Report from Dagstuhl Seminar 17392

Body-Centric Computing

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Abstract

The rise of technology that can support the active human body – in contrast to the previously prevalent paradigm of interacting with computers while sitting still – such as wearables, quantified self systems and mobile computing highlights an opportunity for a new era of "body-centric computing". However, most work in this area has taken quite an instrumental perspective, focusing on achieving extrinsic performance objectives. Phenomenology, however, highlights that it is also important to support the experiential perspective of living an active life, that is, technology should also help people focus on their lived experiences and personal growth to deepen their understanding and engagement with their own bodies.

We find that despite the work on embodiment, the use of technology to support the corporeal, pulsating and felt body has been notably absent. We believe the reason for this is due to limited knowledge about how to understand, analyse and correlate the vast amount of data from the various sensors worn by individuals and populations in real-time so that we can present it in a way that it supports people's felt experience. In order to drive such an agenda that supports both instrumental and experiential perspectives of the active human body, this seminar brings together leading experts, including those who are central to the development of products and ideas relating to wearables, mobile computing, quantified self, data analysis and visualization, exertion games and computer sports science. The goal is to address key questions around the use of sensor data to support both instrumental and experiential perspectives of the active human body and to jump-start collaborations between people from different backgrounds to pioneer new approaches for a body-centric computing future.

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Edited in cooperation with Josh Andres

1 Executive Summary

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Joint work of all attendees
Main reference Florian 'Floyd' Mueller, Damon Young: "Five Lenses for Designing Exertion Experiences", in Proc. of the 2017 CHI Conference on Human Factors in Computing Systems, Denver, CO, USA, May 06-11, 2017., pp. 2473–2487, ACM, 2017.
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The rise of technology that can support the active human body – in contrast to the previously prevalent paradigm of interacting with computers while sitting still – such as wearables, quantified self systems and mobile computing highlights an opportunity for a new era of "body-centric computing". However, most work in this area has taken quite an instrumental perspective, focusing on achieving extrinsic performance objectives. Phenomenology, however, highlights that it is also important to support the experiential perspective of living an active life, that is, technology should also help people focus on their lived experiences to deepen their understanding and engagement with their own bodies. We find that despite the work on embodiment, the use of technology to support the corporeal, pulsating, felt body has been notably absent. We believe the reason for this is due to limited knowledge about how to understand, analyse and correlate the vast amount of data from the various sensors worn by individuals and populations in real-time so that we can present it in a way that it supports people's felt experience. In order to drive such an agenda that supports both instrumental and experiential perspectives of the active human body, this seminar brought together leading experts from industry and academia, including those who are central to the development of products and ideas relating to wearables, mobile computing, quantified self, data analysis and visualization, sports science, exertion games, computer sports science as well as phenomenology. The goal was to address key questions around the use of sensor data to support both instrumental and experiential perspective of the active human body and to jump-start collaborations between people from different backgrounds to pioneer new approaches for a body-centric computing future.

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3 Introduction

Josh Andres (IBM Research – Melbourne, AU), Joseph Marshall (University of Nottingham, GB), Florian Mueller (RMIT University – Melbourne, AU), and Dag Svanes (NTNU – Trondheim, NO)

In late 2017, 23 researchers and academics from Europe, Australia and the USA gathered for a week to discuss the future of body-centric computing. Dagstuhl, a non-profit center for computer science research, which is located in a rural area in Germany and provided the workshop space in an 18th-century picturesque castle, hosted the seminar. The goal of the seminar was to discuss the future of what it means to design interactive technology when centering on the human body; a trend highlighted by emerging technologies such as wearables, quantified self systems, mobile computing and exertion games, which stand in stark contrast to the previously prevalent paradigm of interacting with computers while sitting still. The motivation for the seminar stemmed from the realization that until today, most work in this area has taken quite an instrumental perspective, focusing on achieving extrinsic performance objectives, such as "who jogged the most miles this week?" while rewarding athletic performance and "personal bests". However, theories, such as phenomenology, have highlighted that it is also important to support the experiential perspective of living an active life, that is, technology should also help people focus on their lived experiences and personal growth to deepen their engagement with their own bodies. Despite the work on embodiment, the use of technology to support the corporeal, pulsating and felt body has been notably absent, the organizers of the seminar proposed. One reason for this could be that there is limited knowledge about how to understand, analyse and correlate the vast amount of data from the various sensors worn by individuals so that we can present it in a way that it supports people's felt experience. Another issue is that HCI researchers typically do not have direct knowledge of or training in how the corporeal, pulsating and felt body works as a complex organo-socio-system. In order to drive such an agenda that supports instrumental, experiential and in-bodied perspectives of the active human body, the seminar brought together leading experts on the intersection between the human body and interactive technology to discuss key questions around the use of interactive systems to support both instrumental and experiential perspectives to pioneer new approaches for what we propose to frame as a body-centric computing future. Body-centric computing we propose touches on a number of areas focused on supporting healthy, happy and productive people and societies. The core areas are health, including prevention, rehabilitation, disease management and cognitive/physical performance. Another core area is wellbeing, supporting pleasure and connectedness. Sport, or insights from sport science, is another core area, where the perspectives of the body as a site for constant performance, training, learning and improvement being important aspects. Entertainment, including gaming, is also another core area. The seminar began with talks by all attendees, in which they presented their work in the area, their theoretical perspective that guides their work, and a description of their most and least favorite body-centric computing projects. After the presentations concluded, no more slides were used for the remainder of the week, with all activities being conducted either as a round table, standing up, outside or exercising, fitting with the seminar theme. Furthermore, any group activities were supplemented movement practices to involve the whole body to support a "the brain as part of the body" approach. This physical in support of the cognitive/social was further supplemented by optional morning and evening activities,

such as playing golf, jogging, cycling, hiking or slacklining. The structure of the seminar was based around theory, design and their intersection, as that pertains to body-centric computing. From the start, it was acknowledge that if concerning oneself with technology that supports the active human body, not one particular theory will suffice, but rather, that a mix of theories will need to be engaged in, with all their weaknesses and strengths, with the big picture being what we get from studying this.

3.1 Interactivity session

An interactivity-style session involved participants trying out each other's body-centric computing systems. These were hands-on experiences where participants involved their bodies, and they were asked to think about what instrumental, but also experiential perspectives the design actively supported. Joe Marshall (University of Nottingham) set up a swing where the user wears an HMD and sees a virtual world that responds to the movement of the swing. This work elicited questions around how movement can be deliberately fed back to the user in an altered fashion to elicit novel entertainment experiences.

Anna Lisa Martin-Niedecken from the Zurich University of the Arts presented her dual flow-based fitness game "Plunder Planet" Martin-Niedecken, 2017 #1429 that adapts to players' abilities in real-time, provoking questions around what role technology plays in allowing people to experience their bodies in an individual and social context.

Lifetree by Patibanda et al. [3] is a VR game that aims to teach proper breathing technique. Participants who tried out the game said that their experience elicited questions such as what role technology can play in promoting wellbeing, where a major challenge to wellbeing today seems to be the prevalence of technology. Florian 'Floyd' Mueller from RMIT University in Australia presented various headphones that use noise-cancelling, in-ear and bone conduction technologies in order to raise the question whether we can say if one particular technology is more body-centric than another. Dag Svanaes from the Norwegian

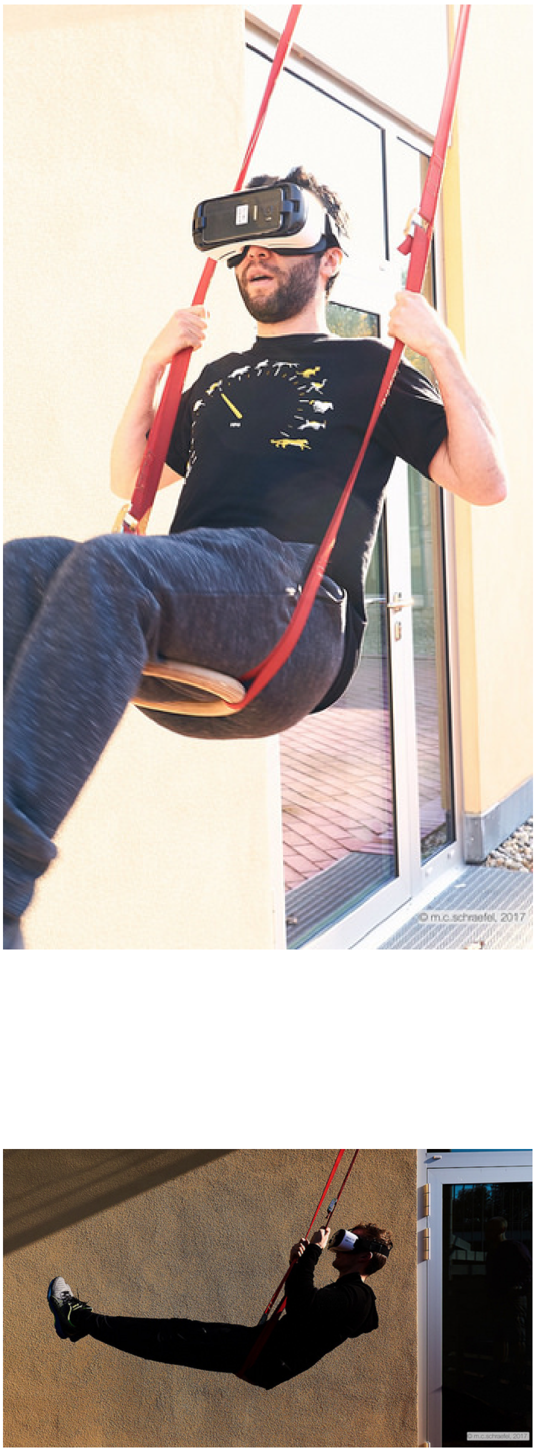

Figure 1 VR on a swing

Figure 2 "Plunder Planet" cooperative multiplayer-setup at Dagstuhl.

Figure 3 "Plunder Planet" single player-setup with two different controllers (Source: ZHdK).

University of Science and Technology presented an interactive tail [4] that moves in response to the hip-movement of the user, controlled via sensors and actuators. This work elicited questions around the role of the body in human-computer integration experiences. Perttu Hämäläinen from Aalto University in Finland presented his work on using AI to predict and animate movement in virtual worlds, provoking questions around how AI can inform the movement of embodied systems such as exoskeletons or the tail mentioned above.

3.1.1 Methods for body-centric computing

Methods for how to design body-centric computing were not only heavily debated, but also tried out through a design exercise. This included activities where the goal is to diffuse levels of attention on and through the body. First, activities were undertaken with closed eyes where the goal was to shift attention to various body parts just by focusing one's level of bodily attention. To contrast this, activities where followed where there was the goal was to achieve no attention or limited focus, for example, we were asked by Thecla Shiphorst (Simon-Frasier University, Canada) to walk very slowly through the surrounding forestry, in silence.

The goal to diffuse attention was later compared by participants with the cross-eye concentration action required to see random dot autostereograms. Through this diffused attention, a heightened awareness using the body was aimed to achieve to sense the experience. As part of this experience, participants were asked to pick three moments that they found memorable, and "imprint" them by pressing the index finger and thumb together so it squeezes the other hand, leaving a tactile experience of that particular moment. These imprints where then used to accomplish the design task to design an interactive shape-changing chair. The intention was to seek inspiration from lived experiences, while stressing that "slow" can be an inspirational quality when it comes to body-centric computing.

Figure 4 Walking very slowly through the surrounding forestry, in silence.

Figure 5 One of the design outcomes.

3.1.2 Designing a chair without chairs

The design of the final chair was not as important as how participants got there, with all teams applauding that the imprinting methods helped them to quickly agree on a particular feeling their designed chair should elicit. In particular, participants applauded that the slow-walking-in-the-woods activity allowed them to get into the right state of mind. Furthermore, without this prior activity, participants thought consensus would not have been reached so quickly, as such, they believed that the silence – in contrast to a default "discussion" activity – actually created a community. Participants also found that the activity seemed to help solidify the experience, and it appeared to built a sense of trust that then facilitated to take risks during the design phase. The activity appeared to function as way to gaining clear and focused design qualities. In particular, participants found it remarkable that the activity did not aim to make connections, but rather focused on the experience to contribute to a common ground or shared starting point for the design exercise. Although the "actual" design time was relatively short, participants found that the time spent on the sensitizing activity was well spent and accelerated the following activity task. Participants also noted that through the exercise, they were much more at easy combining things during the design phase that perhaps otherwise would have not made much sense if we were in a critical state, the "anything goes" state of mind is perhaps more productive than being "critical, smart, and the brilliant designer you always want to be". Overall, the activity reminded participants how much their state of mind affects their design process, and when it comes to body-centric computing, how important these pre-activities are before getting into the "actual" design task.

Questions that were raised were whether such an activity for body-centric computing could also work in distributed teams, and how it would work with people skeptical of such an approach? What if the design team works in a build environment, could this approach also work in a dense city environment? Furthermore, which step of the design process could it best be incorporated? Participants also asked for studies that would compare the results of such design activities where people would engage in body-centric activities vs. not, how would the outcome change? What other forms of "warm-up" activities do exist? Are some of them more individual than others, and how does that affect collaborative design? Furthermore, as it is hard to design body-centered without taking your own bodily experiences into account, how does one manage the tension between self-centered and body-centered? Where do methods such as user-centred design fit in here? Furthermore, it was noted that design that come out of such activities often fall into a "meditation genre", such as the somaesthetic yoga mat [1], however, could such activities also be used to design for also bodily, but less meditative actions? For example, what would happen if you start designing right after a jog? It was also noted that this particular activity focused on designing from our experiences, whereas in reality, a more clear brief is usually given, hence the design process might therefore unfold differently, even if the same activity is engaged in. Participants also observed that two lines of conversations emerged when reflecting on the activity, one was about designing for the human body from the lens of what is good for the human, while the second lie is about designing new experiences that are experiential and not necessarily good for the human body; however, they do not necessarily need to stand in contrast, as Mueller and Young previously highlighted [2]. Participants also tried out taking on a first, second and third-person perspective when designing for the human body [4]. The first person perspective is concerned with the personal, felt perspective of the body, whereas the second perspective is concerned with the interdependencies between bodies, and the third person perspective is concerned with the external, more "objective" view on the body. Discussions that followed from this highlighted that the first third person perspective is probably the most prevalent in most of today's available wearable technology systems, with a few emerging systems also considering the first person perspective. The second person perspective is probably the hardest to grasp, with not many examples being available as guidance.

3.2 Why body-centric computing?

In a collaborative sharing exercise, participants deliberated on their motivations for working on body-centric computing. The answers varied and included to help people live a healthier life, personal enjoyment of physical play, the aim to facilitate personal growth, to do good for others, promote physical activity and movement skill learning, create feelings of empowerment, improved quality of life, to facilitate health and wellbeing, enabling experiences for people with disabilities who cannot have them, to understand what it means to be human and as a counterpoint to the current mind-focused technological landscape.

3.2.1 Collaborative working sessions at Dagstuhl

Others said that based on the realization that every human has a body, and we design technology for humans, it is a necessity for every designer to be body-centric.

3.3 Open questions around body-centric computing

There are many open questions around body-centric computing, in order to group and prioritize them and to identify what is important for the seminar participants, we created an open market, where representatives of an open question could "pitch" the question and form groups to team up, with the intention to form groups who collaboratively work on the identified topic. One particular open question that arose was how to articulate bodily experiences for design. At the moment, there is only limited knowledge of how to communicate, share and articulate bodily experiences. This is not only relevant for in-team communication in the design process, but also an integral part of the user interaction with an artifact. It is further assumed that the ability of articulating an experience has an effect on the ability to discriminate between nuances of the experience, thereby reconfiguring and refining the experience as it unfolds. Participants related this to the Sapir-Whorf hypothesis, which suggests that people speaking different languages, with varying numbers of words to describe different colours, also have a varying ability to discriminate between nuances. Drawing on this, better ways of designing for intimacy, empathy, mindfulness and sociality should be the result, allowing for a critical intertwinement between the human body and these experiences. Another open-question is how much knowledge about the human body one needs to design for body-centric computing? Of course, one might argue that the more the better, however, one position was that it is also impractical to expect all designers take kinesiology courses; others questioned if that is the case. Is there some basic knowledge that might be sufficient, or do we always need to bring experts in? For example, HCI curricula currently teach aspects of the vision system and Fitts' Law about our perceptual and performance capacities. Does our new interest in pervasive, body-centric computing not require us to add in more specific knowledge about other relevant physio-chemico-hormonal

Figure 6 Using VR to disrupt awareness of space to force relearning of how to navigate in the physical world.

processes? If so, how do we provide designers with the necessary knowledge to draw from and interpret their own bodily experiences with confidence? Overall, there is a need for more methods and concepts for personalized and adaptive body-centric systems based on fine-grained knowledge of the human body. Another question that emerged is how to respect experiences of body changes. For instance, how do we design for restricted movement? This question arose from the discussion around whether physical restriction could be used as a mean to facilitate empathy for people living with physical disabilities.

In result, how can we design body-centric computing systems that affect movement, like physical restrictions, to facilitate limits across life course and experience? And how can designers create these experiences and ensure they are accurate (if they are meant to reflect a "real" experience)? Such an exploration could, for example, lead to exertion games in which the player starts off with a physical constraint like a distorted view that impacts orientation in the virtual world along with coordination of movement in the real world, and then through leveling up experiences increased empowerment. This progressive approach could be a way to design for transformation and development yet acknowledging that real-life strength and flexibility develops over months rather than individual exercise sessions, using technology to make this larger timespan more immediately visible and explorable. Another open question concerns the role of technologies that have caused a disconnection between humans and their bodies. One example is the mobile phone: on the one hand there is the concern that mobile phones have disengaged people from their bodies and their co-located people. On the other hand, people have cultivated intimate bodily relationships with their mobile phones, for a quirky example see the phantom vibration syndrome, where people think their mobile phone is vibrating when it is not. There are also many technical open questions around body-centric computing, a particular pertinent one was identified as detecting when people touch each other, and to what extent. Certainly solutions already exist, however, they are often not very portable, require tethering or are not very low-power. Developing systems that can unobtrusively sense human touch that is mobile and can be worn for long periods is still technically very challenging. The researchers highlighted emerging technologies in this space, such as advanced AI and machine learning that will make it increasingly possible to infer information such as a user's full body movement from just head tracking. For example, one current technical limitation to advance the field has been identified as affordable exoskeletons. Exoskeletons are powerful devices to amplify human movement, however, they are not generally available and if so very expensive. Furthermore, a shortage of prototyping tools for body-centric computing is also limiting the field, for example, the Lilipads for wearable computing predict a recent advancement in this direction. Finally, another important underexplored area concerns ethics around body-centric computing. Moving the body comes with certain risks, however, these risks have value in and of themselves, and interaction designers need to be aware of how to deal with this. Participants argued that the alternative is to design for stillness, which might not facilitate immediate injury, but ultimately leads to obesity and unhappiness, something that all participants aimed to avoid.

Acknowledgements. We thank Dagstuhl for their extensive support, Kristina Höök, Steve Benford, and all the participants who contributed, especially m.c. Schraefel, Kathrin Gerling, Jakob Tholander, Elena Marquez Segura and Marianne Graves Petersen.

4 Overview of talks

4.1 Josh Andres – IBM Research Australia & RMIT University

Josh Andres (IBM Research – Melbourne, AU)

I Lead UX, design at IBM research Aus, where we also work on HCI projects and partner with universities to collaborate. More narrowly we are focusing on: exertion, integration, body/sense augmentation, system led moments. To study the user experience. I believe that BC-C will offer us a perspective to support personal growth through bodily affordances (specially movement, self sensing, and as a collective citizen). Also, by supporting experiences where human capability is augmented with a blend of wellbeing and entertainment.

4.2 Playful Physical Computing for Health and Wellbeing

Kathrin Gerling (University of Lincoln, GB)

I am a researcher with a background in Computer Science affiliated with KU Leuven, Belgium. My main research areas are human-computer interaction, games and accessibility. I am particularly interested in when and how technology can be leveraged to support healthy lifestyles and improve wellbeing. My previous research has included movement-based play for older adults and people using wheelchairs, exploring basic issues around accessibility and directly working with people to create engaging and empowering playful experiences.

Body-centric computing in the context of games and playful experiences faces a number of unique problems. Much of our work starts out with a technology-centric design approach that risks the introduction of early constraints rather than asking questions around the body of the player and the experience intended by the designer and developer. For example, many games-related projects addressing older adults (including my own work) choose a technology (such as accelerometer controls or camera-based systems) and desired health outcome (e.g., reduction of sedentary behaviour), but fail to provide an in-depth exploration of the relationship between the ageing body, physical activity, and playful technology, and the implications for game development.

A key research challenge for body-centric game development therefore emerges from the need for a better understanding of the relationship between our bodies and playful technologies to enable us to develop systems that are empowering, engaging and effective in terms of outcomes for health and wellbeing.

4.3 Body-Centric Interfaces for People with Atypical Bodies

Nicholas Graham (Queen's University – Kingston, CA)

Body-centric computing can enhance the abilities of people with atypical bodies. I describe the design of an exergame allowing children with cerebral palsy to engage in physical activity, and through networked play, to socially engage with their peers. Participatory design revealed that children with cerebral palsy enjoy fast-paced action games, similar to those played by their typically-developing friends. I show how games can be designed to provide this fast action play while adapting to deficits in gross motor function, fine motor function, and visual-spatial processing. Our Liberi exergame has been used in home and clinical settings.

4.4 Marianne Graves Petersen

Marianne Graves Petersen (Aarhus University, DK)

Marianne Graves Petersen is associate professor on University of Aarhus, Computer Science Department since 2006. She has Ph.D from Computer Science Department, University of Aarhus on thesis "Designing for Learning in Use of Everyday Artefacts".

She has numerous research area including human-computer interaction, interaction design, pervasive computing and home-oriented IT.

4.5 Stefan Göbel

Stefan Göbel (TU Darmstadt, DE)

Dr. Stefan Göbel is an assistant professor with a permanent position as academic councilor, lecturer and head of the Serious Games group at the Multimedia Communications Lab at Technische Universität Darmstadt (TUD). Research topics cover the development (authoring, creation), (personalized, adaptive) control and (technology-enhanced) evaluation (and effect measurement) of Serious Games. Dr. Göbel is also driving the interdisciplinary key research area on "Serious Games" at TUD level (www.serious-games.tu-darmstadt.de)and provides lectures and practical courses in Serious Games and Game Technologies. Dr. Göbel has extensive experience in initiating, managing and coordinating projects – both publicly funded and industrial – on regional and (inter)national level. Examples include the EU projects INVISIP (personal role: initiator and S/T coordinator), art-E-fact (coordinator), INSCAPE, U-CREATE, 80Days and ALFRED (both management board and WP lead); currently he is coordinating the ADVENTURE approach. Application fields cover Storytelling-based Edutainment appliances and Serious Games for training, education and health (e.g. in the field of Ambient Assisted Living). Stefan Göbel holds a PhD in computer science from TUD and has long-term experience in Graphic Information Systems (GIS; topic of the dissertation is 'Graphic-Interactive Access to Geodata Archives', being prepared at the Fraunhofer Institute for Computer Graphics), Interactive Digital Storytelling, Edutainment and Serious Games. Dr. Göbel is the author of 100+ peer reviewed publications and serves as PC member and reviewer at different conferences (e.g. ACM Multimedia, CHI, ICME, Edutainment, EC-GBL, ICEC or FDG) and organizations (e.g. European Commission, Austrian Science Found and Swiss National Science Foundation). 2003 Dr. Göbel initiated and hosted (as well as 2004 and 2006) the International Conference on Technologies in Interactive Digital Storytelling and Entertainment (TIDSE), which merged with the International Conference on Virtual Storytelling (ICVS) to form the International Conference on Interactive Digital Storytelling (ICIDS) late 2008. In 2005 Dr. Göbel initiated the GameDays as national 'science meets business' workshop for Serious Games. Since that time he is permanently hosting the GameDays on an annual basis in cooperation with Hessen-IT, TU Darmstadt and other institutions from academia and industry. Since 2010, major parts of the GameDays have been implemented as International Conference (fully dedicated) on Serious Games.

4.6 Empowerment, Curiosity, AI (in exergames)

Perttu Hämäläinen (Aalto University, FI)

My talk comprises two parts: First, I explain how my work has been centered around creating feelings of empowerment and competence for the user as a mover, and also a curious exploration of the diversity of human movement. The two concepts are intertwined; we are by nature curious, and empowerment and competence as a mover – either through skill development or technology – endows us with the capability of exploring. Both empowerment/competence and curiosity are also central concepts of the psychology of intrinsic motivation. Curiosity drives an organism to explore in the absence of extrinsic rewards, and helps in building a rich understanding of the world, which is useful in adapting to new situations and problems. On the other hand, we are also driven towards activities where we feel competence and achievement of overcoming challenges. Taken together, competence and curiosity provides an explanation for many forms of open-ended play, where animals and children come up with movement challenges for themselves and each other, exploring the movement affordances of the environment. A great example of this is provided in this video: https://www.youtube.com/watch?v=58-atNakMWw.

The second part of my talk concerns the future, issuing a call for arms of sort to investigate the possibilities of AI technology in exergames, in particular the emerging technology of movement AI, which enables biomechanically valid simulated characters to improvise movements without animation data, based on high-level goals given by the game designers. I envision three main categories of use: AI as movement opponent, AI as movement partner, and AI as game tester; the latter means that instead of recruiting players to test an exergame with their bodies, it is increasingly possible to have a simulated body take the role of the player and learn to play the game. The essential research question is what kinds of player experience data can such simulated testing predict, e.g., exertion level, movement difficulty, specific muscles exerted, and accessibility or playability with disabilities.

4.7 Martin Jonsson

Martin Jonsson (Södertörn University – Huddinge, SE)

Martin Jonsson presented some of his research on the interplay between body, experience and material, in the context of interaction design. The research includes activities in schools where sensor based interactive systems was used to create bodily experiences around abstract physical concepts such as energy. Other research activities explores design and tinkering with hybrid digital and physical materials and the relation between the formulation of experience and certain qualities of these hybrid materials. Finally a recent strand of Martins research concerns how to develop interactive technologies that supports an increased understanding and awareness of the body, along the lines of the somaesthetics philosophy, emphasizing how all our experiences are fundamentally grounded in how we perceive the world though and with our body.

4.8 Bodily Play Experiences for Fun (Only)

Joseph Marshall (University of Nottingham, GB)

In this presentation, I describe two exertion games which I have been involved in building which explore different aspects of physical play. In Balance of Power, players score points by moving other players to their side of the play space; how they do that is entirely up to them. This rugby inspired computer game is deliberately designed to engender forceful physical contact. VR Playground uses a VR headset on a playground swing to create an exciting thrill ride, where the forces of the swing are redirected into zooming along a road or jumping over high buildings. These two experiences highlight my approach of building high energy physical games and experiences simply for the pleasure of playing and to explore the nature of play; I also briefly discuss my scepticism of the widespread claims that such physical game-play will improve player health.

4.9 Playful and Holistic Workout Experiences

Anna Lisa Martin-Niedecken (Zürcher Hochschule der Künste, CH)

Anna Lisa Martin-Niedecken is a Senior Researcher at the Subject Area in Game Design, Zurich University of the Arts. With her background in sports science her R&D work mainly focuses on movement-based games. She is particularly interested in how technology shapes gameplay and bodily experiences in the individual and social play context. One of her current R&D projects is on exergame fitness training. The adaptive exergame fitness game environment «Plunder Planet» was designed with and for children and young adolescents and combines user-centered designs on the levels of body, technology and play (physical and virtual). Beside her R&D work, Anna is teaching BA and MA (game) design students in the field of Serious & Applied Games.

4.10 Long-term self-tracking of personal health

Jochen Meyer (OFFIS – Oldenburg, DE)

Numerous wearable and personal networked health devices are available that allow self-tracking of behaviors such as physical activity or sleep, vital parameters such as heart rate or body composition, and other health parameters such as fitness. These devices are low-cost, easy to use also by technical and medical layperson, and can be used extended periods of time in real life. The primary promise of these devices often is on behavior change such as becoming more fit or losing weight. However their true value may lie in use cases such as giving insights into one's own health, raising awareness for health, or supporting decision making. We need research to investigate questions such as how to design systems that support these use cases, or how they influence one's own health.

4.11 Body-Centric Computing: Experiencing the Body as Play

Florian Mueller (RMIT University – Melbourne, AU)

I propose that one part of body-centric computing is to enable people to experience their body as digital play. This is grounded in sports philosophy that argues for the value of personal growth facilitated through physical activity that ultimately ends in the good life, helping us to figure out who we are, who we want to be and how to get there. I illustrate this thinking by presenting recent work from the Exertion Games Lab, including a balance game using a digitally-controlled galvanic vestibular stimulation system, a game using a wireless pill, and a wearable robotic arm that augments the eating experience. http://exertiongameslab.org

4.12 Elena Márquez Segura

Elena Márquez Segura (University of California – Santa Cruz, US)

I did my PhD in Human-Computer Interaction, at Uppsala University (Sweden), and Stockholm University (Sweden). Before that, I completed a BEng & MEng degree in Telecommunication Engineering at Universidad de Sevilla, Seville (Spain) and studied a master's program in Interactive Systems Engineering at KTH, Stockholm (Sweden). That's maybe what allows me to do research in this field of Human-Computer Interaction and Interaction Design, but what drives my research is my passion for play and playfulness, for interesting social experiences in collocated settings, and for movement. Movement has been central during my whole life. I've engaged with multiple sports as a practitioner as well as an instructor – I'm trained as an AntiGravity Fitness, BarreConcept, and STOTT Pilates instructor.

In my talk, I suggest representative papers in my work and that of others, a bundle of keywords with representative theories and methods that I've used in my work, and a few exemplars in my work, which I think can speak to a body-centric design perspective. I conclude highlighting how works of others present here in Dagstuhl have informed my research and design practice and expressing my excitement about how we will potentially inspire one another and the possibility of further collaborations.

4.13 Corina Sas

Corina Sas (Lancaster University, GB)

My research interests include human-computer interaction, interaction design, user experience, designing tools and interactive systems to support high level skill acquisition and training such as creative and reflective thinking in design, autobiographical reasoning, emotional processing and spatial cognition. This work explores and integrates wearable bio sensors, lifelogging technologies and virtual reality. Analytical orientations: ethnographic and experimental studies, design thinking and design rationale.

4.14 Thecla Schiphorst

Thecla Schiphorst (Simon Fraser University – SIAT, CA)

Thecla Schiphorst is Associate Director and Associate Professor in the School of Interactive Arts and Technology at Simon Fraser University in Vancouver, Canada. Her background in dance and computing form the basis for her research in embodied interaction, focusing on movement knowledge representation, tangible and wearable technologies, media and digital art, and the aesthetics of interaction. Her research goal is to expand the practical application of embodied theory within Human Computer Interaction. She is a member of the original design team that developed Life Forms, the computer compositional tool for choreography, and collaborated with Merce Cunningham from 1990 to 2005 supporting his creation of new dance with the computer. Thecla has an Interdisciplinary MA under special arrangements in Computing Science and Dance from Simon Fraser University (1993), and a Ph.D. (2008) from the School of Computing at the University of Plymouth.

4.15 m.c. schraefel

m.c. schraefel (University of Southampton, GB)

prof m.c. schraefel, phd,fbcs, ceng, cscs (lower case deliberate). Professor of Computer Science and Human Performance, Fellow, british computer society, Research Chair, Royal Academy of Engineering, Chartered Engineer. Head, Agents Interaction and Complexity Group And now a wee bit more: Deputy Head of Department, Research, and current REF champion (for those in the UK) for CS.

Wellth Lab Research FOCUS – How to design information systems to support the brain-body connection for lifetime quality of life, including, fitness to learn, fitness to play, fitness to perform optimally, always; to understand through these paths how to enhance innovation, creativity and discovery.

4.16 Designing from and for the Body with Technology

Anna Stahl (RISE SICS – Kista, SE)

When designing for the the body we need to engage in body exercises since this is our design material. In this presentation I bring up two examples describing senzitizing activities that were part of the design process and influenced the outcome, walks in the forest and engaging in the pragmatic philosophy of Somaeasthetics. From the forest walks we propose being, bringing, bridging as important elements in the design process to. From the practicing and designing from Somaesthetics we extracted four experiential qualities that can be used in generative designs; subtle guidance, making space, intimate correspondence and articulation

4.17 Dag Svanæs

Dag Svanes (NTNU – Trondheim, NO)

Svanæs received his Ph.D. in Human-Computer Interaction (HCI) from NTNU. His research over the last 15 years has been in the fields of HCI and Interaction Design. His main focus has been on user-centered design methods and basic theory of interaction. A common theme is the importance of non-cognitive aspects of human-computer interaction – often called embodied interaction. At a practical level this involves a focus on the physical, bodily and social aspects of interaction. In his research he makes use of role play and low-fidelity prototyping in realistic settings to involve end-users in the design process.

4.18 Jakob Tholander

Jakob Tholander (Stockholm University, SE)

I am senior researcher at the MobileLife centre at the Department of Computer and Systems Sciences, Stockholm University. I also hold a position in Media Technology at Södertörn University. I do research in human-computer interaction with a particular interest in tangible and embodied interaction both from a practical design oriented perspective as well as through contributions on a more conceptual level. Recently, I have been focusing on exploring how to design technology for bodily engaging interactions such as movement.

4.19 Elise van den Hoven

Elise van den Hoven (University of Technology – Sydney, AU)

Elise van den Hoven (www.elisevandenhoven.com) is affiliated to the University of Technology Sydney, Eindhoven University of Technology, University of Dundee and the Australian Research Council's Centre of Excellence in Cognition and its Disorders. Her research interests are in Design research, Human-Computer Interaction, Interaction Design, User Experience Design and User-Centered Design. Her favourite application areas are in Physical, Tangible and Embodied Interaction and Human Memory and Remembering. She combines these two in the Design research program Materialising Memories (www.materialisingmemories.com). This program aims to support everyday human remembering activities, including everyday digital photo sharing with family and friends, remembering someone who passed away, or supporting people living with dementia and their carers. Elise' theoretical perspective on the topic of this Dagstuhl could be summarized by the following keywords: Tangible/Embodied Interaction, Embodied Cognition, External/Distributed Cognition and Epistemic Action. On the same topic she recommends the following of her own papers:

References

1. *Grasping gestures: Gesturing with physical artifacts.* AIEDAM journal, special issue on The Role of Gesture in Designing, 2011.
2. *Embodied Metaphors in Tangible Interaction Design.* Personal and Ubiquitous Computing journal, 2012.
3. *Physical Games or Digital Games? Comparing Support for Mental Projection in Tangible and Virtual Representations of a Problem-Solving Task.* TEI, 2013.

Inspiring work is done by Joanna Berzowska, for example, the Skorpions project (www.xslabs.net/skorpions) which deals with kinetic electronic garments.

4.20 Technology based Healthcare Innovations for Active and Healthy Ageing

Rainer Wieching (Universität Siegen, DE)

Demographic change is a huge challenge for western societies. Diseases and related health problems in the ageing society may increase dependency of older adults and their need for care. A consequence might be reduced quality of life of older adults and increased costs for healthcare systems. Hence, there is a large interest in innovative and effective ICT-based solutions that delay older adults' need for health care services, improve their quality of life and thus mitigate the pressure on healthcare systems. Body centric computing (BCC) provides interesting opportunities for designing technologies that support active and healthy ageing (AHA) in older adults sustainably. The design process should involve older adults themselves and relevant stakeholders in the respective healthcare system. Mixed method approaches, i.e. combining qualitative and quantitative methods provide a detailed understanding of relevant practices and attitudes with respect to health, quality of life and technology use for AHA support of older adults and their interactions with relevant stakeholders. Qualitative and quantitative data needs to be collected from older adults and relevant secondary stakeholders like care givers, policy makers or health insurance companies should also be included in participatory design of such AHA support systems. Study setup should therefore embedded in living lab structures and randomized controlled trials (RCT) to ensure value sensitive design and evidence based data and appropriate outcomes of the design process.

Research results illustrate that the combination of innovative BCC technologies and their alignment towards older adults' social contexts and environments may increase their motivation to use technologies for AHA support and address their heterogeneous practices and attitudes more accurately. BCC solution should be designed to support the individual but also collaboration and cooperation between older adults and relevant stakeholders with respect to AHA. While doing so BCC technologies for AHA may consider different health areas and involve older adults' social environment to ease the integration into daily lives of older adults and thus create opportunities for long-term use and sustainable health impacts.

4.21 Resource-Efficient Intra-Body Communication

Florian Wolling (Universität Siegen, DE)

In body-centric computing, wearable devices are frequently utilized to detect certain events or even to continuously measure body parameters and motion. For most applications it is expedient to relay those data to a more powerful yet bigger device such as a smartphone that, finally, processes, interprets, and visualizes the data. For the transmission usually Bluetooth, WiFi, or other popular wireless technologies are utilized while cables are, usually, not reasonable due to a reduced wearing comfort and fatigue. In his presentation, Florian Wolling from the University of Siegen in Germany introduces body-coupled communication, a technique that is situated between conductive and radio frequency transmission. It is a promising yet less-explored method to use the user's body as a bounded medium, and the modulation of its natural electric field for communication between body-worn devices. The signals are induced capacitively into the body and detected likewise with two interspacing electrodes. While radio transmission suffers from a high energy consumption, shadowing, and motion effects, body-coupled communication is an energy-efficient alternative that uses the limited distribution volume of the human body and low baseband frequencies. Outside the body, the signal strength decays very fast with $1/r^3$ and, thus, prevents eavesdropping. Consequently, the approach enables the design of less obtrusive wearable devices with smaller dimensions and longer battery life.

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