others, and digital materialities are important to consider as this chapter is concerned with the information processing of digital data as a result of sensor systems. However, it is important to note that there is no dichotomy between physical and digital materialities, but rather a constant quick back and forth of users engaging with physical and digital materialities as part of the bodily experience, which should become clear throughout this chapter.

Based on hands-on experiences of engaging ethnographic-informed design research on the topic of creating playful experiences for the active human body, we have derived a set of reflections on how to design interactive technology for an active human body. We use specific examples from our own research in the Exertion Games Lab (http://exertiongameslab.org) to illustrate this thinking.

This work on the design around the active human body is the result of having engaged with this topic for over a decade and having developed a portfolio of projects that demarcate the field. The projects make a contribution through their associated research-through-design (Zimmerman, Forlizzi, & Evenson, 2007) processes we engaged with, but they are also complemented with an ethnographic investigation that contributes towards further understanding in design knowledge by investigating possible future interactions with the technology. As such, these ethnographic investigations differ from other approaches such as those described by Pink et al. in this book (Pink, chapter 7) where ethnography is used to understand people's current practice when engaging with digital materialities in order to provide guidance for designers. In our work, we use ethnography to provoke future interactions to no only understand what is, but what "should be", in line with a future-oriented approach to research, a strength associated with design research (Zimmerman et al., 2007). Therefore the projects presented combined with the research-through-design processes provide a perspective on the design of materialities for the active human body. Our investigation started with our early work on exertion games, these are digital games that require physical effort from players (Mueller et al., 2003; Mueller et al., 2011; Mueller, Gibbs, & Vetere, 2008). These exertion games are a key departure point for us to engage the active human body.

Related work

Prior work has previously investigated the role of the body in interactive technology design, which informed and guided the understanding of the body as digital materiality put forward in this chapter. Many of these previous investigations lean on

phenomenology as a theoretical basis, for example see Fogtmann et al., Larssen et al., Loke et al. and Moen (Fogtmann, Fritsch, & Kortbek, 2008; Larssen, Loke, Robertson, Edwards, & Sydney, 2004; Loke, Larssen, Robertson, & Edwards, 2007; Moen, 2006). It appears a phenomenological view on people "experiencing the world through their bodies being in it" (Fogtmann et al., 2008) often aids interaction design researchers to highlight the opportunities a consideration of the human body affords when interacting with technology. In particular, we believe Merleau-Ponty's view of phenomenology is relevant, as he puts forward a heightened sensitivity to the human body acting in the physical world filled with other human bodies, highlighting the consequential social aspect that comes with such a view (Merleau-Ponty, 1945/1945). Accordingly, we believe that designing for interactions with objects (see for example the works on tangible interfaces (Hornecker & Buur, 2006)) is a different endeavor to designing for interactions with bodies. We hope our work provides initial guidance towards an understanding of the design of such interactions.

The design of bodily interactions has been particularly examined in the context of games, as probably driven by the emergence of the Nintendo Wii and Microsoft Kinect. For example, the investigations by Bogost (Bogost, 2006, 2007) and Lehrer (Lehrer, 2006) led to the idea that digital games that involve the body afford a different kind of gameplay than mouse and keyboard or gamepad games. Bogost proposes that the larger bodily movements the players engage in have an increased performative character that can attract and involve by-standers, expanding the social play experience of everyone involved. On the other hand, Lehrer draws on theories around emotions to argue that the increased bodily movements have the potential to alter the emotional state of players, and as such also affords different experiences that

designers need to consider.

The work by Sheridan et al. highlights that designers who consider bodily interactions need to consider the potential of physical materiality to support the body, and that these physical materialities often afford playful engagement with the body (Sheridan, Dix, Lock, & Bayliss, 2005). Dourish with his theory of embodied interaction brings together trends in interactive system development that have put an increased emphasis on the users' bodily interactions within the physical world (Dourish, 2001), however, designers have lamented that his investigations are too conceptual to be put into design practice (Antle, 2009). Responding to this, this chapter offers a design-focused view on the opportunities and challenges when it comes to digital materialities and the active human body. In the next section, we put forward our view on the role of the body when it comes to digital materialities and how developments have evolved over the last couple of years and what shift in perspectives this brought out. We then present a set of our own works in order to demonstrate our thinking on this topic in order to set out a direction for future work in order to advance the field.

The Body as Digital Material

The argument put forward here is that prior work in interaction design mostly treated the active human body as a physical form of the user that interacts with digital materialities. Even more recent systems like the Microsoft Kinect afford a clear separation between the body and the digital material – the body on one side of the living room, the screen with digital content on the other – that leads to the proposed view of seeing the human body as a new form of interface, replacing the traditional

mouse and keyboard or gamepad interface. The next step forward suggested in this chapter is a non-separation between the active human body and the digital material. As such, it proposes to see the body as a form of digital material based on the findings from our ethnographic studies that suggest that our participants often did not make a distinction between digital and bodily materiality. Consequently, the question then arises how interaction designers can support such a view of the body as digital material. In order to provide a pathway to answer this question, this chapter presents next a set of examples from our own work that aim to highlight how such a view can be approached in practice, and as such, aims to provide an initial understanding towards a view of seeing the body as digital material. We see our works as initial stepping stones towards an enhanced knowledge about how to design interactions for the active human body and as such contribute to our understanding of digital materiality, however, we also acknowledge that these are only preliminary investigations at the beginning of an exciting journey. We also acknowledge that some of these examples follow more, and others less, this approach, which is a natural consequence of them coming out of design practice with all its opportunities and compromises that designers need to make when aiming to realize functional systems using today's technologies. Furthermore, it is noteworthy to mention that this approach of seeing the body as digital material is informed, and was informed by, the design practice reflexively, informing each other as the work progressed along. We hope that the examples presented next offer the interested reader initial insights and serve as inspiration and guidance for future work that will extend and expand this field further, helping it grow.

Exemplary Systems

Based on our past experiences of designing, evaluating and researching exertion games for over a decade, we now offer insights on the design process and how our studies involving everyday players contributed to their success. We begin with a description of a couple of digital experiences for the active human body that are relevant to understand the idea of seeing the active human body as digital materiality. Together, they aim to present a wide range of diverse experiences. Nevertheless, as we are working in the field of game design (influenced significantly by the seminal work of Salen & Zimmerman (2003)), they focus on play. After the description of each system, we present reflections on how the interactive component of each play system contributed to the overall experience. We then describe how we arrived at this reflection based on our analyses of players' experiences. We did this through ethnographic-style studies in which we exposed users to the systems and observed how they interact in such a future scenario. We hope that with this reflective account we are able to guide others who are interested in understanding the design of materialities for the active human body and ultimately regarding the body as digital materiality. After this, the chapter presents two design tools we developed in order to support other designers who create experiences for the active human body; again, we focus on exertion games here. These tools are available online for free and we recommend their use when designing exertion games. They offer a structured approach when it comes to the design of such interactive systems and might offer initial guidance for readers interested in the topic. After the tools are introduced, the limitations and advantages of using an approach that reflects our personal design experiences are discussed. The chapter continues with discussing future work before

concluding with a summary of the contributions.

In the next section, we begin with describing some of the exertion games coming out of the Exertion Games Lab at RMIT University in Melbourne, Australia. We articulate how we engaged with players of these games in order to understand their experiences as a way to contribute new knowledge and design better experiences in the future. In order to keep the contribution concise, we focus on one particular reflection and discuss its implication in depth in order to provide a comprehensive picture of our contribution to the field. Although the author describes them using the collective "we", huge credit goes to the many members of the lab that designed and developed these systems.

Cart-Load-O-Fun

Cart-Load-O-Fun is a system that explores the intersection between play and commuting on public transport. We developed this system as part of our research practice and installed it in trams in Melbourne and on commuter trains in Sydney, Australia in 2013 and 2014. Travelling on public transport is often not an engaging experience, and in response, we designed Cart-Load-O-Fun to demonstrate that there is an opportunity to enrich the commuting experience by exploring play in this public space. This opportunity was explored by deploying a social exertion game designed for public transport in trams and trains. We then studied people's interactions with the game in-the-wild (Rogers, 2011), i.e. not in simulated trains, but on actual trams and trains that ran as part of regular public transport timetables. The goal was to understand how people would interact with such systems in which the commuter's body is moving as a result of the train or tram moving, while the use of sensors in the

environment affects the moving body and is affected by the moving environment. As such, the digital sensor data is drawing on the moving body but also the moving environment and how they interact with each other. In particular, we are intrigued by the fact that the commuter is part of a *moving* space, however, he/she is often not moving very much at all. In response, we are interested in how game design can exploit this relationship.

The aim of the project was to provide guidance for designers who consider moving spaces such as trains and trams as a design resource to evoke playfulness in users of these spaces. In response, the result might allow for more engaging experiences for users of these spaces.

In Cart-Load-O-Fun two players collaboratively play together while commuting on a tram or train. We augmented existing bars in the carriage with pressure sensitive sensors so that when holding onto the bars (as passengers often do for safety reasons, especially when standing), they are in effect operating a game controller. The two passengers control a single character from a top-down third person perspective. One player controls the character's movement on the x-axis while the other player controls the y-axis. They do so by applying force through squeezing the bar. Squeezing the bar was chosen as input as passengers already tend to hold onto bars when travelling and grip harder when a tram is accelerating and decelerating. Players must work together to collect gems that randomly appear in the game, while avoiding enemy characters that bounce around the level. Each gem collected adds two seconds to the timer. A game usually lasts 60 seconds.

It is interesting to note that the act of commuting, i.e. travelling on the train or tram, actively contributes to the play experience: while the train or tram is moving, the

passengers' bodies are also moved, often swaying and being rattled by the movement of the carriage. This affects their "holding actions": when the train or tram accelerates or breaks, passengers need to hold onto their bars tighter, resulting in a different pressure of their grips. This in turn affects the outcome of the game. So players are in control of their game character through their gripping action, however, once the train or tram is moving, the movement of the carriage and resulting swaying of the passengers also affects the game. As such, players are continuously engaging with the varying levels of control that emerges as a result of their conscious grip actions and the grip actions resulting from being moved by the train or tram. So far, the game only supports two players; however, we can envision a future version of the game with additional sensors that support more players at the same time.

Reflection: Transform

Our work on Cart-Load-O-Fun highlights how interactive technology can transform commuting into a play experience. Passengers on public transport usually do not see commuting as a play experience. The introduction of the visual elements making up the gameplay experience allows players to see their holding-onto-bar activity as one of play, turning the activity of standing and holding-on into a playful experience.

We believe it is interesting to note that passengers are still standing and holding onto the bar while commuting, so the bodily actions appear (for an outsider) to be the same as when commuting without the game. Furthermore, the commuters are still achieving their goal of getting to and from work. Nevertheless, what we believe the interactive experience is facilitating is transforming the perception of the commuting experience. The commuting action is not just one of passively waiting

until the destination is reached, it is now also an active means of playing: only by commuting are the players able to play the game.

Previous work has highlighted that the managing of levels of control can be an engaging game element, and that such management is particularly key for engaging entertainment experiences when it comes to the control of the human body (Marshall et al., 2011): prior designs showed that controlling an artificial amusement ride bronco with a breathing sensor is engaging as the players need to manage the control between not breathing too much, yet breathing some (in order to catch some air). Our Cart-Load-O-Fun complements this work by demonstrating the potential of using the management of control of the body as a game design resource for engaging game experiences. In result, these game experiences have the potential to transform existing "boring" commute rides into engaging play experiences, and as such, demonstrate one way how the body can be seen as digital materiality: the moving body is part of the design enabled by sensor technologies embedded in the environment.

We see this opportunity of technology to transform the perception of existing non-engaging activities into playful activities as an interesting area to develop further. We argue that with advances in sensing technologies and reduced costs, there is a timely opportunity of transforming existing activities (especially non-engaging ones) into playful experiences.

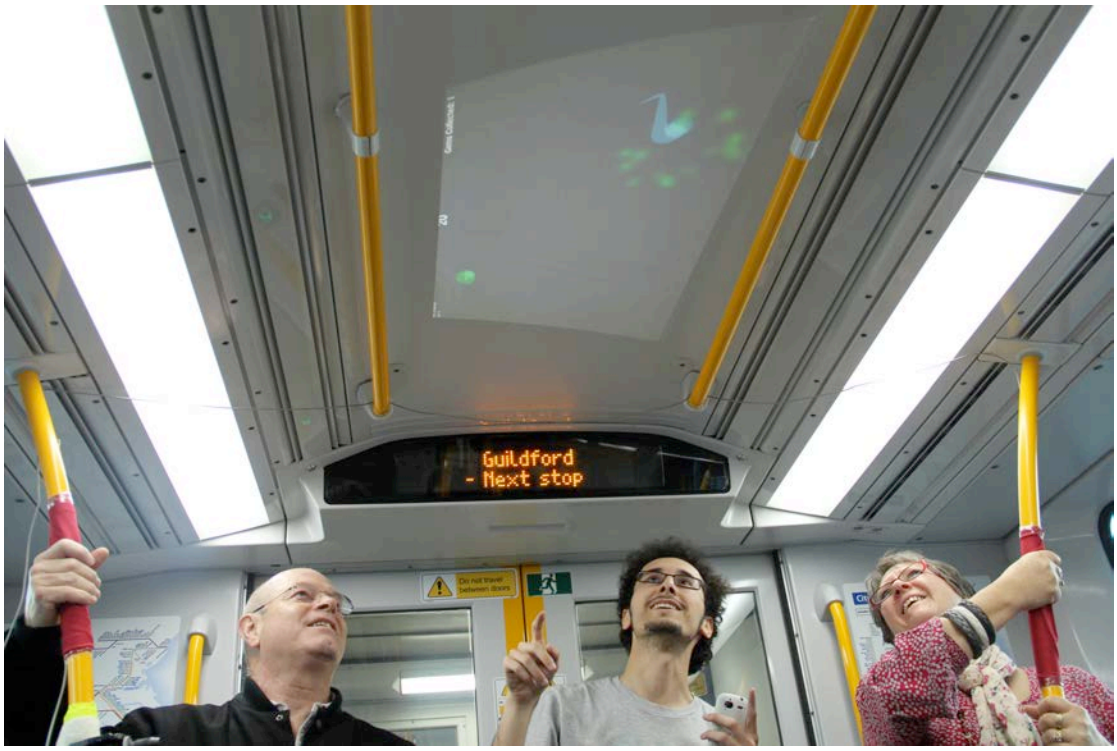

Figure 8.1 Cart-Load-O-Fun on a train

SweatAtoms

SweatAtoms is an interactive system we developed at the Exertion Games Lab to explore material representations of physical activity to support the experience of being physically active (Khot, Hjorth, & Mueller, 2014). SweatAtoms highlights that technology can support a playful interaction around exertion through material artifacts; in our case these material artifacts are coming out of a 3D printer.

SweatAtoms works the following way: our system transforms physical activity data, such as people's heart rate, into 3D printed material artifacts. These artifacts aim to form an aesthetic and informative expression of physical activity data in a material format. By presenting the user with a material representation of his/her heart rate data (instead of the traditional graph on a screen), we believe there is an opportunity to

engage the user in a different and novel way with the data that traditional representational media do not support or at least do not lend themselves easily to. As such, we use the SweatAtoms system to understand something about how we can enhance the relationship between being physically active and the associated data that is nowadays available to us with the many wearable sensors currently on the market.

An in-the-wild-study (Rogers, 2011) where we deployed the system in six households revealed interesting insights into how people would use such a system (we work with the assumption that in 10 years time, 3D printers will be making their way into people's homes as did paper printers previously). In this study, the participants were able to experience five different material representations of their physical activity for a period of two weeks each. Our results suggest that the material artifacts were able to inspire a new interest in participants' involvement and engagement with physical activity. In particular, we were able to use the results to make three concrete design recommendations to support physical activity using material representations: we recommend seeing these representations of physical activity

- as an opportunity to form an autotopography (González, 1995), which refers to the understanding of the material artifacts as physical signs to spatially represent the identity of the user. For example our participants used the material artifacts to decorate their rooms, pointing visitors to the fact that they represent personal data from specific achievements.
- as personalized rewards. For example participants reported that they felt rewarded when the 3D printer produced a particularly intricate material artifact after a rather strenuous physical activity.
- and for reflection and reminiscence. For example our participants told stories

about their activities to others using the material artifacts to guide their storytelling structure and used them to point out specific highlights of their physical activity journey.

Figure 8.2. Some of the material artifacts that the 3D printer produced based on people's heart rate data

Figure 8.3. The SweatAtoms system in people's homes

Reflection: Alternative Representation

We see SweatAtoms as an exemplar system representing some of the opportunities technology offers to reshape a person's engagement with physical activity based on an

alternative representation of his/her activity data. By capturing exertion activity through some of the emerging wearable sensors, we have the opportunity to present the resulting data in various forms, and digital fabrication tools offer unique opportunities to offer alterative representations. These alternative representations offer opportunities to reshape a person's engagement with physical activity as our study suggests. As such, our work highlights that if we see the body as digital materiality, we have an opportunity to transform this materiality into other forms, complementing the original bodily experience in new and novel ways that was previously not possible or at least difficult without digital technology.

Musical Embrace

In the next section we describe Musical Embrace, again developed in the Exertion Games Lab. It is a research vehicle we developed in order to investigate the potential of the concept "social awkwardness" as intriguing game design element, in particular when it comes to social awkwardness facilitated by the body (Huggard, De Mel, et al., 2013; Huggard, Mel, et al., 2013). Musical Embrace is a two-player game. The players need to control a sensor-equipped pillow that is suspended from the ceiling and falls at chest height with their torsos in order to collaboratively navigate a virtual world filled with sound sources. As such, the pillow functions as controller that is only operable if both players coordinate their torsos together. The pillow is wirelessly connected to a screen that is positioned to the side to display the virtual world that the players need to traverse through. The players do so by collaboratively applying pressure to the four sensors situated on the corners of the pillow-like controller. Each sensor is mapped to the four directional keys, i.e. up/down and left/right, of the controller. If players apply

pressure to the top sensors simultaneously their viewpoint will move forward. If they apply pressure simultaneously to the bottom sensors their viewpoint will move backward. Tilting the entire unit to the left or right will rotate the viewpoint to the left or right. The use of hands is not permitted; however, in order to intensify the pressure, the players can use their arms to embrace the other player, hence the name Musical Embrace. The goal of the game is to move through the virtual environment with speed and accuracy to collect the most amounts of rewards, i.e. virtual coins. Audio cues guide the players to the virtual coins, they increase in volume as the player moves in the right direction. The players have one minute to complete the game and collect as many rewards as possible.

Musical Embrace helps us understand the potential of concepts such as social awkwardness for the design of engaging experiences, in particular we believe it is noteworthy that social awkwardness has a traditionally negative connotation, however, here it is a facilitator for an engaging experience. As such, this work adds to our understanding of uncomfortable interactions (Benford et al., 2012), a topic previously investigated from an interaction design perspective. In short, Musical Embrace is helping us understand the benefits of considering social awkwardness as facilitated by bodily interactions when designing interactive experiences.

Figure 8.4. Musical Embrace

Reflection: Linking bodies together

The design process of Musical Embrace highlighted the opportunity of employing technology to link bodies together in a way that supports the emergence of what has been described as social play (Isbister, 2010). This contrasts with the majority of existing digital systems that support bodily social play such as Kinect Adventures (contributors) and Wii Bowling (Nintendo, n.d.), where the players' bodies interact with the game independently from one another: the player's bodies do not interfere with one another. With Musical Embrace, however, the players' bodies are linked together through the affordance of the pillow. This results in an interpersonal bodily play experience that players appear to find engaging. The design of Musical Embrace, including the hard- and software, facilitated this interpersonal bodily play: The

controller encourages a collaborative bodily approach by the players in order to successfully navigate the shared virtual world. In previous work, it has been highlighted that technology is particularly useful when it comes to linking bodies together over a distance through the use of networking technologies (Mueller et al., 2003; Mueller, Agamanolis, Vetere, & Gibbs, 2009; Mueller, Gibbs, & Vetere, 2009), here Musical Embrace highlights that technology offers opportunities to link players' bodies together that in turn can facilitate the emergence of bodily social play.

Tools for designing digital experiences for the active human body

Having now presented several systems that exemplify how one can design materialities for the active human body and, pushing this idea even further by seeing the active human body as digital materiality, the question how this perspective can inform future designs might now arise. In order to provide a starting point towards answering this question, we direct the reader to some of the design tools we have developed over the last couple of years. These tools were initially targeted at designers who want to create games and playful experiences for the active human body. They are available online and might guide people interested in creating materialities for the active human body and seeing the body as digital materiality. It might be useful to add that these tools have been evaluated in a design context previously and we have collected evidence (Mueller et al., 2014) that suggests that they can actively support designers in their practice.

Exertion Cards

The Exertion Cards are a set of design cards that are aimed to facilitate the design

process of creating interactive exertion experiences (Mueller, Gibbs, Vetere, & Edge, 2014). The Exertion Cards have been successfully used in workshops in order to facilitate the ideation process of exertion games. For example, students and professional designers have used the cards successfully in order to generate exertion game ideas (Mueller et al., 2014). The Exertion Cards present a series of dimensions that designers are encouraged to "think about". These dimensions represent a set of design choices, neither of them are either "good" or "bad", but rather aim to make the designer realize that making these choices will have implications on the resulting play experience.

For example, one of the cards ask designers "to what extent is physical risk considered?", reminding him/her that physical risk is a key element when it comes to designing digital experiences when the body is involved. However, physical risk is not necessarily something to avoid, but can rather also be an interesting design resource. As such, the card asks designers to think about the extent to which physical risk is considered. If there is a low level of physical risk considered, there is as consequence a low level of injury to be expected. In contrast, if there is a high level of physical risk considered, designers might be able to facilitate excitement due to a risk-reward balance. As such, the card aims to make designers aware that a) they should "think about" physical risk and b) that they should also "think about" to what extent they consider physical risk and c) that the various levels of consideration can result in different user experiences.

There are 14 Exertion Cards in total. They all feature the same structure in terms of aiming to make designers aware of what to "think about" when it comes to designing for exertion. The dimensions for each card come from the Exertion

Framework (Mueller et al., 2011), a conceptual theoretical framework for the analysis of exertion games, and represent a designer-focused approach to support the design practice of designers that is readily applicable[1].

Figure 8.5. Four of the Exertion Cards

The Exertion Cards evolved out of our many years of research in this topic, especially from observing and immersing ourselves into the design work, where we identified the need for academic knowledge to be translated into practical tools for designers that suit their practical day-to-day operations. We think that translating academic knowledge into practical guidance for designers is also part of the academic discourse and should be considered as an elemental part of the investigation. We found that carefully studying and engaging with the target group, in our case game designers, is an effective strategy to achieve this, and recommend to others to consider this in their work as we also find it personally rewarding.

Movement-based Game Guidelines

In the following section Movement-Based Game Guidelines are presented, our result of extending thinking about the motivation that drove the Exertion Cards' work. The Movement-Based Game Guidelines were developed after the Exertion Cards and are related, but target different stages of the design process. Whereas the Exertion Cards are particularly useful for the ideation process, the Movement-Based Game Guidelines are meant to be used when designers already have an idea in mind and want to improve upon an existing design. In other words, the Movement-Based Game Guidelines are more aimed to "check" whether a designer's game idea has followed established principles. The Exertion Cards are designed to be more useful in the earlier ideation part of the design process.

There is also a website and accompanying paper (Mueller & Isbister, 2014) about these Movement-Based Game Guidelines that describe the work in detail. The guidelines were developed based on the combined experience of Florian 'Floyd' Mueller's work with the Exertion Games Lab and Katherine Isbister's Games Innovation Lab at New York University of designing exertion games for over 20 years. The resulting guidelines were refined through the feedback from 14 experts in academic, indie and commercial game development fields that have experience in movement-based game design.

By interviewing them about their experiences in their daily practice and letting them engage with the guidelines, an interesting dialogue emerged in which the designers became active participants in refining the guidelines. It might be interesting to point out that the dialogue often started with an elaboration by the designer about where in their practice they observed certain aspects of the guidelines before they

moved on to actively shape and refine the guideline based on their practical experiences. Of course we acknowledge that it might have helped that many of them had prior experience of exposure to academic contexts and were therefore knowledgeable about the process of knowledge creation.

The structure of the guidelines is based on design patterns (Björk & Holopainen, 2005; Borchers, 2001) and phrased in hopefully easy-to-remember wording that is aimed at being appealing to designers. Each guideline includes *Do's* and *Don'ts* as well as explanations and examples. The anticipated use of the Movement-based Game Guidelines consists of going through the website and examining each guideline with the provided examples and considering whether the current game design idea could be improved by considering the guideline.

We note two key observations: First, although the guidelines also support the design of exertion activities, we chose to use the word "movement-based" as our experts, although divided, thought that movement-based has recently emerged as a common term used in industry. Secondly, the term "guidelines" was extensively discussed. On the one hand, what we are presenting are not rigorous guidelines in a strict sense, they are more like design patterns, an idea we originally departed from (building on the fact that design patterns have been previously used successfully when it comes to designers of interactive systems (Borchers, 2001). However, again our experts pointed out that making a tool applicable to designers also needs to involve presenting it in the right form and format, which includes identifying a suitable title. In consequence, many title variations were discussed and it was decided that guidelines most accurately matches both the intention behind the work as well as sounds appealing for practitioners in a way that motivates rather than discourages

engagement[2].

We can also add that we have trialed both tools in combination during a 6-day game design workshop with students and staff interested in the topic of designing digital experiences for the active human body. The goal of the workshop was to enhance one's understanding of the topic by actively designing a bodily play system that demonstrates a particular aspect of the bodily focus. When asked about the cards and guidelines, participants reported that they found them valuable for their design process as they made them "think about things they would not have thought of". As such, it appears the tools were able to extend the participants' current practice by adding food for additional thought. Although a richer evaluation might reveal a more thorough understanding of the consequences of having used the cards and guidelines, we believe our initial engagement showed promising results that confirm prior engagements that were more formally evaluated. In consequence, we believe it might be interesting to consider both of these tools in further investigations concerning materialities for the active human body and examine how seeing the body as digital materiality is complemented by the implicit knowledge expressed in these tools.

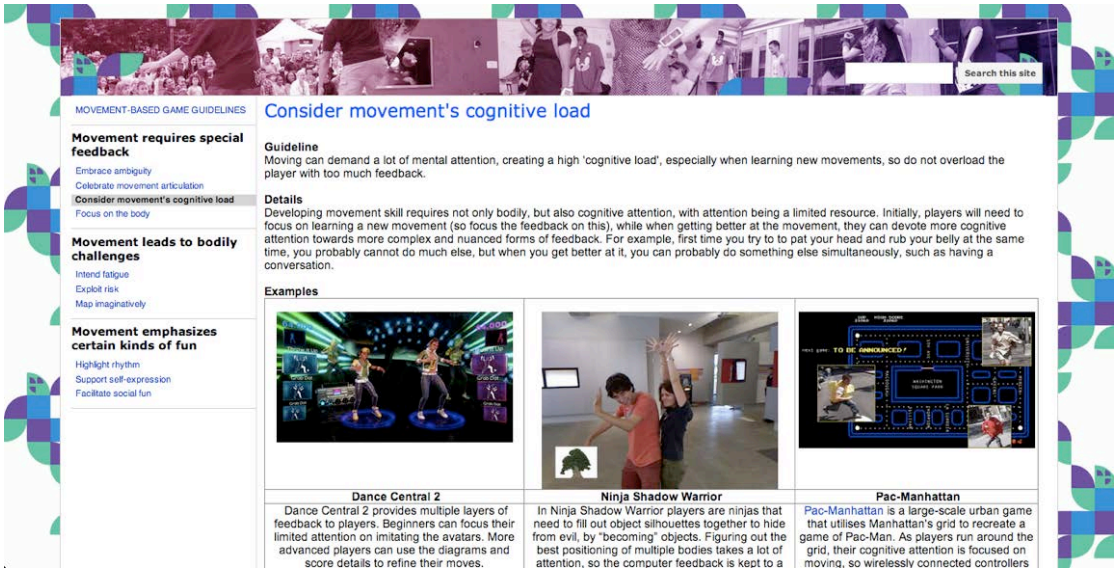

Figure 8.6. The Movement-Based Game Guidelines website

Limitations

Of course no such work is complete, especially when working in the practical domain of design. As such, we acknowledge the following limitations of the work. First of all, the presented insights are derived from a personal view of the topic since they are based on our experiences of designing exertion games. However, we believe this personal account can offer insights not available with other methods of reflection and as such provides a unique opportunity.

Secondly, in this chapter, we were able to present only a limited number of exertion games. By articulating several games we tried to describe the wide range of contexts exertion games can play a role in. However, by increasing the number of games further contributions to design knowledge could be made. Also, including additional reflections on other games could also extend the contribution.

Thirdly, this work only scratches the surface when it comes to understanding

the analysis of the presented games. Such investigations would allow for deeper and more thorough understandings of the design process and user experiences, expanding our knowledge of what currently "is" in order to inform what should "be". This future-oriented view matches with a research-through-design agenda (Zimmerman et al., 2007), which originally influenced our work.

In sum, we acknowledge that our work has limitations, however, we believe it provides a useful starting point for further work in the area of seeing the body as digital materiality and we therefore believe it could serve as springboard for further investigations. In particular, we hope our work highlighted that a future-oriented approach can provide inspiration that allows for seeing materiality as a conceptual view that goes beyond current technology limitations. Ultimately, we hope with our work we not only were able to answer some of the questions emerging from the field, but also were able to highlight unexplored areas that might inspire others to investigate further, essentially contributing to a better understanding of the field as a whole.

Future Work

We aim to take this work further and note that this research can benefit from future investigations in terms of examining more and conceptually different systems to derive further insights. Furthermore, additional tools that support designers in additional stages of the design process and through alternative ways might also benefit the domain. For example, one avenue we find interesting to explore further is the idea of communicating knowledge about the design of exertion games not just through cards and guidelines, but by actively playing and designing them. We believe that

playing games is one way of understanding games, and can hence lead to better game design. Similarly, designing games can help us understand something about the games. In essence, we believe these two aspects, understanding games and designing them are interlinked, however, we also believe that this interlinking could be supported by tools. Creating such tools that support this interlinking is another avenue for future work that sounds appealing to us. We believe investigating this cannot only significantly help us understand something about the field as a whole, but also support us in actively advancing and shaping the field. We are currently investigating ways to make this a reality.

Conclusion

We have presented in this chapter an early understanding on the design of new technologies to support interactions in which the human body actively navigates a world full of physical and digital materialities. Based on hands-on experiences of engaging with design research with a clear future-oriented focus on the topic of creating playful experiences for the active human body, we derived a set of reflections on how design can support a view of the body as digital materiality. We hope the work is able to offer a useful perspective that complements other work done in the field.

We proposed that there is no dichotomy between physical and digital materialities, but rather a constant quick back and forth of users engaging with physical and digital materialities as part of the bodily experience, and extending this, that the active human body, thanks to interactive technology advances, can even be seen as a form of digital materiality. To illustrate this thinking, we used specific

examples from our own research practice. The examples made contributions through their associated research-through-design processes we engaged with, but they were also complemented with ethnographic investigations that contributed towards further understandings by investigating possible future interactions with the technology. These ethnographic investigations differ from other approaches that often aim to understand people's current practice, whereas we used ethnography to provoke future interactions to understand what "should be". Therefore the projects presented provide a future-oriented perspective on the active human body as digital materiality.

In sum, the aim is to inspire and guide others that aim to support the active human body navigating a world full of physical and digital materialities by seeing the body as digital materiality, ultimately furthering our understanding of what it means to design for the active human body.

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References

Antle, A. N. (2009). Embodied child computer interaction: why embodiment matters. *ACM Interactions, March+April*, 27-30.

Benford, S., Greenhalgh, C., Giannachi, G., Walker, B., Marshall, J., & Rodden, T. (2012). *Uncomfortable interactions*. Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems, Austin, Texas, USA. 2005-2014. doi:10.1145/2207676.2208347

Björk, S., & Holopainen, J. (2005). *Patterns in game design*: Charles River Media.

Bogost, I. (2006). Persuasive Games: Wii's Revolution is in the Past. Retrieved from http://www.seriousgamessource.com/features/feature_112806_wii_1.php

Bogost, I. (2007). Persuasive Games: The Missing Social Rituals of Exergames. Retrieved from http://seriousgamessource.com/features/feature_013107_exergaming_1.php

Borchers, J. O. (2001). A pattern approach to interaction design. *AI & SOCIETY, 15*(4), 359-376.

contributors, W. Kinect Adventures! Retrieved from http://en.wikipedia.org/w/index.php?title=Kinect_Adventures!&oldid=577747109

Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*: Boston, MA, USA: MIT Press.

Fogtmann, M. H., Fritsch, J., & Kortbek, K. J. (2008). *Kinesthetic Interaction - Revealing the Bodily Potential in Interaction Design*. OZCHI '08: Conference of the computer-human interaction special interest group (CHISIG) of Australia on Computer-Human Interaction, Cairns, Australia.

González, J. A. (1995). Autotopographies. *Prosthetic territories: Politics and hypertechnologies*, 133-150.

Harrison, S., Tatar, D., & Sengers, P. (2007). *The three paradigms of HCI*. alt.chi Session at the SIGCHI Conference on Human Factors in Computing Systems San Jose, California, USA.

Hornecker, E., & Buur, J. (2006). *Getting a grip on tangible interaction: a framework on physical space and social interaction*. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Montreal, Quebec, Canada. 437-446

Huggard, A., De Mel, A., Garner, J., Toprak, C. C., Chatham, A. D., & Mueller, F. (2013). *Understanding a Socially Awkward Digital Play Journey*. DiGRA 2013

Huggard, A., Mel, A. D., Garner, J., Toprak, C. C., Chatham, A., & Mueller, F. (2013). *Musical embrace: exploring social awkwardness in digital games*. Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing, Zurich, Switzerland. 725-728. doi:10.1145/2493432.2493518

Isbister, K. (2010). Enabling Social Play. In R. Bernhaupt (Ed.), *Evaluating User Experience in Games: Concepts and Methods*: Springer-Verlag New York Inc.

Khot, R. A., Hjorth, L., & Mueller, F. (2014). *Understanding physical activity through*

3D printed material artifacts. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Toronto, Ontario, Canada. 3835-3844. doi:10.1145/2556288.2557144

Larssen, A., Loke, L., Robertson, T., Edwards, J., & Sydney, A. (2004). *Understanding Movement as Input for Interaction–A Study of Two Eyetoy Games*. Proceedings of OzCHI '04, Wollongong, Australia.

Lehrer, J. (2006, November 16, 2006). How the Nintendo Wii will get you emotionally invested in video games. Seedmagazine.com. Brain & Behavior. Retrieved from http://www.seedmagazine.com/news/2006/11/a_console_to_make_you_wiip.php

Loke, L., Larssen, A., Robertson, T., & Edwards, J. (2007). Understanding movement for interaction design: frameworks and approaches. *Personal and Ubiquitous Computing, 11*(8 Special Issue Movement-Based Interaction), 691-701.

Marshall, J., Rowland, D., Egglestone, S. R., Benford, S., Walker, B., & McAuley, D. (2011). *Breath control of amusement rides*. Proceedings of the SIGCHI conference on Human Factors in computing systems, Vancouver, BC, Canada. 73-82. doi:10.1145/1978942.1978955

Merleau-Ponty, M. (1945). *Phenomenology of Perception (Routledge Classics)*: Routledge.

Moen, J. (2006). *KinAesthetic Movement Interaction: Designing for the Pleasure of Motion* (Unpublished Dissertation, Stockholm: KTH, Numerical Analysis and Computer Science.

Mueller, F., Agamanolis, S., & Picard, R. (2003). *Exertion Interfaces: Sports over a*

Distance for Social Bonding and Fun. SIGCHI conference on Human factors in computing systems, Ft. Lauderdale, Florida, USA. 561-568. doi:http://doi.acm.org/10.1145/642611.642709

Mueller, F., Agamanolis, S., Vetere, F., & Gibbs, M. R. (2009). *A Framework for Exertion Interactions over a Distance*. ACM SIGGRAPH 2009. 143-150

Mueller, F., Edge, D., Vetere, F., Gibbs, M. R., Agamanolis, S., Bongers, B., & Sheridan, J. G. (2011). *Designing Sports: A Framework for Exertion Games*. CHI '11: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vancouver, Canada. 2651-2660

Mueller, F., Gibbs, M., & Vetere, F. (2008). *Taxonomy of Exertion Games*. OzCHI '08: Proceedings of the 20th Australasian Conference on Computer-Human Interaction, Cairns, Australia. 263-266

Mueller, F., Gibbs, M., & Vetere, F. (2009). *Design Influence on Social Play in Distributed Exertion Games*. CHI '09: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems., Boston, MA, USA. 1539-1548

Mueller, F., Gibbs, M. R., Vetere, F., & Edge, D. (2014). *Supporting the creative game design process with exertion cards*. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Toronto, Ontario, Canada. 2211-2220. doi:10.1145/2556288.2557272

Mueller, F., & Isbister, K. (2014). *Movement-based game guidelines*. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Toronto, Ontario, Canada. 2191-2200. doi:10.1145/2556288.2557163

Nintendo. (n.d.). Wii Sports. Retrieved from http://wii.nintendo.com/software_wii_sports.html

Rogers, Y. (2011). Interaction design gone wild: striving for wild theory. *interactions, 18*(4), 58-62.

Salen, K., & Zimmerman, E. (2003). *Rules of Play: Game Design Fundamentals*. Boston, MA, USA: The MIT Press.

Sheridan, J., Dix, A., Lock, S., & Bayliss, A. (2005). Understanding Interaction in Ubiquitous Guerrilla Performances in Playful Arenas. In S. Fincher, P. Markopoulos, D. Moore, & R. Ruddle (Eds.), *People and Computers XVIII — Design for Life* (pp. 3-17): Springer London. Retrieved from http://dx.doi.org/10.1007/1-84628-062-1_1. doi:10.1007/1-84628-062-1_1

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). *Research through design as a method for interaction design research in HCI*. Proceedings of the SIGCHI conference on Human Factors in computing systems, San Jose, California, USA. 493-502. doi:10.1145/1240624.1240704

Notes

[1] The Exertion Cards are available to download and we encourage users to print them out as tangible tokens during design sessions. The URL is: http://exertiongameslab.org

[2] Like the Exertion Cards, the Movement-Based Game Guidelines are also available online. The URL is: http://exertiongameslab.org