HUMAN TECHNOLOGY

ISSN: 1795-6889

www.humantechnology.jyu.fi

Volume 12(2), November 2016, 193–251

BODYSTORMING FOR MOVEMENT-BASED INTERACTION DESIGN

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Abstract: *After a decade of movement-based interaction in human–computer interaction, designing for the moving body still remains a challenge. Research in this field requires methods to help access, articulate, and harness embodied experiences in ways that can inform the design process. To address this challenge, this article appropriates bodystorming, an embodied ideation method for movement-based interaction design. The proposed method allows for early consideration of the physical, collocated, and social aspects of a designed activity as illustrated with two explorative workshops in different application domains: interactive body games and interactive performances. Using a qualitative methods approach, we used video material from the workshops, feedback from participants, and our own experience as participants and facilitators to outline important characteristics of the bodystorming method in the domain of movement-based interaction. The proposed method is compared with previous ones and application implications are discussed.*

Keywords: *movement-based interaction, design methods, embodied interaction, bodystorming, ideation methods, play.*

DOI: http://dx.doi.org/10.17011/ht/urn.201611174655

INTRODUCTION

Theories of embodied interaction have been gaining traction in human–computer interaction (HCI; Svanæs, 2013), in particular in domains that design for the moving body, such as games and the interactive arts (Alaoui, Bevilacqua, & Jacquemin, 2015; T. Bekker & Sturm, 2009; Loke & Khut, 2011; Wilde, Cassinelli, & Zerroug, 2012). However, HCI researchers have not yet established a set of design practices, methods, and tools that are readily accessible and acceptable to the research community (Höök et al., 2015; Lee, Lim, & Shusterman, 2014). In the domain of movement-based interaction design, research endeavors have been aimed at understanding what it means to have rich bodily experiences (e.g., Höök, 2010; Loke & Khut, 2011; Loke & Robertson, 2011; Mentis et al., 2014; Schiphorst, 2007, 2011; Wilde, Schiphorst, & Klooster, 2011). A considerable body of work has examined the importance of the social context in shaping the interactive experience (e.g., Gajadhar, de Kort, & Ijsselsteijn, 2008; Jakobs, Manstead, & Fischer, 1996; Magerkurth, Engelke, & Memisoglu, 2004; Manstead, 2005; Márquez Segura & Isbister, 2015).

However, the best way to inform the early stages of the design process still remains a challenge. In particular, researchers in HCI have called for methods for describing and accessing embodied experiences that can inform the design process (Höök, 2010) and for ways to articulate insights from such methods and practices. Regarding social play, research has advanced the understanding of the psychological and emotional impact of the social context, even though the published insights remain useful primarily for evaluative purposes (Márquez Segura, Turmo Vidal, Rostami, & Waern, 2016). Works are lacking that integrate both the physical and the social contexts and that formulate and articulate knowledge in ways that can be used by designers and researchers not only analytically but in a generative way (Márquez Segura, 2016).

In this article, we argue that, in the domain of interactive playful activities, mainstream design processes overemphasize the role of technology as being both the design goal and the main driver of the design process. This is typically the case in technology-sustained approaches (Waern, 2009), in which designers view technology as that which sustains the whole activity. In such approaches, technical constraints can severely limit design possibilities (Márquez Segura, Waern, Moen & Johansson, 2013). By contrast, we suggest using a technology-supported design approach (Waern, 2009), in which designers view technology only as a part of that which sustains the whole activity. In particular we suggest creating technology-supported designs in which technology is designed together with the sociospatial aspects of the activity that it is designed for (Márquez Segura et al., 2013). As we discuss later in this article, current embodied ideation methods fall short in providing guidance for designing this combination of aspects early in the design process. Drawing from situated and embodied design methods, we propose a new method by appropriating bodystorming in the domain of movement-based interaction. Bodystorming (Oulasvirta, Kurvinen, & Kankainen, 2003; Schleicher, Jones, & Kachur, 2010) is commonly used to refer to brainstorming activities that heavily rely on a rich bodily and situated engagement with the ideation process wherein designers use their bodies to enact design functionality or usage (Burns, Dishman, Johnson, & Verplank, 1995) or because the brainstorming session is performed in a similar environment that is targeted in design (Oulasvirta et al., 2003; Schleicher et al., 2010).

Moreover, we recommend using a design practice called embodied sketching to design embodied core mechanics early into the design process. Embodied sketching has already been proposed in Márquez Segura, Turmo Vidal et al. (2016) and Márquez Segura (2016) as an overarching design practice with a set of characterizing principles that distinguish it from previous embodied methods. However, in this article, we go deeper into one specific type of embodied sketching, embodied sketching for bodystorming, by addressing two points. First, we present a review of the existing literature on embodied design methods. Second, we set forth a series of underpinning principles for the concept of bodystorming. These principles are important to understanding the appropriation of the concept of bodystorming as presented in this article. In supporting these points, we report on the analysis of two workshops held in collaboration with colleagues as illustrations of the application of the bodystorming method proposed here within the context of early ideation of design concepts for movement-based collocated social interaction. The first was performed within the design domain of interactive movement-based games in collocated social settings and the second one in the neighboring domain of movement-based interactive performances.

The bodystorming method presented here emerged from work in the domain of collocated play and it strongly relies on a social play element. However, the design goal of the second bodystorming workshop did not specifically target collocated play. Hence, despite using very similar approaches to bodystorming, the different application domains and design tasks brought about different types of design activities and outcomes. Yet both workshops were successful in allowing participants to engage in embodied ways of thinking, acting, and cocreating very early in the design process, as well as to come up with ideas on the spot that involved a complex design space of people, technologies, artifacts, and physical and spatial elements. Within such complex design situations, both bodystorming sessions allowed the designers to envision, choreograph, and act through various embodied core mechanics and sociotechnical physical activities.

After the presentation of these two instances of bodystorming, important features of the method are presented; some are general features that both cases share, while some are contingent on the particularities of each case. Next, the five underlying principles of the ideation method presented in this paper are revisited and used as analytical lenses to review the bodystorming instantiations presented in this paper and other embodied ideation methods presented in the Background section of this paper. This helps to situate the method presented in this paper among previous research by elaborating on the novelty and substantial contribution that the former presents with respect to the latter. Finally, we present the implications for the application of this method, emphasizing how the contributions of this study can be useful for designers and researchers interested in choreographing embodied activities that are technologically supported.

BACKGROUND

An Embodied and Technology-Supported Approach to Design

In the domain of social play, the use of the social and spatial contexts to influence the situated experience is well established (e.g., Gajadhar et al., 2008; Jakobs et al., 1996; Magerkurth et al., 2004; Manstead, 2005). However, in most design approaches, the focus is on designing an interactive artifact; social and spatial factors as design resources typically are not included. This can lead to very artifact-focused types of interaction (Tholander & Johansson, 2010) and a feeling of playing “alone together” (Ducheneaut, Yee, Nickell, & Moore, 2006; Turkle, 2012).

One major reason behind this is that many designers focus on designing a technology that sustains the whole experience (Waern, 2009). Using such technological solutions raises a risk that users orient their focus towards the technology that is sustaining, guiding, or mediating the activity. This approach ends up favoring "playing, seating, and viewing arrangements that hinder mechanisms such as mutual eye contact, natural reciprocation of approach or avoidance cues and mirroring, or emotionally relevant communication signals" (Márquez Segura et al., 2013, pp. 3366–3367). To avoid this, we advocate for a design approach that is technology-supported. We do so by designing the technology as one part of the targeted activity, that is, only one component among others that support the activity (Márquez Segura, 2016; Márquez Segura et al., 2013; Márquez Segura, Waern, Márquez Segura, & López Recio, 2016). This contrasts with technology-sustained approaches (Waern, 2009) in which the technology is viewed as sustaining the entire activity.

The technology-supported approach has been followed by researchers in the domain of pervasive games for outdoor play for children (e.g., Soute, Markopoulos, & Magielse, 2010). These authors suggest the term Head Up Games (HUGs) to describe their design goal of liberating players from having to look down at mobile technology all the time. The concept of HUGs is aligned with our design goal of considering the sociospatial setting, physical artifacts, and the social agreement among the players themselves as important design resources (Márquez Segura, 2016; Márquez Segura et al., 2013).

The Design Resources in an Embodied and Technology-Supported Approach

In the context of movement-based collocated social play, we have suggested an alternative approach to mainstream technology-driven approaches, one that considers elements in addition to technology as possible design resources, such as physical artifacts and sociospatial elements (Márquez Segura, 2016; Márquez Segura, Turmo Vidal et al., 2016; Márquez Segura et al., 2013). This technology-supported approach (Waern, 2009) underscored that the technology is only one part of what the designer designs. This is similar to the concept of HUGs presented above. We also suggest the design of the spatial distribution of all the parties involved in the activity (players, physical and digital artifacts, and technology). In our studies (Márquez Segura & Isbister, 2015; Márquez Segura, Turmo Vidal et al., 2016; Márquez Segura, Waern et al., 2016; Márquez Segura et al., 2013), and those of others (see, e.g., the work of De Kort & Ijsselsteijn, 2008), it becomes apparent how this is central to managing attention, which in turn influences the type of engagement and overall experience. However, the sociospatial distribution of players and artifacts has not yet been fully explored as a design resource (Márquez Segura, 2016; Márquez Segura & Isbister, 2015; Márquez Segura et al., 2013).

Our technology-supported approach takes a phenomenological stance, where the goal of the designer is to design (interactive) objects in the world rather than a world inside an interactive object (Fällman, 2003b), like designs that follow a technology-sustained approach promote. If a mobile device is perceived as a world of objects, similar to how desktop computers are often viewed, one's attention tends to focus on what goes on "inside" the device. However, where mobile interaction is concerned, what happens "outside" the device is just as important. Focusing solely on the inside (i.e., the virtual world) leads designers and users to neglecting both the role of the body in interaction as well as the role played by context, whether physical or social (Fällman, 2003b). In line with Fällman, our previous work showed that technology-supported approaches help to address the constraints of artifact-focused interaction by taking an embodied perspective of interaction (Márquez Segura, 2016; Márquez Segura et al., 2013).

The concept of embodied interaction was originally proposed in the HCI field by Paul Dourish (2001) as an approach toward understanding people's activities as fundamentally situated in a physical, as well as social and cultural, world. Although this is true for all activities (including the interaction with any information technology system), the perspective becomes especially relevant when designing movement-based interactive technologies because of the fundamental role that physical actions have for being, understanding, and interacting with the technology and, at the same time, with the surrounding physical and social world.

Embodied Core Mechanics: Designing the In-the-Moment Activity

The concept of embodied core mechanics appeared gradually in our work as a possible alternative design goal for movement-based interactive systems that seek to foreground a rich embodied experience, one that focuses on the in-the-moment activity (Márquez Segura, 2016; Márquez Segura, Turmo Vidal et al., 2016). Designing actions is not only instrumental for an end (e.g., using movements to navigate a movement-based interactive game), but also as ends themselves (actions that are enjoyable for the users in that these set the stage for physical and social action and participation). This is borrowed from game design in which the concept of core mechanics is used to describe the actions that players engage in to proceed in a game or "the essential play activity players perform again and again in a game" (Salen & Zimmerman, 2003, p. 316). Examples of core mechanics can be categorized as simple actions, such as driving in a car race or jumping as a means for skipping a virtual rope in a movement-based interactive game; they also refer to a combination of interrelated actions, such as those needed to play paintball, which involves running, strategy planning, aiming, firing, dodging, and so forth. In game design, the core mechanics are typically shaped by the design of the game's rules, and they are key to advancing the game state (Márquez Segura, 2016).

In adding the prefix of embodied to core mechanics, we emphasize the way that these actions rely on and make use of the physical, spatial, and social contexts all around. This does not mean that there are disembodied core mechanics; rather, these are realized in one's lived physical and social worlds (Márquez Segura, 2016). Yet often, these worlds are not fully considered when designing core mechanics. With embodied core mechanics, we propose an approach to design that considers core mechanics as "physically realized" and "socially situated" (Dourish, 2001, p. 115), that is, to equally and specifically consider during the design process how the core mechanics can be strongly supported by the surrounding physical and social contexts (Márquez Segura, 2016).

Following on an embodied and a technology-supported approach to design, we propose the concept of *embodied core mechanics* to refer to desirable and repeatable embodied phenomena that are supported by the technology, physical artifacts, and the players in the space where the activity unfolds. Studying and exploring their spatial distribution as well as the roles of each to support the activity are essential for giving rise to particularly rich embodied phenomena (Márquez Segura, 2016). Designing embodied core mechanics involves a significant challenge: How can a designer design, compose, and choreograph a physical and social activity in a landscape of physical and digital artifacts and social actors? In other words, how can all the components involved in interaction interact in a rich embodied way, making full use of their embodied ways of being?

The concept of embodied core mechanics emerged within our research group as a useful evaluative lens to inform design but, until recently, has not been fully developed as a potential generative tool for design itself (Márquez Segura, 2016). We argue that the concept can become generative when used in combination with embodied ideation methods for design. Specifically, we explored through our research how embodied core mechanics can be sketched in the early stages of the design process. In the next section, embodied ideation methods are revisited.

Embodied Ideation Methods

In design practice, a plethora of methods and techniques are available to support creativity and ideation (e.g., Gray, Brown, & Macanufo, 2010; Osborn & Bristol, 1979), including traditional brainstorming, personas, sketching methods, and affinity maps. These have become best practice methods, often used informally in interaction design (IxD) but without being attentively studied or validated (Fällman & Stolterman, 2010). This is a critical issue in IxD, which has sparked research endeavors aimed at filling this gap and studying, developing, and validating the methods (Fällman & Stolterman, 2010). Because our research group operates within the design domain of embodied interaction, we find particularly compelling those methods that try to understand and address the social and physical context in which they design by harnessing the bodily, social, and situated experience of designing.

In HCI, movement and enactment have been identified as aids, borrowing from dance and theatre techniques, for understanding the embodied situation. For instance, M. M. Bekker, Olson, and Olson (1995) studied the way designers engaged in movements that are characteristic of actions typically performed by users of a certain product during design sessions, which helped them identify and articulate details of behavior that could be relevant for design. Relatedly, Arvola and Artman (2007) examined how gestures could be used together with sketches and techniques from improvisational theater, such as role-play, to express features, design concepts, and important qualities of designs. Theatrical techniques were also used by Brandt and Grunnet (2000) in user-centered design processes. For example, in their Smart Tool Project, these authors explored refrigeration technicians' work in order to design a concept for a future electronic service tool. Thus, they had designers and technicians role-play various staged scenarios using props. This helped the designers to better understand the users' actions and needs.

Blomkvist and Arvola (2014) proposed a method called service walkthrough in which they used an embodied approach for the evaluation of a smartphone app prototype that guides tourists during sightseeing. They first identified relevant moments in the service and the roles of the people involved in that service. They gathered relevant props that could be used as enablers for enactment and set up their walk through in a realistic location (one where the app would likely be used). Then, they assigned roles to designers, who then enacted these using a lo-fi prototype. The results of this situated enactment provided impressions and feedback about the prototype used in context.

Buchenau and Suri (2000) proposed the experience prototyping approach to design, which considers important aspects of the experience beyond the look and feel of a product. They defined it as "any kind of representation, in any medium, that is designed to understand, explore or communicate what it might be like to engage with the product, space or system we are designing" (p. 425). Their approach is useful for (a) understanding existing user's experiences in their context of use, (b) exploring design ideas and evaluating them, and (c) communicating and sharing ideas with an audience. Experience prototyping is an umbrella concept that includes different techniques, such as traditional sketches, storyboards, and scenarios, as well as novel techniques, such as those borrowed from the theatre. Buchenau and Suri illustrated their approach with examples in various spatial contexts. Although some were not specified, others happened in a naturalistic setting or in a simulated space of the real setting. Their experience prototyping examples also varied regarding the type of enactment involved (scripted or not) and the resources used (e.g., props, final product, prototypes, and/or social and physical contexts). From all the examples in their work, we highlight two that are particularly interesting for how they made use of the physical and social contexts of the design activity as design resources.

In the experience prototyping example called "Exploring a Train Journey," Buchenau and Suri (2000) tried to identify passengers' needs for a new rail service by exploring and engaging in users' behavior during a train journey. They used an actor to guide the session and facilitate scripted scenarios and roles for designers in the actual physical and social contexts they were designing for. They used techniques such as role-play to improvise semiscripted situations and bodystorming. In another example, they explored design ideas for the interior of an airplane. They recreated a full-scale layout of the plane in order to experience the feeling of acting in such an environment. Participants engaged in bodystorming by enacting a number of typical situations and activities for that context, such as receiving and eating meals or talking to other passengers.

In both examples, Buchenau and Suri (2000) utilized the bodystorming method, drawing from the work of Burns, Dishman, Verplank, and Lassiter (1994) and Burns et al. (1995). Although bodystorming is an often cited-method in IxD (e.g., Gray et al., 2010; Márquez Segura, 2013; Oulasvirta et al., 2003; Schleicher et al., 2010), designers and researchers use this term to broadly refer to bodily engagement with a design artifact, situation, or design idea. Burns et al. (1995, para. 2) presented it together with "repping," or "reenacting everyday peoples' performances," as a method from performance and improvisation for "living with that data in embodied ways."

Several other documented cases can be found that present different bodystorming methods. For example, in Oulasvirta et al.'s (2003) research on bodystorming methods, the authors presented a type of brainstorming "in-the-wild," in which designers sit and brainstorm in the same context that they design for. This method calls forth empathy, as well as immediate feedback from imagining how a particular idea would fit the observed context.

Using a different approach, Franinović (2013) and Hug, Franinović, and Visell (2007) presented the results of a "sonic" embodied workshop where participants were asked to generate sonic ideas using voice, body, an action–object matrix, and nonverbal acting. As an example of a nonverbal method, participants had to follow rules similar to the game Charades in order to act out their product or potential scenario. To do this, they used their body, available props, movements, and the sound that all of these created in this process. To evaluate the bodily presented ideas, other participants needed to evaluate the idea by describing their understanding of the presented idea. These authors used bodystorming to help participants generate embodied artifacts to test the designed interaction idea and to share their ideas and communicate with other participants in a fast and efficient way. Similarly, in another study, Houix, Misdariis, Susini, Bevilacqua, and Gutierrez (2014) presented the results of two participatory workshops exploring scenarios in relation to body sonic interaction design. Taking advantage of participatory design methods, they asked participants to analyze a self-selected object in order to define basic actions (e.g., sliding or pressing) to generate new scenarios of use. Later, they used artifacts to prototype the design ideas and test the scenarios by acting out the situation with everyday objects, such as a jam jar or rechargeable lamp.

Schleicher et al. (2010) grouped various embodied methods under the term bodystorming. One is called use–case theatre, which involves staging the space where the future design will be deployed, using props, and engaging professional actors as living personas. In this type of bodystorming, part of the interaction can be scripted and part left for improvisations to uncover emergent behavior that might not have been envisioned in advance. Strong prototyping is another type of bodystorming in which designers build and recreate a space that resembles the real setting for which they will design. Within this space, the researchers evaluate their early prototypes, testing how they play out under different controlled circumstances (e.g., lighting conditions; Schleicher et al., 2010).

A final contribution to the bodystorming literature by Schleicher et al. (2010) is called embodied storming. The authors suggested performing a predesign exercise with the goal of grounding the designers' understanding of the design domain from a first-person perspective. They did so by encouraging designers to act as the people for whom they were designing. These authors suggested this predesign activity is to "first create the experience of physical performance, not to ideate but to enact experiential awareness" (Schleicher et al., 2010, p. 47).

In our research, we focused on appropriating bodystorming for the domain of movement-based collocated social interaction in the form of an embodied ideation method involving a group of designers who are physically and socially active in thinking and experiencing together for possible future designs. In particular, we sought to include this form of bodystorming early in the design process of movement-based interactive activities. This type of ideation activity fits particularly well with theories of embodied interaction, given how it harnesses the embodied experience of designers while engaging in ideation design phases. Designers acting as if they were experiencing a system, or showing how the system would behave, allows them to understand options and issues that arise from their bodily and felt experience.

Appropriating Bodystorming for Movement-Based Interaction

Although a common agreement on the bodystorming method does not exist, the embodied methods above are inspirational. However, none of them have been explicitly postulated for the design of rich embodied experiences in the domain of movement-based interactive activities. Inspired by ours and others' embodied methods, we proposed in the paper "Embodied Sketching" (Márquez Segura, Turmo Vidal et al., 2016) overarching principles for design methods to support a rich embodied experience in the domain of movement-based collocated social play. First, we proposed the employment of embodied methods early in the design process, before the construction of fully functional prototypes, followed by the use of such methods as generative tools and not only as evaluative ones. As introduced before, we advocate for a technology-supported approach that focuses on designing *an activity* instead of *a technology*. Finally, resonating with previous embodied methods, we suggest using and leveraging bodily ways of being, perceiving, and acting to drive creativity.

These design values have been translated in our previous work (Márquez Segura, Turmo Vidal et al., 2016) into five characterizing principles for embodied sketching design practices:

- Employ an activity-centered approach;
- Use the physical and spatial context as a design resource;
- Use nonscripted hands-on activities, harnessing the participants' free ways of acting as a design resource;
- Use both movement and play as a method and design goal;
- Facilitate a sensitizing and design-conducive space, working at the same time towards problem understanding and a solution.

The first two principles reflect on our particular technology-supported approach and the design goal of designing an interactive activity rather than a technology. The third principle and part of the fourth (with regard to the use of movement) draw from theories of embodied interaction in general and from phenomenology and somaesthetics in particular. Somaesthetics is an interdisciplinary field concerned with "bodily perception, performance, and presentation" (Shusterman, 2013, para. 1). It includes theory (analytic somaesthetics), methods (pragmatic somaesthetics), and practices (practical somaesthetics) that foreground the role of the body not only as an object of aesthetic representation, but also as a very valuable tool for aesthetic appreciation, a "locus of sensory-aesthetic appreciation (aesthesis)" (Shusterman, 2008, p. 19).

The work presented in this article takes inspiration from pragmatic somaesthetics, which concerns techniques and methods for honing one's somatic sensibility. Archetypal in this domain are disciplines such as Feldenkrais or Tai Chi (Shusterman, 2006, 2008). In HCI, research programs with an arts and performance background have presented diverse techniques for bodily awareness and facilitation of the felt experience so as to inform design in embodied ways. Recognized works in this domain are those of Schiphorst (2007, 2009, 2011), Wilde (2008), Khut (2007), Loke and Khut (2011), Loke and Robertson (2011, 2013) and Larssen, Robertson, and Edwards (2006), among others.

The last of our principles draws on Schön's (1984) concept of reflection-in-action. Schön understood design as a discipline that foregrounds both problem solving and problem solution. Fällman (2003b) explained this duality in Schön's work:

> If design in this way is seen as the process of unfolding the problem setting/problem solving pair, it makes sense to see the designer as being involved in a conversation—a dialogue—rather than structured and linear process of moving from the abstract to the concrete, regardless of whether or not iterations are allowed. (p. 229)

Our research uses the above principles as an analytical starting point to revisit the concept of bodystorming and to illustrate our appropriation of it in the context of movement-based interaction design. The bodystorming method, as it emerged and was refined in our work, was a form of embodied sketching that allowed designers to generate design ideas from scratch in the context of movement-based collocated social play. In particular, it was used for sketching embodied core mechanics by engaging physically in a play-based codesign ideation activity with peers.

From the start, we thought of bodystorming as an interesting method for generating different embodied core mechanics and for exploring how to support these with different design resources including physical and digital artifacts, rules, and goals that govern behavior (implemented technologically or controlled socially) and spatial and physical features of the environment where play takes place. This article presents one example of a bodystorming session that was in line with the intended purposes (physical collocated social play). It also presents an example of bodystorming in a different domain, where neither the collocated aspect of the element nor physical play was an explicit goal. Yet, in both examples, play and playfulness were harnessed as a design strategy.

Play and Playfulness as a Design Method

Play and playfulness are recognized allies in creative thinking (Brown, 2009; Csikszentmihaly, 2013; Deterding, 2011; Gray et al., 2010; Sawyer, 2012). Novelty, exploration, and appropriation are key features that play brings forward, points recognized by design-driven companies, like IDEO.[1] Tim Bowen, CEO of IDEO, suggested embracing play and playfulness as a design method and highlighted three aspects of play that bring about creativity (Brown, 2009):

- Exploration. Being open to new ideas, embracing divergent and lateral thinking, and asking not only "What is this?" but also "What can I do with this?";
- Building. Engaging in very hands-on experiences of the design materials; and
- Acting out. Having a first-person approach to the design domain and the design solutions.

Gaver (2002, para. 7) proposed playfulness as a way of conducting serious research: "As we toy with things and ideas, as we chat and daydream, we find new perspectives and new ways to create, new ambitions, relationships, and ideals." A person plays as a way of experiencing and understanding the world and oneself independently of one's age. When playing, one tinkers with ideas and artifacts, and it is precisely this play that can render them in a different light.

An important aspect of play is its resignification character, meaning that play can reframe and change the way that any activity is understood (Deterding, 2009; Goffman, 1961; Huizinga, 1955; Poremba, 2007) within the "magic circle of play" (Huizinga, 1955, p. 10). This means that the stakes of what happens in the context of play are lowered, which is particularly interesting in the domain of designing social and collocated movement-based play, where action is exposed to social pressure and judgment. De Kort and Ijsselsteijn (2008) showed how the collocated and social aspect of play could bring about negative feelings, such as shame, embarrassment, and social anxiety. Although they did not study movement-based play, we think this is more acute in such scenarios given how movement exposes people.

To address this issue, we tried to create an atmosphere supportive of physical and social play in the workshops presented in this article. For both workshops, play artifacts were brought into the sessions, which were intended to inspire design resources and design functionalities. Playthings and play equipment can stimulate divergent thinking, which in turn can positively affect creativity (Susa & Benedict, 1994). Also, artifacts different from those that will comprise the final design are useful in triggering unconventional thinking, which can result in novel design aspects, such as functionalities (Djajadiningrat, Gaver, & Frens, 2000). In addition, a demarcated play/design area was drawn with the placement of the play artifacts. Further steps to invite playful engagement will be elaborated later, along with the particularities of the situations they addressed.

BODYSTORMING THROUGH TWO INSTANTIATIONS

The bodystorming method is discussed in this section through two design explorations that belong to different design domains. In the following, we present side-by-side the background of each case, followed by the method, the analysis, and the results, to allow the reader to contrast the distinct design situations and the different ways that these two instantiations of the bodystorming design practice gave rise to different outcomes as the practices unfolded.

Background of Each Design Case

The HangXRT Case

The purpose of this bodystorming workshop was to open up the design space for novel body game ideas that use the concept of hanging as a core mechanic. The first author of this paper was part of an international research collaboration with the Exertion Games Lab (XGL) at RMIT University, Australia. That research group was designing and studying computing technology games that encourage vigorous physical activity resulting in physical fatigue, as usually happens with real-world sports (Mueller, Gibbs, & Vetere, 2008). These types of games have been called exergames (Sinclair, Hingston, & Masek, 2007) and exertion games (Mueller, Agamanolis, & Picard, 2003).

Such games provide a number of advantages, from obvious physical rewards to social (Mueller et al., 2008) and cognitive benefits (Gao & Mandryk, 2012). These perks have been associated with vigorous physical activity (Mueller et al., 2003) and the "casual" aspect of these games that, according to Gao and Mandryk (2011, p. 36), motivate players "to exercise at a moderate intensity for short periods of play" and provide benefits associated with frequent bursts of moderate-intensity activity (Gao & Mandryk, 2011, 2012,). However, many of these positive outcomes do not come exclusively as a result of arduous physical activity. For example, increased engagement, motivation, positive emotions, and social connectedness are also brought about by play activities that involve the body actively—although not necessarily up to the point of exhaustion—as well as the social context where the activity takes place (Bianchi-Berthouze, 2013; Bianchi-Berthouze, Kim, & Patel, 2007; Isbister, Schwekendiek, & Frye, 2011; Kleinsmith & Bianchi-Berthouze, 2007; Lindley, Le Couteur, & Berthouze, 2008; Weerdesteijn, Desmet, & Gielen, 2005).

During the collaboration with RMIT, the first author of this paper contributed to their vision of exertion interfaces, which they envisioned to be "used in the same way traditional sports games function in social relationships" (Mueller et al., 2003, p. 562) with the technology-supported design perspective presented above. One particular project where our interests intersected was a game design in which the group had been involved: hanging off a bar (Mueller et al., 2012). This game was created to probe a novel form of interaction in exertion games, that is, exploiting the interesting disparity between doing "little" (holding a pose) and experiencing an intended heavy physical fatigue. The game had already been iteratively tested by the XGL group at the time of our research group's involvement. Most of the reported feedback from playtesting sessions related to how to improve the particular interface and the particular game design (Mueller et al., 2012). There were also some interesting comments about the physical spectacle that the game offered to the audience

(Mueller et al., 2012). However, embodied core mechanics using hanging as the core had not yet been fully explored, even though hanging showed potential to become a generative concept for novel body games. The first author of this paper organized an exploratory design session to open up the design space of games that could use hanging at the center of a collection of embodied core mechanics to potentially become interactive games.

The Move:ie Case

This bodystorming case provided us with a different application scenario for our embodied technique: the design process of interactive performance, that is, a movie for children with which they could physically interact, assisted by technology. The workshop was organized by the third author of this paper and it took place at the Department of Computer and System Sciences of Stockholm University, where a group of interaction researchers were collaborating with a local artist, Rebecca Forsberg, who directed *Liv*, a short movie for children that was the starting point of the Move:ie project. *Liv* focuses on the experience of a girl who wants to dance and faces her parents' refusal. The goal of the Move:ie project was to come up with technological artifacts or installations that would make the *Liv* movie a bodily interactive movie.

All authors of this paper, together with five more participants, participated in a workshop to explore interactive modalities and designing interactive activities that would relate to the movie. In this context, the first author was offered the opportunity to bring her bodystorming method to shape the ideation process. Due to logistic reasons, we split into two groups of four people each,[1] facilitated within the groups by the first (a proponent of the bodystorming method) and third (the organizer of the Move:ie workshop) authors of this paper.

Deployment of Bodystorming

In the HangXRT Case

This session was planned as a bodystorming workshop with four researchers and designers from the XGL research group; the first author of this paper served as the facilitator and presented the bodystorming method and guided the activity. Play artifacts were provided as design resources for inspiration in the workshop: Styrofoam swords, a Pilates ball, a basketball ball, tennis balls, a skateboard, and Styrofoam mats, among other objects. In order to focus on hanging as a main activity, TRX[2] fitness equipment was attached to fixed eyelets on the ceiling of the hallway near the XGL.

The bodystorming workshop lasted an hour, in which the concept of bodystorming was first introduced to the workshop participants. They were told that they could use any artifact present in the session as inspiration in their enactments; the facilitator encouraged them to come up with new ideas and try them out for themselves. The facilitator also explained bodystorming as structured in a turn-taking manner, meaning that a person would explain and enact his or her own idea and afterwards the rest would be able to try the idea out themselves, to suggest additions, variations, and so forth. The entire session was video recorded with a static camera.

In the Move:ie Case

The entire workshop was video recorded with a static camera (one camera for each group once they were split into two). The workshop was structured in four stages: a warm-up session for the whole group (Step 1), an ideation stage (Step 2) followed by a video packaging of the final ideas (Step 3) for each of the two groups, and finally a joint debriefing (Step 4). The goals for the joint warm-up session were to (a) bring about a playful mindset, (b) get closer to all the participants, and (c) be physically and mentally prepared to engage in a very bodily ideation process. This session was led by a choreographer and the first author of this paper (who also is a Pilates trained instructor) and included Pilates warm-up exercises, dance movements, improvisational theatre exercises, and some informal playground games.

After this warm-up, the participants of the workshop, which comprised several colleague interaction designers and researchers, two movement experts, and the director of the movie *Liv*, were divided in two groups to collaboratively generate a collection of ideas that resonated with the goals and values of the *Liv* movie, which had been introduced previously by the director. In order to facilitate ideation, the facilitators of the workshop (first and third authors of this paper) brought to the workshop spaces playthings (e.g., balloons, pieces of a local outdoor game, toys, modeling clay), crafting materials (e.g., cardboard, colored papers, stickers, pen, markers, scissors), and other materials to tinker with (e.g., clothes). The groups worked simultaneously but independently in separate spaces and each had access to their own set of playthings and artifacts. Participants were encouraged to make use of the space around them and the play artifacts as design resources. Finally, each participant was encouraged to come up with one idea that would be later discussed and iterated with the other participants in a turn-taking fashion. However, the way that this last instruction was carried out in the two groups differed. The first group participants followed a more synthesizing ideation process where participants first generated a number of individual ideas, which were then shared and merged together into four final ideas. This contrasted with the more generative and divergent ideation process followed by the second group, where one idea was presented and collaboratively built on until the idea reached exhaustion (that is, there were no more contributions to advance it further) before moving on to another idea. The latter process is more aligned with the bodystorming design practice that this paper presents and, from here onwards, the paper reports only on this bodystorming session.

The ideation session was structured in two phases (Steps 2 and 3 of this workshop): ideation and packaging. During the first phase, each participant was given 5 minutes to think about a possible design idea aligned with the values of the movie that could complement the movie. Then, one participant would explain and enact his or her idea to the members of the group. Afterwards, the other participants asked clarifying questions about the idea and proceeded to come up with suggestions, joining in as co-creators of the idea by taking away, adding, and changing elements in the original idea (e.g., artifacts, materials). The process continued until the group was satisfied with the concept. This process was repeated for each participant of the group.

After this first ideation phase, both groups paused for lunch and then the workshop resumed. In the packaging phase (Step 3 in the workshop), the participants were given a few minutes to recapitulate each idea and then package it in the form of a video prototype. The last phase of the Move:ie workshop was a joint debrief session once the video prototypes were recorded where both groups met to present and discuss the video prototypes.

Methodological Similarities in the Cases

The two bodystorming cases presented in this article have several methodical similarities. First, the environment was used as a design resource. In the HangXRT bodystorming case, participants used the spatial setting together with the available props. In the Move:ie, several playthings were provided to the participants, which were supplemented spontaneously with artifacts present in the room (e.g., trash bin). Additionally, both were similar in the sense that we researchers advocated a "show, don't tell" attitude, meaning that the participants were encouraged to explain an idea through physical enactment rather than simply describing it verbally. Finally, in both cases turn-taking was used to regulate participation and to collaboratively build ideas, although it was used differently. In the HangXRT case, one participant would suggest an idea and the rest would modify it until exhaustion. Then that or another participant would suggest a different idea, and the whole process would be repeated. In contrast, in the Move:ie case, participants first presented their individual ideas to the rest of the group and, only after that, they used turn-taking to jointly develop and polish each idea. This was designed from the onset of this workshop to make sure that each of the resulting ideas was originally influenced by the expertise and background of the different participants.

Analysis

To analyze the data collected during the two bodystorming workshops, we employed a qualitative interaction analysis approach (Jordan & Henderson, 1995) inspired by conversation analysis of video material (Heath, Hindmarsh, & Luff, 2010). The first and second authors of this article analyzed the video recordings in depth (the first author had participated in both workshops). For each action in the recorded data for each workshop, we noted the contributions each participant made, as well as what he/she contributed to the activity (e.g., suggesting a change, testing something, creating something new), the type of contribution this was (e.g., if it was a comment, a reaction, a suggestion), and how it was made (e.g., if it was a verbal contribution, an action, or a gesture). The way that each contribution influenced the idea active at that moment was also coded with the purpose of tracking the evolution of ideas over time.

The goal of our analysis was to understand the way that embodied core mechanics came to life and how they were supported by an underlying structure of objects, people, rules, space, and other contextual elements. The resources participants used in their ideation process were also analyzed. In particular, we took note of (a) the various artifacts that were used and the roles of these in the process, as well as noting participants' mention of technology that was not present in the bodystorming workshop; (b) the use of the space, for instance, how the players distributed objects around the space or if they used zones for different purposes; and (c) the configuration and roles of the players, that is, where they placed themselves, how many players were involved in each idea, which player pattern they followed.[3] As part of this analysis process, we scrutinized how these elements were combined together within the proposed rules, goals, and other underlying concepts in creating the sketched activity. Finally, those ideas that seemed to be more successful were noted. In the Move:ie case, the chosen idea was the one that the participants presented to their peers as a video prototype. In the HangXRT case, the reaction and behavior of the participants was noted by observing how ideas were received by the group, whether the rest of the group engaged with it and how, and the time they spent on it.

This type of analysis was performed for both bodystorming sessions. However, we also conducted an additional specific analysis for each of them. After the HangXRT workshop, a postsession discussion was held with one participant of this bodystorming event, the first author of this paper, and the director of the XGL, who was part of the design team of Hanging off a Bar but not part of the HangXRT workshop. The goal was to brief the director on the workshop's results and discuss interesting phenomena and opportunities for design. There, the video material was reviewed, stopping and playing back moments whenever a researcher found something interesting, which was further discussed. The discussion centered first on interesting experiential qualities and bodily actions, judged mainly for their novelty within the domain of exertion games.[4] Then, the researchers evaluated the potential of different embodied core mechanics to be further developed into a full-fledged exertion game. Finally, they discussed briefly the way that various design resources supported particular embodied core mechanics. In this article, we focus on this later aspect, which is further investigated in the subsequent video analysis described above.

The separate analysis of the Move:ie workshop involved a type of focus group with the workshop participants. At the end of the Move:ie bodystorming session, the authors of this paper conducted an open and informal interview with the participants of the workshop, focused on their impression and evaluation of the workshop, with an emphasis on the method followed and questions about the structure of the workshop, the materials used, among others. This informal interview will become relevant later in this article, when discussing the characteristics of the bodystorming method, in particular with regard to the method employed and the use of play and playfulness to entice participation and invite creative engagement with envisioned embodied designs.

RESULTS

Results for the HangXRT Case

The analysis of the video recording resulted in the identification of 10 distinctive game ideas[5] that we named (1) "ninja swords," (2) "projections on the floor," (3) "sitting on a ball," (4) "standing on a ball," (5) "flying football," (6) "dodge balls," (7) "lasers," (8) "competitive path following," (9) "hitting targets" and (10) "single legged." Some of these distinct game ideas include identified and distinct variations.

In "ninja swords," a person hanging from the TRX tried to avoid the hits from Styrofoam swords that were aimed at him or her by other participants. In "projections on the floor," a person hanging from the TRX had to move according to some envisioned projections that could be implemented in a future design through a technological intervention; these were represented by small Styrofoam mats that the participants placed on the floor. In the "sitting on a ball" game, a person hung from the TRX while sitting on a Pilates ball and trying to maintain balance without touching the floor. Similarly, in "standing on a ball," a person hanging from the TRX tried to maintain balance while standing on top of the Pilates ball. In "flying football," a person hanging from the TRX had to kick the Pilates ball. In "dodge balls," a person hanging from the TRX had to dodge the tennis balls that the other participants threw at him or her. In "lasers," a person hanging from the TRX had to avoid a burst of imagined lasers that others would shoot, which was created by the sweeping motion of Styrofoam swords by the rest of the participants, simulating laser grids to prevent thefts in action movies. In "competitive path following," two people hung from the TRX (one in each grip) and competed against each other by following an imaginary path on the floor. In "hitting targets," two people hung from the TRX (one in each grip) and they had to compete against each other to "fetch" yellow dots that they imagined appearing on the floor. Finally, in "single legged," a person hanging from the TRX had to maintain balance while standing on only one leg.

Overview Representation

The Bodystorming Braid (Figure 1) presents an overview of the evolution of all embodied core mechanics sketched during the HangXRT workshop. The Braid displays the way game variations built on previous ideas and the way that artifacts and actions appeared, changed, or lingered from idea to idea. Each unit in the Bodystorming Braid represents a sketched embodied core mechanic, which we call an embodied sketch. For each of them, we highlight key game elements that characterize the embodied core mechanic sketched and that support a particular game experience. These elements comprise the goal and rules shaping the activity, a simple key characterizing action at the core of the embodied sketch, and the artifacts involved, which include both physical artifacts and technology mentioned or faked by the participants. (In HCI, faking technology functionality during users tests to focus on the interaction is known as a Wizard of Oz [WoZ] technique; Dahlbäck, Jönsson, & Ahrenberg, 1993. However in such studies users are typically unaware that the technology is not working autonomously. It was different here in that all participants were aware and collaborating toward faking needed technological functionality.) Because of the amount of data presented in Figure 1 to demonstrate the flow of the workshop activity, it is not possible in print format to show much detail. However, to assist the reader, several close up images are provided in Appendix A.

Figure 1 shows how most of the sketched embodied core mechanics had variations (except the games "sitting on a ball," "dodge balls," and "lasers") that resulted from changes in the central action that the players were exploring, the roles and participation of the players, the artifacts used, or the way these were used. Often, a very simple initial embodied sketch was iterated, extended, and developed into a more complex one, such as the "hitting targets" embodied sketch (described below). Figure 1 also provides a glimpse into the participants' engagement with each embodied sketch. First, the length of the representation of each sketch provides a sense of how much time the participants engaged with it, which might be an interesting indicator of the success of a particular embodied core mechanic. In the subsection below, we show how some sketches quickly faded away while others captivated the attention of the whole group who either tested the sketch longer, polished it further, or explored different variations that maintain key aspects of the original sketch. Moreover, the Bodystorming Braid in Figure 1 gives a sense of the generative quality of embodied sketches, as those that originate from, and share strong family resemblances with, a sketch are grouped together as variations of this sketch.

Finally, Figure 1 includes screenshots (most visible in Appendix A) to give the reader a sense of the ongoing activity and some general indication of the use of space. However, the details of how the activity unfolded cannot be fully captured in either Figure 1 or Appendix A. Therefore, this representation is complemented with three rich descriptions of embodied sketches to provide a better sense of the general vibe of the workshop and the activities that were created there.

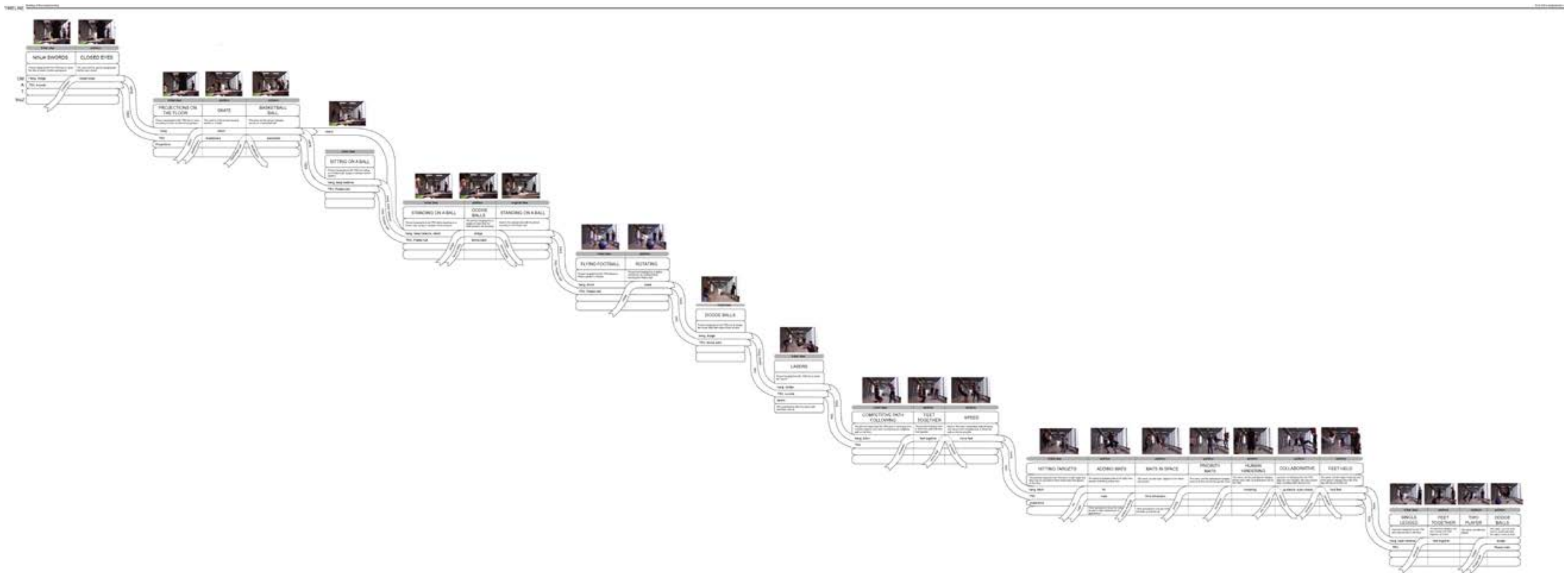

Figure 1. Bodystorming Braid. The figure is to be read horizontally, that is, from left to right. It is accompanied with screenshots from the video recordings of the HangXRT workshop. Due to the size of the Bodystorming Braid, it is not possible to present a single image containing it that at the same time is readable. A larger version is available at http://tinyurl.com/odxx6o6. Each unit in the graph represents an embodied sketch. For each embodied sketch, the Braid specifies a brief description that can include the rules, player roles, and game goal. It includes two other elements that conform to the sketched game activity: the core mechanics and the artifacts used. Finally, it represents two additional categories that relate to the bodystorming method: (a) the "envisioned technology" category, which illustrates particular technologies to support the game activity; and (b) the "WoZ" (Wizard of Oz) category, which shows how players take over the role of this technology or other game artifacts (or equipment) that are not present in the bodystorming session. The figure depicts the way the embodied sketches evolve over time giving rise to sketch variations and completely new ones. For clarity and information, a series of close-up images and explanatory texts that comprise this Figure are provided in Appendix A.

Three Illustrative Instances in Detail

The first embodied sketch illustrates the generation of several other embodied sketches. It is also a good example of a design ideation process driven by the creation, addition, and modification of embodied core mechanics as they are sketched. The second embodied sketch presents a different type of ideation process, driven by the addition, change, and removal of artifacts. The final example demonstrates an embodied sketch that did not succeed in creating a game idea that satisfied or interested the participants. This example is chosen to illustrate how ideas emerge and are discarded. Each of these illustrations presents the original embodied sketch and its variants focusing on describing the resources involved, the rules and goals of the game idea, and the behaviors of the participants (and the observer participants), thereby providing the reader with a glimpse of empirical evidence that we collected and the type of video analysis performed.

Example One: "Hitting Targets" - A Core Mechanic-Driven Process. The embodied sketch "hitting targets" had a total of six variations; three will be described in detail. At the beginning, two people were hanging from the TRX, each one holding one of the TRX's ends. The group had suggested a competitive task: Each player had to compete to be the first to catch an imaginary yellow dot that "appeared" randomly in the environment. Originally, one of the idea originators who was hanging from the TRX was the one to call where the dots appeared, for instance, picking a spot on the floor and shouting to the other player, "There!" Both of them would then swing from the TRX to reach the spot as fast as possible (see an example in Figure 2). This idea was welcomed by the group, who enriched it by adding new artifacts and embodied core mechanics. First, the group noticed that the person who called the dots always was the first to arrive. Thus, the observer participants took control of the dot's appearance, making the game fairer. The idea was then modified into the embodied sketch we named "adding mats." The participants who were not hanging from the TRX grabbed some Styrofoam mats and threw them onto the floor as a way to simulate the appearance of the dot. The two hanging players had to rush to be the first one to step on the mat (Figure 3). After playing a few rounds of this embodied sketch, a rule changed the play activity toward a more challenging embodied sketch. Now the mats would not only be on the floor, but the participants simulating the appearance could also suspend them in the air, adding a new dimension and increased difficulty for those hanging from the TRX (Figure 4). While the mats originally had been introduced as a way to simulate visual dots, their meaning had been playfully reimagined into real objects that could float in the air.

Figure 2. Game idea "hitting targets" Participants rush to catch the imaginary yellow dots first.

Figure 3. “Adding mats.” Iteration of game idea “hitting targets.” Participants rushed to hit the mat first.

Figure 4. “Mats in space.” An iteration of game idea “hitting targets.” Now the mats were placed in three dimensions.

After playing with the mats variations for a while, one of the TRX players tried to prevent the other player from reaching his or her goal. This was done by pulling down on his or her end of the TRX, which in turn hindered the opponent’s trajectory of movement (who was swinging to reach the spot). The players (and the observer participants) appreciated the move and the game continued in this mode for a while. We called this variation “human hindering.” The essence of the initial embodied sketch was maintained, but a new key core action was added: hindering by pulling the TRX. This changed the overall game goal from just reaching the spot to hindering one’s opponent’s movements toward the spot while trying to reach it. This in turn created two distinct player roles: one player would focus on reaching the spot while the other was more focused on hindering the opponent. This embodied sketch modification, like most of them, was introduced without any verbal discussion.

In the subsequent iterations, other key player actions and rules came into focus and that of hindering was dropped. One variation involved two other players tasked with helping one of the eyes-closed TRX players reach the spot. Another variation, called “feet held,” involved the TRX player initiating a swing movement while another participant held his or her feet. When the player achieved some momentum, the participant holding the feet would let go and the TRX participant would let go of the apparatus and “fly” through the air in an attempt to hit the mat.

Example Two: “Flying Football” - An Artifact-Driven Process. Throughout the workshop, many ideas surfaced where the variations were driven by the addition of or changes in artifacts. The embodied sketch “flying football” retained one artifact (the Pilates ball) from a previous sketch (e.g., “standing on a ball,” where a player hanging from the TRX had to maintain balance atop the Pilates ball). The challenge of this latter embodied core mechanic sketch seemed to excite the rest of the designers, four of whom tried it out. However, one designer slipped while atop the Pilates ball, unintentionally kicking the ball away. Subsequently, the participant came up with the next embodied sketch, “flying football,” in which the TRX-hanging player kicked the Pilates ball away (Figure 5). The main goal and embodied core mechanic of keeping balance while standing on a ball was dropped, but the core action of having a person hanging, as well as the TRX and the Pilates ball (artifacts) were kept.

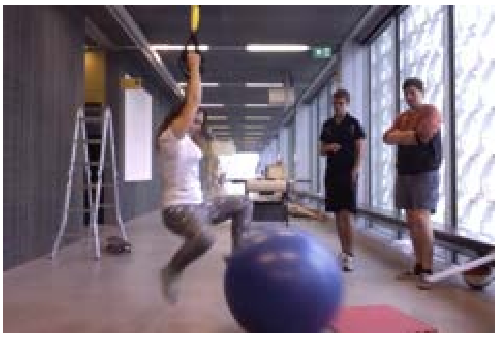

Figure 5. Game idea "flying football." Participant hanging from the TRX connected the shot on the Pilates ball.

Example Three: One Failure Story. The embodied sketch named "standing on a ball" can be followed in the interaction analysis shown in the table in Appendix B. Due to space reasons, only an excerpt of the analysis is provided. In the "standing on a ball" embodied sketch, Participant 4 (P4) introduced and sketched his idea, which consisted of grabbing the TRX and keeping balance on top of the Pilates ball, without falling from it. From almost the beginning, P1 suggested that the person on the TRX should avoid something that would be thrown at him or her. She grabbed a tennis ball when suggesting this addition, but the suggestion was not implemented when mentioned. Meanwhile, P4 seemed to enjoy struggling to keep his balance while turning slowly around towards P1. It was not until both P1 and P4 established eye contact that P1 threw the balls, which became the embodied sketch of "dodge balls." The players did not pick up on the idea of dodging balls and P4 kept on with the original embodied sketch of "standing on a ball," with P2 and P3 trying this sketch out.

Characterizing the Bodystorming

Ideas typically emerged one after the other without much hesitation. Pauses were rare; only two occasions of notable pause took place. The first period of hesitation (lasting 25 s) occurred at the beginning of the session, when a participant started to explain verbally what to do to the other participants. The facilitator stepped in to encourage active participation in a show-don't-tell fashion. The other occasion (lasting 40 s) followed the "dodge balls" embodied sketch, when the team discussed verbally what to do next. P4 said, "*What about like 'resident evil,' like red lasers coming through that you have to avoid them...*", which was followed by P2's reflection regarding the common features of the embodied core mechanics sketched (e.g., balancing when having an unstable object as support, such as wheels or a ball under your feet). This was followed by a pause, in which P4 starting swinging from side to side on the TRX. None of the suggestions took hold until later, when P3 revisited one idea: "*I like the laser idea,*" which was welcomed by P4 who suggested a particular way of implementing it: "*Let's try with the swords….*" P3 continued the reflection, "*Because the laser is... is... something that with the digital thing…*"

Participants were mostly active and engaged both in physical play and in discussing options, taking a very active bodily stance towards the ongoing activity. As for the spatial distribution of the participants, they would typically surround the TRX with a very hands-on attitude ready to participate: They would assist those sketching (explaining or playing at the center) by handing in new materials or helping in any other way to sketch the embodied core mechanic (e.g., holding the big ball when somebody wanted to step on it). They also pinpointed issues and suggestions to fix problems, like when one participant pointed out that the length of the TRX was troublesome, to which another participant responded by fetching a ladder to shorten the TRX straps. Often, participants enacted the role of technology, faking its functionality and showing the outcome using artifacts (in a manner that bears resemblance with the Wizard of Oz technique, Dahlbäck et al., 1993, used in HCI). Artifacts seemed to work as physical anchors for the projection of the functionality the participants envisioned for the technology.

One example of envisioned usage of technology can be found in the embodied sketch “projections with skate” where the participants anticipated a technology that would project certain patterns on the floor and the participant holding the TRX while atop a roller skate would need to either avoid or follow. Another example appeared when sketching “hitting dots” and its variations, explained previously.

Artifacts were in the scene at all times, even when not playing a part in sketching an embodied core mechanic. Participants were often fiddling with them while talking. Sometimes, this nonpurposeful handling gave rise to new ideas, such as the “ninja swords” idea, which was suggested by P4 who had been holding swords in his hands for some time. Occasionally, these artifacts led to play disconnected from the main play activity, as when two participants who were holding toy swords engaged in a play fight.

Post-Session Discussion

This section summarizes three related experiential qualities that were discussed by the three researcher-designers (the first author of this paper, a participant of the workshop, and the director of the XGL) to continue with the researchers’ discussion about the bodystorming method. As previously stated, the discussion took place right after the HangXRT workshop.

In & Out of Control. One of the interesting experiential qualities that the group regarded as common in successful embodied core mechanics sketched and was considered to have design potential was the feeling of moving in and out of control of your own body and your movements, especially in relation to the space and the other participants. In the video, many instances of surprise can be seen from those hanging when they suddenly found themselves closer to somebody else or at a different location than expected, which usually brought about laughter.

Balance, Stability, and Unusual Positions. The three researcher-designers noted that many instances of fun came from experiencing movements in a new way. In particular, a focus of discussion was how hanging altered the experience of gravity as the participants’ fulcrum point changed when swinging, which was caused by the characteristics of the hanging apparatus the TRX (e.g., its length, mobility) and the type of grabbing, leaning, and hanging on it that this equipment afforded. Balance or the control of equilibrium was challenged, as was the user’s stability or the capacity to return to balance. Exertion came as a response to regaining balance, but sometimes the outcome of this resulted in unexpected situations (as discussed in the in- and out of-control quality). The challenge increased for coordinated action. For example, in the “human hindering” variation of “hitting targets,” when one player interfered with the movements of another, this resulted in spinning in unexpected directions and a lack of coordination.

Ilinx. Related to the previous experiential qualities, part of the discussion revolved around one particular sensation, which was described as Caillois' ilinx (Caillois, 1961). Derived from the Greek term for whirlpool, Caillois described it as behaviors "based on the pursuit of vertigo and which consist of an attempt to momentarily destroy the stability of perception…. It is a question of surrendering to a kind of spasm, seizure, or shock which destroys reality with sovereign brusqueness" (1961, p. 23). Caillois directly associated ilinx with core mechanics such as swinging, "being projected into space, rapid rotation, sliding, speeding, and acceleration of vertilinear movement, separately or in combination with gyrating movement" (p. 24), all of which can be recognized in our workshop.

Design opportunities discussed revolved around the type of exertion that hanging invited. Muscles not typically used in everyday life exercises were used and in unusual ways. The researchers commented that climbing and other sports that require pulling one's weight off the floor used similar muscles as this bodystorming workshop, but those other activities typically involve fixed structures, like a bouldering wall. This was also the case for the game "hanging off a bar." However, the dynamic and flexible character of the TRX artifact posed an extra challenge to stabilization, adding swinging as a core action and bringing in the experiential qualities above.

Finally, the bodystorming method was discussed. The researchers involved in the debriefing who had also participated in the workshop commented on how the physical setting of the workshop contributed to the goal of including design resources beyond a conventional piece of technology, inspiring them to use the environment or other physical artifacts in ways they had not thought about before. The setting encouraged them to think holistically and about how several of these components could be combined and used. They also commented that bringing in play artifacts both constrained and enhanced the play activities in ways that contributed to idea generation. Considering the use of play as a method for design, the group discussed the way in which play lowers the stakes and provides a social frame that permits doing "the embarrassing." This was also a design quality that the group at the RMIT was exploring at the time (see, e.g., Huggard et al., 2013).

Results for the Move:ie Case

As explained above, the results presented from the Move:ie workshop reflect the outcome from the one group that most closely followed the bodystorming method. This group produced four different scenarios based on one originating contribution from each participant. Within each scenario, at least one final idea developed, the result of joint collaboration among all the group's participants and video recorded to be presented to the other designer group. This section presents the four scenarios with the various ideas that emerged within them, resulting from the joint ideation phase of the group that was facilitated by the first author of this paper.

Design Scenario: "Sandbox"

The first scenario (named "sandbox" after one of the initial ideas that opened up the design space) explored a solution for outdoor children's play that involved physical materials alongside projections. The original idea included a sandbox onto which something would be projected. Such projection should encourage the children to move in ways that reminded of the movie itself (e.g., drawing beautiful lines in the sand in a fluent manner could represent the aesthetics of ballet dancing of the movie, sudden movements that disrupt these initial ones could represent how the main character rebels against the rules imposed by her society, high energetic movements could represent the energy of the main character to thrive, movements that reached to usually unexplored corners of the sandbox or that dug deep in the sand could represent the explorative and rebelling nature of the main character).

A second idea developed after the original one that envisioned a similar activity for users, but introduced a change of material and technology. Instead of sand and projections, there would be a water fountain alongside lights that would encourage the children to move in specific ways. However, this second idea was not developed further and the group returned to the original proposal. Other suggestions included changing the material to, for instance, Styrofoam or other moldable materials. Moreover, the possibility of including lights was discussed, and using established physical games, such as the statues game, was considered for inspiration. Several contributions built on the original idea. For instance, P3 suggested gamifying the experience: to come up with a game in which the children could unlock some item to take but, in order to do so, they should dance in a certain way. Other suggestions departed more from the initial idea. The possibility of the children "owning spots" was explored, which brought back the idea of unlocking a material on the ground in order to take it. The possibility of leaving traces on the material was also proposed.

As the ideation process continued, sometimes new concepts would be brought in or the participants would combine new ideas with ones that had appeared before. Some ideas that had been discussed earlier and pushed to the background would resurface but changed, combined, or just further developed. For example, the concept of unlocking something appeared first in the gamification idea, then disappeared from the discussion for a while, but later came back to stay. By the end of the ideation phase, the suggestion that prevailed was having an installation where children would move and when the music stopped they would have to perform a specific movement in order to unlock something to retrieve an item.

After the break and during the packaging phase (Step 3 in this workshop), all the participants were given some time to recap their earlier design idea before they packaged it into a video prototype. As a result, they reconceived some ideas (e.g., merging both the projection idea and the unlocking process) and some core mechanics (e.g., moving objects in a certain pattern). However, they could not reconcile them into a single idea. Three ideas appeared instead that were discussed in detail before the video documentation. In the first one, children would have a reactive moldable surface under which artifacts would be placed. In order to unlock the moldable surface and take the artifact, children would push around the hidden artifact until it was under the "right spot" and only then be able to take it. In the second version, children would dance on top of a similar moldable surface following a specified choreography; a successful and accurate completion would unlock the artifact underneath for the children to take (Figures 6 and 7). In the last idea, the moldable surface would be "alive," meaning reacting to pressure on top, adjusting to the shape of whomever or whatever exerts the pressure, like ergonomic adaptable mattresses. With such a surface, children could nestle against the surface, which would react to their movement and embrace them (Figure 8). The original idea in this scenario was inspired by *Liv*, borrowing the concepts of empowerment and ownership by doing, acting, and moving, as well as the idea of a resulting impact from that doing, acting, and moving.

Figure 6. Design scenario "sandbox." Participant kept performing the dance around the responsive, moldable surface to unlock an artifact beneath.

Figure 7. Design scenario "sandbox." The participant performed the dance well and proceeded to collect the unlocked artifact.

Figure 8. Design scenario "sandbox." The surface almost covered the participant.

Design Scenario: "Bubbles"

In this idea's original conceptualization, kids would explode bubbles that could be real or created through augmented reality. Further additions comprised the inclusion of the parents; the creation of rules, such as the parents guiding the kids into exploding the bubbles; using geocaching to find bubbles; and so on. What was interesting about this idea, in comparison to the previous one, was that every suggestion revolved around the original idea of the bubbles and the core mechanic of exploding them. In the final idea before lunch, children and parents would play together in an augmented reality collaborative mobile game. Children would have two artifacts, one for creating augmented reality bubbles and one for exploding them. The parents would be able to see through their smartphone where in the virtual space the bubbles had moved after the kids had created them and they then guide their children to the bubbles so that the children could explode them. The entire gameplay would be recorded by the mobile phone, with the extra augmented layer on top, for the parent and child to watch together afterwards (Figure 9). The original idea in this scenario was inspired by the movie, borrowing the concepts of believing and trusting what is not apparent to the sight. Later variants also included the value of joint collaboration.

Figure 9. Design scenario "bubbles." After exploding the bubbles, the participants replayed the game on their smartphone.

After lunch, the participants had a period of recollection on the idea that surfaced immediately before lunch, recalling the technology involved and the rules proposed, as well as the roles of parents and children. They identified elements that could be used in the enactment and proceeded to record the video. However, new additions were not made nor were elements dropped and thus the idea did not have any changes after the lunch break and was represented as its final iteration before lunch.

Design Scenario: "Monster"

One participant proposed a design scenario that took as inspiration the movie's theme of children's fear and how to overcome it. The original idea was a monster that was guarding a token that the children should retrieve. The participants came up with a number of suggestions and additions throughout the ideation process, going back and forth from one to the next, back to an old idea, coming up with new ones, combining some, and so forth. Overall, in all ideas the technology was discussed to be embedded in an ambient installation. Some of the ideas envisioned the monster as a physical one, some thought about it as displayed on a screen, and some considered it as something omnipresent (i.e., something that could be felt in the environment, e.g., with music and lights). Children's movement in the design was also discussed, for example, depending on how the children moved, the monster would be able to see them or not. Another suggestion was to create a collaborative game where the children would work together to beat the monster; an agent (adult) was included as a guide throughout the installation.

In the ideation period before the lunch break (Step 2 of the workshop), the prevailing idea involved the kids doing things/dancing alone, surrounded by a not very welcoming ambient technology environment. However, when more children join in, the environment would calm down. After lunch, during the packaging phase (Step 3 of the workshop), the idea was further refined through a brief ideation phase that mainly revolved around the way the children would move, along with other core mechanics. Synchronization among players was settled upon as "the way to beat the monster." The concept of a token was also brought back: The monster would react in a hostile way to a child whose intention was taking a token away from the monster. In order to beat the monster, the child had to move in sync with somebody else (Figure 10). If successful, the monster would be blind to their movements, position, and actions, and hence they

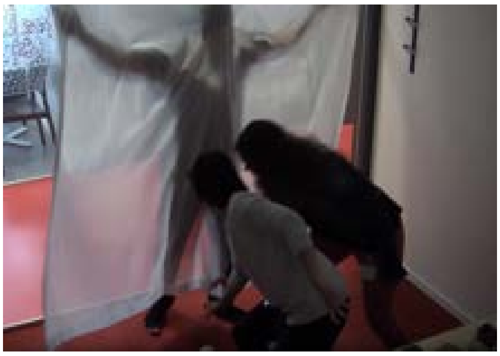

Figure 10. Design scenario "monster." Two participants moved in sync in order to take the token (a ball) from the monster (participant behind the curtains). When the participants moved in sync, the monster could not see them. The participants were able to take the token and the monster was defeated.

would be able to take the token from the monster, which would be defeated. In this last idea, the concept of collaboration that pervaded the first half of the ideation phase lingered. However, some questions remained open, for instance, whether the monster would have a physical or virtual form.

Design Scenario: "Flash mob"

This last scenario was inspired by a particular scene of the movie in which the main character, a child, runs away frustrated because of the obstacles put before her by the adults in her life, that is, not allowing her to dance. The child goes to a muddy vacant lot where she starts to dance with passion. Suddenly, she is dressed up as a ballerina and sees herself surrounded by several dancers who lift her off the floor, spinning her up high, as the prima ballerina she is. The scenario borrowed the idea of believing in oneself, of being lifted, of imagining a situation that beats reality and living it to make it real.

For this scenario, a very complex system was envisioned, including a physical and social activity implemented in the form of a technology-supported flash mob. In line with the scene from the movie described above, when the time came to dance, the music would encourage children and their parents to come and progressively join the dance. The surrounding environment would react to "lift" (i.e., raising from the floor) the dancers with audio and visuals inspired from that scene. When envisioning this design, it was clear that it would involve a complex system. For example, it would include building a social network to support participants to form an online flash mob community that would organize group rehearsals and big flash mob events, upload and share content for rehearsing individually (e.g., videos with the choreography), engage in discussions (e.g., about aesthetic matters, like what to wear for the flash mob or how people should join the choreography when the flash mob starts), and the necessary preparations for the next flash mob. Designers envisioned that users of this system would be both children and their parents. An important design feature would be that content in this social network could be accessible from local devices (e.g., their phones).

From this initial idea, several suggestions and additions followed. For example, the concept of ownership was discussed: It was deemed important that, when engaged in a flash mob, children felt they would own the space through their movements and dances. The group soon decided to simplify the design goal and the designed system and focus only on supporting an ongoing flash mob activity. To facilitate the ideation activity, it was also suggested that the design should focus on a particular setting, for example, a mall. Some ideas contributed to defining what the supportive surrounding environment would look like, such as using projections on nearby walls. Other alternatives were considered, such as including some sort of intelligent agent in a physical or digital form who would mirror the children's movements as an in-situ guide or choreographer. This notion of an agent or the environment to "lift" and support the children was then flipped into thinking about how children with their dancing would influence and "lift" the space around them, be that the environment or an intelligent agent.

At the end of the ideation phase, the idea that prevailed was that children, in a certain public setting, would empower an intelligent agent by lifting it, helping it bloom. The initial idea of the flash mob was slightly pushed to the background. During the packaging phase, the participants underwent a phase of idea polishing, discussing elements in the design context such as the role and look of the environment, the role of children's dancing, and the type of intelligent agent (e.g., whether an avatar displayed somewhere or a physical robot). A great deal of the discussion revolved around about how to implement the idea on video, given the difficulty of representing a reactive environment with the available materials at the workshop. Ultimately, the idea was enacted as follows: The walls of the mall would display scenes of the movie and a physical robot would be placed in the middle of the space. Children would gather around it and dance around it, "lifting" it. The robot would reflect the children's movements, expanding its shape and growing in physical engagement (Figure 11). The idea of a set choreography was pushed to the background in favor or a more casual and free engagement.

Overview Representation

The analysis of the video material resulted in long data logs in which the bodystorming process was chronologically transcribed. The authors of this paper involved in the analysis tried to depict these data sheets graphically, showing the evolution of design ideas in a similar way as the HangXRT project. However, concrete ideas were rarely present in the discussion. Instead, participants were going back and forth with concepts, features, materials, and values that appeared, disappeared, and evolved. Some disappeared for a while only to be resurrected later, sometimes as a modified version. For instance, at the beginning of the ideation of the "monster"

Figure 11. Design scenario "flash mob." The "child" helps the "robot" to rise from the floor.

scenario, we participants discussed introducing a token, but that element disappeared from the final idea before the lunch break. However, it was reintroduced during the second ideation phase before recording.

That the visualizations as chronological representations of the participants' contributions failed to clarify the details entered into our data sheets triggered discussions within our research team regarding the nature of the design ideas generated in this workshop. A closer look into how and when vague ideas were polished and concretized showed this happening primarily when designers were discussing activities: that moment when multiple abstract and vague ideas converged to form one concrete activity. We authors observed that, except for the "bubble" scenario, this convergence happened explicitly when designers prepared to record the video (packaging phase), that is, when they had to agree on how to enact their ideas in the video.

However, further differences among the scenarios regarding their convergence to concrete ideas were also noticed, which necessitated closer investigation. In this article, a double diamond design process model (n.d.) has been used to illustrate the divergent and convergent phases of each scenario. The model typically depicts these phases in relation to the development of a product or design process or the deployment of a service. As the name suggests, the model entails two iterative cycles, with each involving a divergent phase followed by a convergent one. In the first cycle, during the divergent generative phase, the design space is opened up to allow for exploration and for surfacing various possibilities and alternatives. Afterwards, during the convergent phase, the generated ideas are defined, shaped, clarified, and prioritized in relation to certain criteria. In the second cycle, or "diamond," another divergent phase follows, where ideas are further concretized and also tested. The cycle ends with a convergent phase where a final solution is reached.

In the four scenarios, the first ideation phase, represented in the first diamond or cycle highlighted the types of ideas discussed, for instance, a particular material or technology. The first cycle ended before lunch, when participants supposedly had settled on several ideas to represent and video record in the afternoon. A second diamond began after lunch and involved the polishing of the ideas and concluded with a description of the idea that was enacted and video recorded. The balance of this subsection presents the various scenarios with elaboration on how they conformed to the canonical shape of the double-diamond model. Any exceptions to this model are highlighted and we discuss possible reasons for why these cases did not conform.

Figures 12 and 13 represent the "sandbox" scenario. The first part of the ideation phase was divergent. Contributions in this phase ranged from suggestions about artifacts, materials, values, and core mechanics, as well as some discussions about the technology. Figure 12 represents the type of ideas discussed, while these are fleshed out in Figure 13 as concept bubbles that appear, linger, or disappear throughout the different ideation phases. A convergent phase followed, motivated by the requirements of the workshop (i.e., to generate one solid idea before lunch). The ideation phase hence finished with a set of design elements in the form of activity goals and vague core mechanics, such as the children moving according to music and unlocking and/or picking up material. This is reflected in an abrupt end to the convergent phase in Figure 12, without a concrete and defined idea. After lunch, the participants tried to recap the ideas from the morning by engaging another divergent phase in which some earlier surfaced ideas were kept while others were added (e.g., the use of a surface material that adapted to the pressure and body movements). Additionally, old and new core mechanics were discussed, as seen in Figure 13. In the prelunch ideation phase, certain

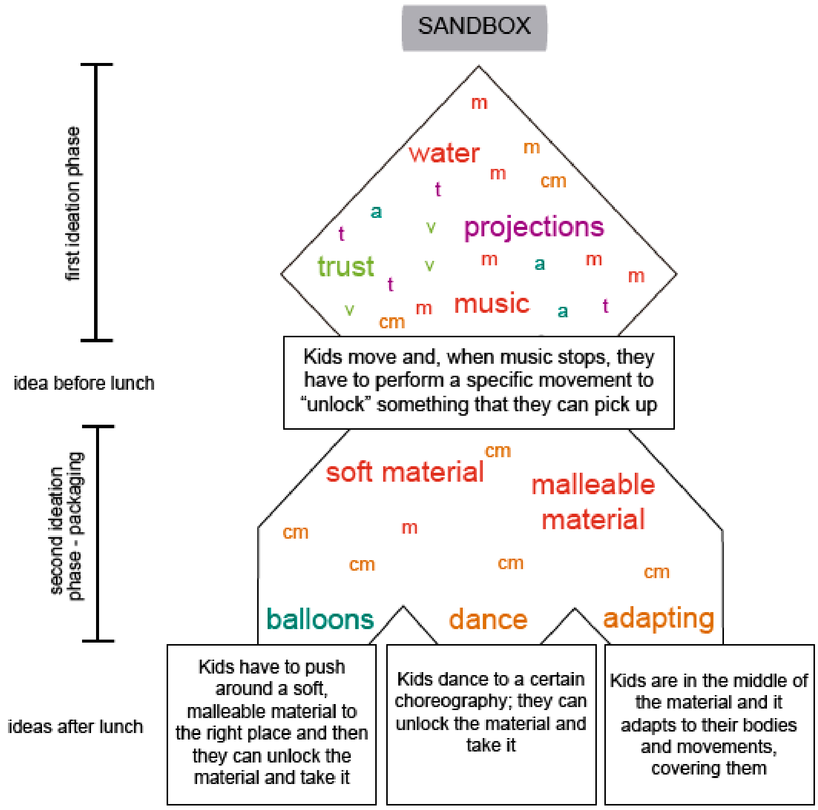

Figure 12. “Sandbox” double-diamond-inspired representation. The representation is to be read from top to bottom. The colored letters inside the diamond are the abbreviations for the different elements involved: *Cm* stands for core mechanics, *v* for values, *a* for artifacts, *m* for materials, and *t* for envisioned technology. Some of the components are labeled (e.g., material/artifact), although these are not favored in any particular way nor do they represent the final idea. They were chosen to illustrate examples of elements discussed during a particular cycle. However, for space reasons, most of the elements discussed by the participants are represented only by letter symbols. Nevertheless, every element that was discussed in each section is represented with its corresponding initial so as to have a sense of what was discussed.

elements, such as materials (sand, water), appeared early and remained throughout most of the ideation phase. Some of the elements that conformed to the first idea (mainly core mechanics, such as moving, unlocking, or dancing) were picked up again after the lunch break. At this point of the design process, the participants seemed to struggle with trying to converge on one idea and they discussed several mechanics that seemed to dispute one another (see, in Figure 13, the mechanics of move vs. unlocking and the mechanics to unlock and choreography vs. malleable). Unable to settle on one idea, the participants decided to present three different solutions, as shown in Figure 12.

Figure 14 represents the ideation process for “bubble,” which is a very particular case because the participants did not need a second ideation-phase after lunch. At the beginning of

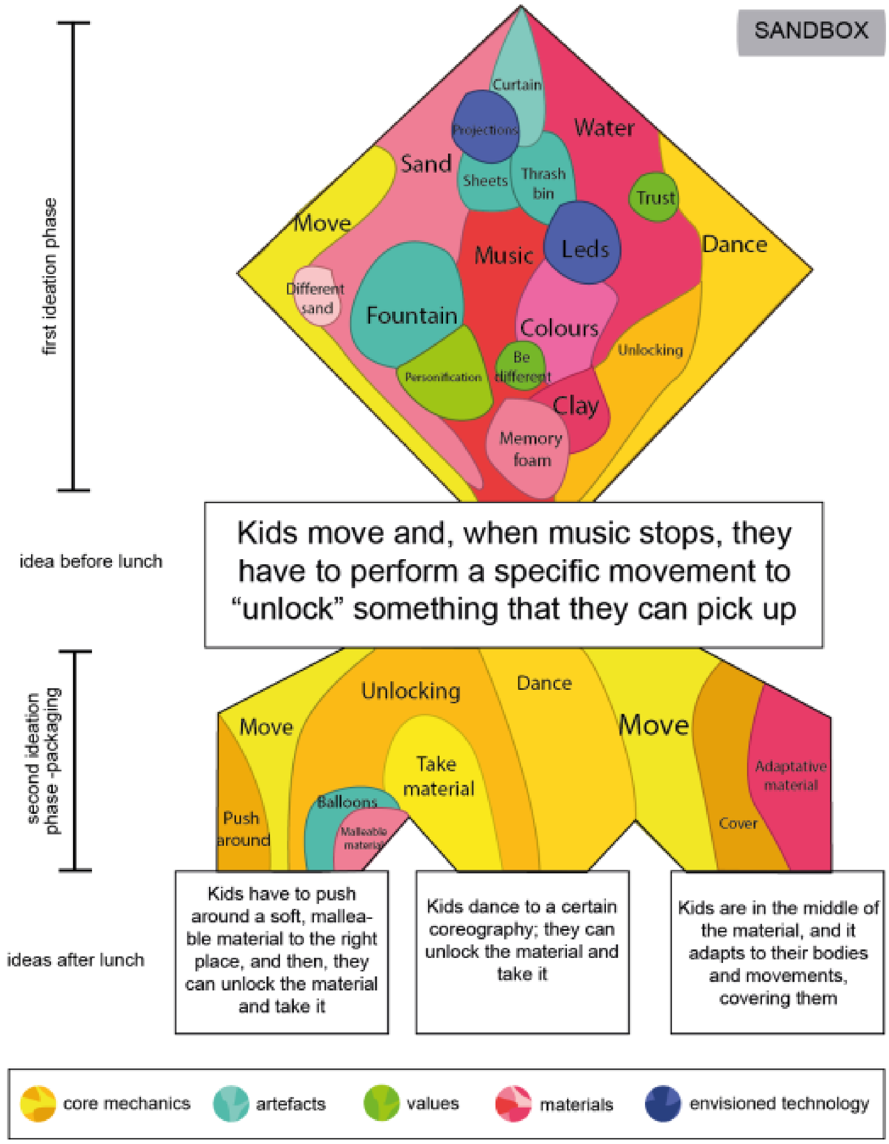

Figure 13. Double-diamond qualitative representation of the "sandbox" scenario. In this representation, the involved elements (i.e., core mechanics, artifacts, values, materials, envisioned technology) have been represented as concept bubbles that appear, linger, and/or disappear throughout the ideation phases. The size of the bubbles does not follow a quantitative criterion; rather it helps to broadly illustrate that a particular idea provoked interest and engagement in the group (reflected in the width of the bubble) and provides an overview of the time of appearance and duration of the elements involved (depicted in the vertical axis). Therefore, ideas that provoked reactions to multiple people are depicted as larger than those that were suggested by a single person and did not provoke big reactions. As an example, the core mechanic 'mov.' appeared quite early in the divergent phase of the first diamond. It was present in the first idea (in the box). During the second ideation phase, during which participants packaged their ideas, the concept was picked up on and used in two of the three ideas. This process can be observed in the rest of the elements. During the after-lunch ideation phase, most of the concepts discussed were core mechanics, which can be observed by the predominantly yellow color during that phase. It is important to mention that in the element artifacts included the physical elements present in the bodystorming session (e.g., balloons, curtain, sheets, trash bin) as well as evoked artifacts, in this case the fountain.

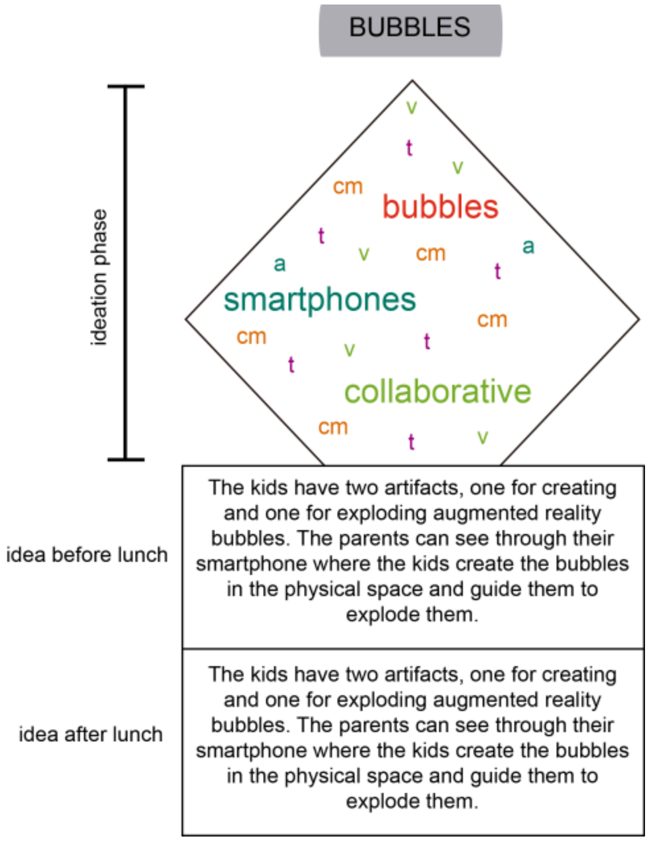

Figure 14. "Bubbles" double-diamond inspired representation. The representation is to be read from top to bottom. The letters in colors inside the diamond are the abbreviations of different elements discussed: *Cm* stands for core mechanics, *v* for values, *a* for artifacts, *m* for materials, and *t* for envisioned technology. Some of the components are labeled (e.g., material/artifact), although these are not favored in any particular way nor do they represent the final idea. They were chosen to illustrate examples of elements discussed during a particular cycle. However, for space reasons, most of the elements discussed by the participants are represented only by letter symbols. Nevertheless, every element that was discussed in each section is represented with its corresponding initial so as to have a sense of what was discussed.

the workshop, there was a divergent phase—where designers proposed several materials, core mechanics, values, and artifacts—and a convergent phase, which resulted in a final idea that was clear and well defined in terms of its goal, rules, core mechanics, and even technology to use. Therefore, in the posterior packaging phase after lunch, only a brief discussion was held about what artifact the child would use and the idea was ready to be recorded.

Figure 15 represents the "monster" scenario. In this case, designers experimented with a broad divergent phase with multiple suggestions and additions mostly regarding values and envisioned technology, but also regarding materials and artifacts. The core mechanics were just vaguely touched upon. The following convergent phase was brief, giving rise to a vague and open idea depicted in the first diamond. After lunch, during a recap period, the group discussed possible core mechanics, such as how the kids should move together in sync, and the artifacts, hence entering into a small divergent phase. That resulted in an idea that could be enacted,

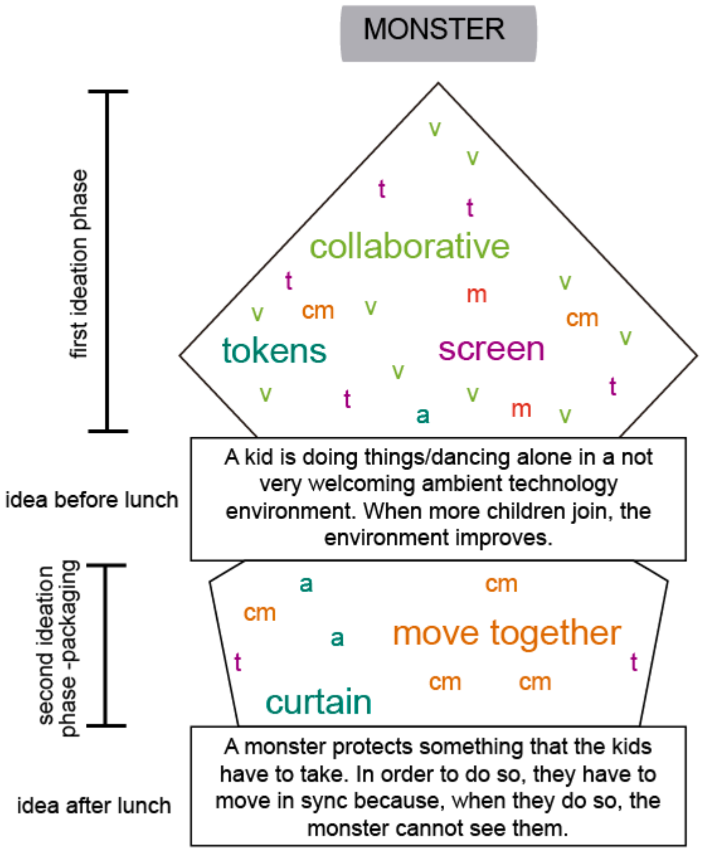

Figure 15. "Monster" double-diamond inspired representation. The representation is to be read chronologically from top to bottom. The letters in colors inside the diamond are the abbreviations of different elements discussed: *Cm* stands for core mechanics, *v* for values, *a* for artifacts, *m* for materials, and *t* for envisioned technology. Some of the components are labeled (e.g., material/artifact), although these are not favored in any particular way nor do they represent the final idea. They were chosen to illustrate examples of elements discussed during a particular cycle. However, for space reasons, most of the elements discussed by the participants are represented only by letter symbols. Nevertheless, every element that was discussed in each section is represented with its corresponding initial so as to have a sense of what was discussed.

although some elements were not specified, such as how the children would move or how "the monster" would scare the children. However, even as the group was recording the idea, they improvised these elements without discussing further. This is represented with the small convergent phase at the end of the second diamond.

Finally, Figure 16 represents the "flash mob." This scenario most resembles the typical double-diamond shape. It started with a divergent phase, where a variety of elements, such as values (e.g., public ownership), core mechanics (e.g., dancing to a scene, "lifting" a figure), artifacts (a wall), and envisioned technology (e.g., use of screens to show the video, use of an online platform to debate and organize) were proposed and discussed, resulting in a first idea (convergent phase): Kids in a public place would empower an interactive intelligent agent by

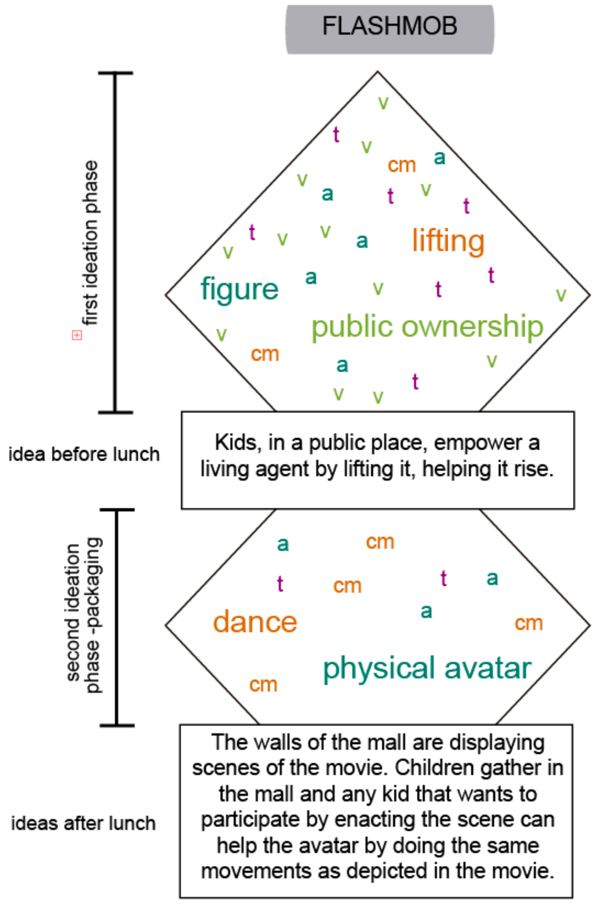

Figure 16. "Flash mob" double-diamond inspired representation. The representation is to be read chronologically from top to bottom. The letters in colors inside the diamond are the abbreviations of different elements discussed: *Cm* stands for core mechanics, *v* for values, *a* for artifacts, *m* for materials, and *t* for envisioned technology. Some of the components are labeled (e.g., material/artifact), although these are not favored in any particular way nor do they represent the final idea. They were chosen to illustrate examples of elements discussed during a particular cycle. However, for space reasons, most of the elements discussed by the participants are represented only by letter symbols. Nevertheless, every element that was discussed in each section is represented with its corresponding initial so as to have a sense of what was discussed.

"lifting" it. After lunch, the second ideation phase began with a divergent phase in which some elements were added (mostly core mechanics) to the original idea, resulting in the final scenario: musical and dance scenes from the movie displayed on the walls of the mall. Within the walls, children would gather around an intelligent agent that would react to their movements and interactions. Some of the children would dance around this agent as a means of "lifting its spirit."

Characterizing the Move:ie Bodystorming

Discussions and suggestions in the postsession discussions involved identifying abstract concepts, values, and material properties. Embodied core mechanics were frequently vague and convoluted. Many of the considered ideas involved interactive activities that were difficult to enact fully for several reasons, such as the involvement of very complex technology that was not possible to recreate and capture on video (e.g., in the "flash mob" or the "sandbox" scenarios), or that the targeted place where the activity would take place was significantly different from the workshop environment (e.g., the "flash mob" that was intended for a public space, like a mall), or that some ideas not only happened in a real-time collocated space, but also involved interaction at different moments using different technologies (like the original idea of the "flash mob").

Physical engagement and usage artifacts happened primarily during the packaging phase, when the participants had to represent and enact the ideas. However, some participants used the artifacts during the ideation phase to build part of their ideas and to explain them to the rest of the group. For example, in the "flash mob" scenario, P2 used an oval-shaped item about the size of a hand to represent a mobile device that the children would use and carry to access videos of the choreography, snippets of the movie, and tips to recreate the scene. The device also could allow the children to contribute to these categories with their own content (e.g., dance move suggestions).

Another example was during the "sandbox" scenario in which P3 put a curtain on the floor to explain her original idea. P3 explained her idea by showing how she imagined that projections would appear in the sand and how children should move from one projection to another. The curtain initially represented the sandbox, but then became a representation of projections on the floor when another participant suggested this. This example shows a frequent observation: Artifacts were used as physical anchors to project nonpresent artifacts or novel nonexisting technology. This is consistent with theories of embodied cognition related to how people "think with things" (Kirsh, 2013, p. 26) by projecting ideas onto a physical artifact.

Artifacts were also evocative tokens that helped to inspire ideas. In a few instances, a participant who was fiddling with a particular artifact came up with an idea related to it or its features. For instance, while exploring the "sandbox" design scenario, one of the designers, P4, suggested changing the sand to a different material: "*I'd like it to be different from ordinary sand,* [rather] *something that we can throw up*" into the air, to which some reflections on and suggestions followed, such as using Styrofoam balls. P1, who had been holding and fiddling with modeling clay, said, "*Now I am like, all the time, playing with this and you have brought up the idea of a material that is different. I was thinking, what if the sand, instead of sand,* [it] *would be something, perhaps not as soft as this, but...*" which redirected the material idea toward a softer, moldable one.

Additionally, artifacts helped polish the ideas once a particular object became something of importance in the eyes of the participants and they manipulated, acted on, and discussed it. For example, for the "sandbox" scenario, stepping on and around the cloth on the floor helped the designers to think about and propose different game/activity goals, as well as interesting core mechanics the material discuss would afford. Abstract and vague ideas were also refined and polished in the packaging phase when participants enacted their ideas in order to video record them. This is when we, as researchers during the analysis phase, observed the appearance of more defined embodied core mechanics. See, for example, the scenario case of "bubbles," in which during the ideation phase, a wide variety of core mechanics were discussed and, even before lunch, the idea was ready to be video recorded.

In general, a strong fictional atmosphere existed throughout the workshop. Participants engaged in pretend play to enact the usage of their envisioned activity, acting as if they were people in their scenarios, like a child and a parent in the "bubbles" scenario, and as if they were technology, like in the "monster" scenario. Yet, during the video recording, a voice over was added to narrate the ongoing activity and explain what the technology was doing: Prior attempts without this feature seemed, to the participants, to leave unclear to somebody outside the workshop the full potential of the idea.

CHARACTERISTICS OF BODYSTORMING

The following section reflects on the commonalities and differences between the two bodystorming studies, in particular with relation to the activities that emerged at each workshop, the outcome, and the usefulness of engaging in this type of embodied ideation method. Both instantiations gave us a glimpse into what it means to use bodystorming at an early stage of a design process. In both cases, it was intended to open the design space by exploring possible designs from an embodied perspective. In both sessions, we as researchers employed a similar bodystorming method, with a strong physical and social aspect, encouraging designers to engage physically with their ideas, and using turn-taking to regulate social engagement and promote collaborative cocreation of ideas.

Usefulness

The distinct design situations, as well as differences in how the bodystorming was carried out in each workshop, gave rise to different results. Yet, the bodystorming was found equally useful in both workshops to support embodied creative thinking, which was key to reach to such results. Our analysis (see Figure 1 and Appendix B) of the HangXRT workshop showed how the ideation process flowed and how new ideas emerged naturally from the very active, social, and physical participation of designers. The social cocreation play aspect of this workshop allowed the participants to work together towards the common goal of making the in-the-moment experience fun in a very hands-on manner—discarding or modifying embodied core mechanics that did not work while enjoying and improving those that did. The outcome of the bodystorming in the HangXRT was a collection of sketches of embodied core mechanics and a new set of interesting experiential qualities to add to those the XGL Lab had explored with their game “Hanging Off a Bar.”

Regarding the embodied core mechanics, the HangXRT workshop was particularly useful not only for sketching novel ones, but also for investigating what made them work well and why. This type of investigation was conducted by (a) designers thinking in action (Schön, 1984) as they were bodystorming, that is, by choreographing their activities by arranging the artifacts they had around, by setting rules and goals, and involving technology; and (b) by us researchers in a posterior analysis of the designers’ actions during the bodystorming, focusing on understanding what designers did, why, and the impact this had in the ongoing play activity.

Regarding experiential qualities, designers at XGL who were familiar with the game “Hanging Off a Bar” were particularly interested in the quality of ilinx that was encouraged through hanging from a pliable suspension equipment like the TRX. This characteristic of the hanging equipment arguably made the play activity more dynamic and allowed for a new repertoire of bodily experiences associated with balance and stability, compared to what static suspension equipment, like the rigid structure used in that game, would allow. These new embodied core mechanics also supported a rich embodied experience in the sense that players were engaged with and attentive to several artifacts, people, and the space around in ways that were dynamic and unpredictable, which contrasts with the way that a player's attention is designed to be directed towards the big screen and the floor in the "Hanging Off a Bar" game. This opened up new possibilities for design.

On the other hand, the open nature of the Move:ie workshop, with no constraint other than coming up with design ideas that bore links to the movie *Liv,* allowed for the emergence of a wide diversity of ideas. The bodystorming method helped the designers to probe a set of relevant concepts, materials, and values for the design task at hand. These could have been discussed via a traditional brainstorming-type design activity, but the bodily engagement that characterized ideation in our workshop allowed for interesting connections to come to life when envisioned activities were enacted and when envisioned materials were projected onto the available artifacts, which is supported by theories of embodied cognition and dance research (Kirsh, 2013):

> Human bodies can be used for all sorts of cognitive purposes. In particular, humans use their bodies not just to act on the world and enact or cocreate a personal world, they use them to represent, model, and ultimately self-teach. They use their bodies as simulation systems, as modeling systems that make it possible to project to unseen things that would otherwise be more inaccessible. (p. 3:27)

The choreographic aspect of design in this bodystorming activity took on the challenge of abstracting, relating, forming, and phrasing (Blom & Chaplin, 1988) in a coarse, sketch-style manner. This was particularly apparent in the materialization of concepts and experiential qualities into embodied core mechanics, as well as in the extraction of interesting experiential qualities from embodied core mechanics.

Activity

The type of bodily activity and resulting outcome in both sessions differed substantially. Movements and physical enactment were used in both, but how and why these were used contrasted. Physical engagement in the Move:ie case embodied a more pretend and fictional character than the HangXRT case, and much of the physical activity of the designers revolved around simulating and pretending to be something or someone else. However, the designers in the HangXRT case engaged directly with activities that were very closely related to what the final activity would be; they had to simulate only some functionalities of technology.

So, although physical activity was key for cocreation in both cases, it was more instrumental in the Move:ie case because designers used their bodies, the space, and the artifacts around to illustrate, explain, and package ideas instead of participating, living, and experiencing their ideas, as in the HangXRT workshop. Yet, in both cases, acting ideas out—either when explaining concepts or packaging them like in the Move:ie case or when playing with a particular embodied core mechanic at HangXRT—inspired interesting modifications and changes of ideas as well as the introduction of new ones.

Play and Playfulness

Participants in both workshops commented on the benefit of having a playful mind-set during the ideation activities in order to explore out-of-the-box ideas, regardless of looking silly or awkward. Both bodystorming sessions presented a wealth of play instances in different forms, such as physical play (more prominent in the HangXRT case), playing with materials (in both bodystormings, with designers fiddling with artifacts), and several forms of pretend play (like when animating objects using the WoZ technique, using artifacts as if they were others, or engaging in role-enactment, which are canonical examples of pretend play; Susa & Benedict, 1994). A very dynamic and energetic vibe in both sessions was also apparent: first, in the HangXRT case, where play was a design goal and, second, in the Move:ie case, where play was not an explicit design goal but the participants still related to an atmosphere of playfulness.

Earlier in this article, relevant concepts and strategies were highlighted as a means to instill playfulness and to build a safe play circle to spur creativity for the participants. In both sessions, the physical space of the bodystorming activity was demarcated with play objects and other tangible artifacts that helped to inspire a playful mindset. This seemed to be enough for the HangXRT participants, given how ready they were for physical engagement; but they are designers and researchers accustomed to active engagement with their and others' play artifacts and prototypes. In Move:ie, however, the participants had mixed backgrounds and play was not a design goal in itself. For them, the warm-up session was important to help them step into the magic circle of play. During the postworkshop interviews, the participants mentioned that the warm-up helped them to loosen up, to feel more comfortable with (their) movements, and to feel close and comfortable with each other, which they found very important for designing embodied interactive activities.

Moreover, we think the warm-up helped us as researchers to infuse a playful atmosphere, enabled participants to feel more at ease with their bodies and their movements, and instilled a spirited mood that continued into the design activity. We credit this to the after-effects of moving together or the residual spin-off of movement, which arouses "feelings of aliveness, aliveness in a personal and existentially vibrant sense quite apart from an energized readiness to resume everyday activities" (Sheets-Johnstone, 2010, p. 2). This is also connected to the classical after-effects of playing together as described by Huizinga (1955), where players have a residual bond with the play activity, feeling connected to players and play afterwards.

Artifacts

The artifacts in both bodystormings were key drivers of the ideation process, although in slightly different ways. In the HangXRT, the participants were inspired by the playthings available to create game elements, functionalities, and actions, which supported the creation of game core mechanics. The play artifacts' affordances, constraints, and symbolism inspired game ideas, and so playthings became game obstacles, like when the Styrofoam swords became lasers to avoid; resources, like the roller skate to navigate the space without touching the floor; or indicators of some sort, like when participants used the mats as targets that randomly appeared in the space. Both the swords and the mats were animated using a WoZ manner. For example, the swords became lasers when a participant simulated their "killer beam" and their sound as a participant walked with it, drawing trajectories to avoid.

Artifacts in the HangXRT workshop became particularly useful in action: As the play activity unfolded, participants moved themselves and moved the artifacts so new dynamic affordances[6] emerged, which in turn triggered new ideas. For example, the initial goal of avoiding a killer laser in the "lasers" embodied sketch became that of contorting to avoid a burst of beams when they used two nearby swords to hinder the player's movements. In the Move:ie case, the artifacts were very important evocative resources. Similar to the HangXRT case with the swords and the lasers, it could be seen in the Move:ie workshop how just handling and fiddling with a particular object triggered new ideas. But while artifacts triggered ideas for action in HangXRT, in Move:ie they often triggered discussions about concepts and material properties. For example, in the "sandbox" scenario, the handling of modeling clay elicited discussions about the material properties including malleability, adaptability, and reactiveness. Objects were also used as demonstrative and explanatory resources in the initial phase of individually envisioning an interactive activity to present their original ideas, such as when a participant "built" a handheld device prototype to explain the "flash mob" scenario, using it to explain how a technological artifact could be used.

Technology and WoZ

An interesting aspect of the bodystorming method in the HangXRT case was how technology appeared in the ideation process even if the workshop was not focused on technology design. Still, some ideas elicited possible technology and technology usage, which emerged in a very ecological way, considering the rest of the design resources. We as researchers found the WoZ practice (Dahlbäck et al., 1993) that emerged very interesting, inasmuch as it allowed the participants to foresee possible future issues that might appear when the technology was in place. For example, when playing the "hitting dots" game, two players were throwing "the dots" on the floor, simulating how they would appear in an automated version of the game. As they played, they realized that they would need some sort of rules regarding their appearance. This in turn triggered a game variant in which dots appeared in the space in a way that made them think about which type of environment could support this type of 3D projection.

In Move:ie, participants were explicitly told to design technology for their interactive scenarios. As mentioned before, participants in this workshop also used pretend play to animate objects and record what the technology would do in their scenarios. Yet, this activity was not called WoZ because the technical complexity of the technology discussed made it difficult for the participants to fake technology functionality. In their recordings, when engaging in pretense usage of technology, they needed to add a narrative voice-over to explain what the technology did and how this affected the users. Hence, in this bodystorming activity, artifacts acted as physical anchors to project envisioned technology.

Analysis, and Representation, and Embodied Core Mechanics

In both bodystormings analyses, we tried to follow a similar fine-grained type of qualitative interaction analysis, noting the contribution and participation of each participant the use of artifacts and the space. However, the results of this analysis varied due to the distinctly different types of activity the participants engaged in and the outcomes. In the HangXRT project, ideas where discussed mostly by playing, complemented with brief commentaries. However, the general attitude was to participate hands-on, bringing in a new artifact or taking over the spotlight and changing something in the embodied core mechanic. Meanwhile, Move:ie discussions relied heavily on verbal interaction, although participants used artifacts

The object of discussion was, therefore, different in both situations: observable embodied core mechanics that designers played at HangXRT, in contrast with the Move:ie case, with abstract concepts, material properties for the most part, although some core mechanics were also fed into the discussions (during the ideation phase). This gave rise to different types of representations of results. We found particularly illustrative for the HangXRT to show a fine-grained chronological account of actions (see Figure 1) so as to offer interactional details important to form an understanding of how the activity evolved in this bodystorming workshop. We also found it useful to depict the evolution of embodied core mechanics with the Bodystorming Braid, showing the artifacts involved, as well as the rules and goals governing action for each embodied core mechanic.

Trying to visualize data coded from the video analysis for Move:ie proved more challenging, as few embodied core mechanics were present and the chronological contribution of the participants involved mostly abstract concepts. However, use of the double-diamonds model (n.d.) allowed us to illustrate a particularly interesting finding: The ideation activity was mostly divergent, with vague and abstract considerations, until the moment when participants settled on a particular activity and discussed the core mechanics involved and how they would materialize into an embodied activity with concrete formal components that would support them, including technological and physical artifacts. This typically happened when participants had to enact the ideas for their video packaging (except in the "bubbles" scenario). But due to the different types, the characteristics, and the number of concepts discussed during the initial ideation phase, we found it challenging to represent them inside each of the diamonds. Thus we opted for depicting only the type of ideas discussed, whether it was a value, an artifact, a material, technology, or a core mechanic. Yet, we realized that this quantitative illustration could not depict the way that concepts evolved and influenced one another. In trying to address this challenge, we worked toward a more qualitative representation, as shown in Figure 13. In this type of visualization, the appearance and the lingering of ideas discussed are represented inside the diamonds. Although their size does not follow an exact quantitative criterion, the vertical axis gives a sense of the timing of appearance and duration, while the width reflects how a particular idea was echoed in the group (whether it provoked the interest and engagement of one or more participants and the valence of such interest/engagement). Hence ideas that provoked reactions, either positive or negative, appear larger than those that were only picked up on by one person without a big reaction.

DISCUSSION

The section Appropriating Bodystorming for Movement-Based Interaction points to a set of guiding and characterizing principles in embodied sketching design practices that served as a guide for our bodystorming method. They are repeated here:

- Employ an activity-centered approach;
- Use the physical and spatial context as a design resource;
- Use nonscripted hands-on activities, harnessing the participants' free ways of acting as a design resource;
- Use both movement and play as a method and design goal;
- Facilitate a sensitizing and design-conducive space, working at the same time towards problem understanding and a solution.

These principles are revisited here in light of the bodystorming cases presented in this article, along with some of the embodied methods presented in the Background section (those in which the bodystorming method is specified with enough detail to be contrasted with our principles).

The HangXRT case was focused on exploring and developing an activity around the core mechanic of hanging. This workshop gave rise to embodied sketches of various embodied core mechanics. As such, this bodystorming workshop centered on designing an activity in which the outcome presented sketches comprising small chunks of activity and important resources to support these activities (i.e., sketches of embodied core mechanics). The physical and social settings in which the activity unfolded became and were used as design resources, as did elements like the TRX, the artifacts and props brought in for the workshop, and the players acting as, or pretending to be, technology. The presence of these elements was key in allowing the various embodied sketches to emerge and in how they interacted with one another. The design resources acted together in a dynamic way, evolving as the activity unfolded, which in turn afforded or invited new potential relevant action. For example, artifacts in use gave rise to sequential affordances, and the use of several artifacts together gave rise to nested affordances (Gaver, 1991). This made ideas flow as participants engaged in a hands-on and nonscripted manner with one another and with other elements around, sketching different embodied core mechanics.

In this bodystorming workshop, movement and play were central to the design goal (i.e., interactive movement-based social play). They also were leveraged to generate the ideas because this bodystorming process fundamentally consisted of idea creation—as well as idea enhancement or evolution—through play.

In the case of Move:ie, the aim of the workshop revolved around creating movement-based interaction concepts to form interactive performances, which is an activity-centered goal. We as researchers led the participants to use movement and play during a warming-up session before the bodystorming sessions, with the intention of facilitating the use of both movement and play during the workshop, as well as their impact on the design process. In the ideation phase, we researchers saw how participants used artifacts and the physical and spatial contexts to discuss and cocreate different ideas, which then converged to form the articulated scenarios. The process in which these ideas emerged and materialized was nonscripted and hands-on. Yet, until the final phase (i.e., video packaging), these ideas did not fully concretize. During the process of enacting the different scenarios, the participants posed new questions, leading to new solutions emerging or old ideas being resurrected.

Regarding the embodied ideation methods presented in the background of this article, some of them fulfilled several of the principles above, but none encompassed all of them. Appendix C presents the various embodied methods, which are analyzed using the guiding principles that characterize the bodystorming method presented in this paper. The principal differences between these methods and our examples are summarized below.

M. M. Bekker et al. (1995) studied the designers' use of characteristic movements of user actions in order to communicate behavioral details. The example they provided was service-centered, and movement was found to be used as a communication tool. These authors did not mention of the use of contextual resources that support the practice. Arvola and Artman (2007) proposed using gestures alongside sketches and techniques drawn from improvisational theatre in order to express design concepts and design qualities. The design goal in their example was product-centered and movement was again mentioned primarily as a means for communicating ideas rather than supporting idea generation. Brandt and Grunnet (2000) explored how refrigeration technicians operated in a research environment in order to develop a design concept for a service tool; they also used techniques borrowed from theatrical practices. Although their approach was activity-centered, their design goal was product-oriented. Also, they used strongly scripted scenarios with the people engaged in role-playing. They did use physical resources, such as a typical refrigeration technician's tools, but it is not clear how the physical and social context influenced design. Blomkvist and Arvola's (2014) service walkthrough used an embodied approach for the evaluation of prototypes. Although the physical and social contexts where the service was located were taken into account, they were used as a backdrop against which to evaluate the prototype rather than as design resources. Moreover, the people taking part in the service walkthrough acted according to predefined roles. Finally, in Buchenau and Suri's (2000b) extensive set of examples of experience prototyping, different cases fulfilled one or more of our proposed principles. However, none of them fulfilled all five principles. For instance, their exploration of a train journey was distinctly activity-centered, with the goal of understanding how users would behave in such a situation. The participants were placed in a real train, but they were instructed to role-play following a scripted set of situations. In their "Experiencing an Airplane Interior" example, the aim was to explore a physical space of an airplane for passengers, with the researchers using semiscripted situations to look at how people behave in the context of an airplane. All of the examples provided by Buchenau and Suri can be seen in Appendix C.

Regarding other versions of the bodystorming method that have been reviewed in this article (i.e., Oulasvirta et al., 2003; Schleicher et al., 2010), those approaches were artifact-, service-, or technology-centered and the design activity revolved around designing, prototyping, or testing concrete things (e.g., Schleicher et al.'s design for a new cafeteria food order system). Furthermore, some of those methods emphasized early prototype testing (e.g., use-case theatre, strong prototyping), while our work as researchers focused on initial explorations to open up the design space. These other bodystorming methods used performative techniques (e.g., use-case theatre) and fictional scenarios (e.g., strong prototyping), but did not use physical and playful engagement for creating a mind-set conducive for explorations and creativity.

Embodied Core Mechanics and Core Mechanics

In this section, we reflect upon the concept of core mechanics and embodied core mechanics as they appeared in our workshops. The prior section titled Embodied Core Mechanics Designing the In-the-Moment Activity presented the original concept of core mechanics from game design, noting these are essential actions employed to advance in a game. We added *embodied* to this concept to highlight an embodied approach to the design of core mechanics. This approach looks at how core mechanics can emerge and are supported by important components of physical and social activities, such as the physical and digital artifacts present or envisioned, the formal or improvised and agreed on rules governing behavior, and elements and characteristics of the sociospatial setting, such as the arrangement of participants involved, their role, and relationship. These components are considered design resources for the design of movement-based physical and social activities from an embodied interaction perspective (Márquez Segura, 2016; Márquez Segura et al., 2013).

In this paper, our descriptions of the design ideas, particularly in the Move:ie case, often used the term *core mechanic* without the embodied prefix. This is not an oversight, but an intentional act. The simple actions discussed in that bodystorming case were usually vague, broad, or decontextualized, and mostly discussed without specifying how those actions would happen and which designed (or contextual) elements would be needed for them to happen.

Examples included "unlocking," "moving," or "push around" (Figure 13), which were mostly discussed without specifying what exactly was unlocked or moved or pushed around, and how this happened. This contrasts with the embodied core mechanics at the HangXRT workshop, which are actions that required and used a certain set and arrangement of play artifacts, formal elements, such as rules and goals, as well as specific sociospatial elements, such as a certain number of players with specific roles each. Hence, an embodied core mechanic is designed by considering simultaneously particularly interesting actions and the activity elements, supports, or resources that participants can use to make these actions happen.

Both ideation cases followed an embodied interaction perspective because, in both, participants harnessed their bodily, social, and situated in-the-moment experience to cocreate, discuss and sketch design ideas for physical and social activities. However, embodied core mechanics were mostly visible and designed during the HangXRT workshop.

Assessing Success

Throughout our analysis of the two bodystorming cases, we as researchers often stumbled over the concept of success and how to assess it. In this subsection, we reflect upon the success of our bodystorming cases. The goal was not to assess how successful each of the ideas generated was on its own or in terms of how feasible or profitable it would be if fully implemented; rather, we were interested in reflecting on the success of bodystorming as an ideation method.

In the HangXRT case, we consider the bodystorming method successful in the sense that the entirety of the activity was engaging and generative. Ideas appeared and generated variations in a fluent and high-paced way. Sometimes an idea would appear as a possible solution to something that was not yet working. For example, in the embodied sketch of "projections on the floor," when a player tried to move from one place to another while standing on a skateboard and holding the TRX, the skateboard seemed to limit the type of movement he or she could do. As a result, P4 commented "*As long as the skateboard is there, we don't have that much room*." This participant suggested using a basketball instead because this artifact would not limit the movement to a straight line as did the skateboard.

Other variant sketches appeared as alternative possibilities that fit into a game activity that was already working. For example, the embodied sketch of "standing on a ball" seemed successful in terms of play, fun, and engagement. The participants were visibly enjoying it with frequent laughter and wanting to get involved (four out of five tried it out). Yet even when ideas were successful in terms of play, fun, and engagement, they often were still iterated to include more challenges by adding constraints, such as the requirement to keep one's feet together or to keep up speed. Regardless of whether an embodied sketch evolved into another to rectify something that was not working or because it generated new possibilities of an already working game idea, we posit that embodied sketches are successful as generative tools and recommend this bodystorming method as an ideation design practice.

In relation to the Move:ie case, we consider it successful as an ideation method when observing how, throughout the different ideation phases, a series of concepts (e.g., values, artifacts) emerged from participants' direct engagement with one another's ideas, with artifacts in the room, and with imagined artifacts projected onto the elements physically present. On the other hand, we researchers had expected greater physical involvement from the beginning of the workshop, but it was not until the participants were "forced" to converge on one idea that direct physical engagement with the sketched interactive activity was visible. The evolution from vague to concrete, from abstract ideas—many in the form of concepts, materials, and values, and also some fuzzy core mechanics—to embodied core mechanics, was challenging. However, after the initial hesitation, participants managed relatively well the redirection from the ideation dynamic of the first half of the workshop to the more physical, social, and performative in the second half. We relate this successful transition to our warm-up session at the beginning of the ideation day; this was supported by the participants' feedback during our informal interviews.

Packaging the Ephemeral

There is a clear analogy between the bodystorming activity as presented in this paper and what has been considered the quintessential design activity: sketching (Buxton, 2007; Fällman, 2003a, 2003b; Schön, 1984). A very important aspect of the sketch is its capacity to "talk back" to the designer (Buxton, 2007; Fällman, 2003a, 2003b; Goldschmidt, 1991; Schön, 1992). As Buxton (2007, p. 115) put it, a sketch is "a catalyst to stimulate new and different interpretations." In the process of sketching, new parts of the design (its components) can be understood, new relationships can be discovered, and new interpretations can be drawn. A general characteristic of a sketch is the way it "reports thinking that took place somewhere else" (Fällman, 2003b, p. 230).

Our embodied sketches, as well as the result of other embodied methods presented in this article, have the particularity that they are not persistent but ephemeral (Arvola & Artman, 2007; Johansson & Arvola, 2007). They are shaped as the activity unfolds, but then disappear afterwards. This presents a critical point for interaction design, as others (e.g., Arvola & Artman, 2007) also have pointed out: How can an embodied sketch be packaged for later reflection? A straightforward answer can be extensive documentation with video recordings. We have presented different ways that we employed to try to capture embodied sketches. For instance, the Bodystorming Braid (Figure 1) presents in a glimpse what happened during the bodystorming session in terms of embodied core mechanics, specifying the artifacts that were used, and the envisioned technologies proposed by the participants. Even though Figure 1 is illustrated with screenshots from the video, it falls short in depicting the spatial setting in terms of the locations of players and their movements. In order to explore a possible solution to this issue, our research group members have started working with augmented videos that show raw material augmented with annotations in the form of the Bodystorming Braid. Yet this format might become time consuming for the viewer if the sessions are too long. Also, it is not suitable for paper-based dissemination. In such a case, a traditional interaction analysis might fit better, even though this type of representation takes up a large amount of space. In our research, we discovered that an analysis of a short interaction (about 30 s) resulted in eight pages of an interaction excerpt. A piece of such an excerpt can be found in Appendix B.

In the Move:ie case, another type of documentation was presented: one inspired by the double diamond design model (n.d.). This model focuses on representing the divergence and convergence of the ideation session with more (Figure 13) or less detail (Figures 12, 14, 15, & 16). Yet, these representations did not step-by-step detail each idea addition and how it changed the final scenario. In addition, the video packaging of final scenarios were challenging in this bodystorming activity in that the participants' enactments and the objects shown were just the skeleton over which participants had been projecting and discussing other objects and uses, which was only partially captured on video. This made for a video-packaged outcome that was not self-contained and arguably unusable for outsiders who did not participate in the bodystorming session or its analysis.

An anecdote can serve as evidence of this. The third author of this paper, together with the first author and three other colleagues who had not participated in our bodystorming workshop, was drafting a paper about novel bio-sensors and bodily tracking technologies to design interactive performances (a later version of that paper will be published as Rostami, McMillan, Márquez Segura, Rossito, & Barkhuus, 2017). The authors used the Movie:ie workshop and another previous workshop organized by the third author of this paper to explore the role that sensor-based interaction modalities could take in the context of interactive performances. In the draft, the "flash mob" scenario was described by the third author of this paper as follows:

> *In this physical toy, the movement and physical interaction with the object would be detected, and certain forms of play, relating to the character that it represents, would change the state of the toy and leave shadows of the movement for the next person who interacts with it. Here, the object is left in a specific state for the next player to interact with.*

This artifact-focused description presents the design as a toy that reacts to a participant's movements, which is quite distinct from the actual "flash mob" idea. Note that the description was written by an individual who was not involved in the ideation session where the flash mob was conceived and who used only the video recordings of the packaged ideas to generate such description. This demonstrates that some very important nuances of the idea were not identified in the video package, such as the inspiration for the flash mob or the values of lifting and empowering.

To mitigate issues like this one, future work could potentially use the video prototypes that the participants created at the packaging phase alongside an overlay of annotations. Exploring different forms of documenting the bodystorming method and a study of the impact of documentation in the bodystorming process itself are other ideas for future research.

IMPLICATIONS FOR APPLICATION

This article contributes to the literature for designers and researchers working in the domain of movement-based, collocated social play by presenting an appropriation of bodystorming methods designed to be used in that particular domain. The bodystorming method proposed here takes an embodied and situated perspective of action and focuses on sketching meaningful embodied interactions through the use of play, movement, and physical and social engagement. This method and our design approach can be classified as intermediate-level knowledge forms (Höök & Löwgren, 2012; Löwgren, 2013), theoretically and methodologically grounded in phenomenology, ethnomethodology, and social psychology, and substantiated by empirical work reported here and elsewhere (Márquez Segura, 2016; Márquez Segura, Turmo Vidal et al., 2016).

The design approach presented in this paper is a technology-supported one focused on the design goal of understanding, exploring, and sketching embodied core mechanics as they appear and are supported by a variety of design resources that collaboratively support such experience. The concept of embodied core mechanics refocuses design on the future in-the-moment activity by leveraging the present moment that unfolds when designers engage in the physical and social experience of moving together. Another implication for design comes from the suggested analysis and documentation forms, which can be of assistance to those designing in a similar domain and focusing on embodied core mechanics. With this research, we contribute to the body of work of choreographic design processes (Pirhonen, Tuuri, & Erkut, 2016). In particular, we think our research findings can assist researchers and designers who choreograph movement-based activities in a world inhabited by digital and physical objects that mediate and support our activities and experiences.

CONCLUSIONS

This article presented embodied ideation methods for movement-based interaction that have been revisited and appropriated by proposing a form of the bodystorming method for the design of embodied core mechanics. This ideation method reflects a technology-supported approach to design in the context of movement-based collocated social play in which the role of the designer is that of a choreographer in a sociotechnical landscape of physical and digital artifacts. This approach has been substantiated in this paper with concepts from others' and from our own research. Our approach to the bodystorming method in design research has been illustrated through two different workshop sessions. The HangXRT case related to our application domain (collocated social and physical play) while the Move:ie case was used to test the method in a neighboring domain: interactive performance.

Although play was an explicit goal only of the HangXRT case, it was used in both cases as a method to spur creativity during the ideation process. Both sessions shared key technical aspects, such as on-the-fly and collaborative building up of ideas, heavy reliance on physical involvement, and physical and spatial design resources as inspiration. These each happened early in the design process. Finally, we ended this article by discussing how the distinctive characteristics of the bodystorming method as presented in this paper contrasted with other embodied ideation methods, which included discussing some interesting aspects, such as the success and ephemerality of workshop outcomes that were sketched.

ENDNOTES

1. The groups were created to have a balanced background mix. Each group included at least one senior researcher, one interaction designer, and one movement expert.
2. This is an apparatus for suspension fitness that uses body weight for strengthening exercises and endurance training.
3. Typical player patterns are competition, collaboration, and cooperation.
4. Experiential qualities that emerged in this briefing were later extended in a follow-up sensitizing workshop (Márquez Segura, Turmo Vidal et al., 2016) in which participants engaged in a practical somaesthetic activity that made use of hanging. Participants in that workshop explored hanging from a first-person and felt experience perspective, rather than from a third-person (i.e., observational) experience of the social play activity, which is reported in this article.
5. From here on, the terms *game idea* and *embodied sketch* are used interchangeably. We consider embodied sketch those game ideas that are bodily demonstrated, refined, and tested.
6. By dynamic affordances we mean "forms of affordance that emerge as part of the (dynamic) interaction with the world" (Cook & Brown, 1999, p. 66). Unlike other takes on affordances, the

properties that give rise to them do not reside in the objects, but characterize our interactions with such objects (Cook & Brown, 1999).

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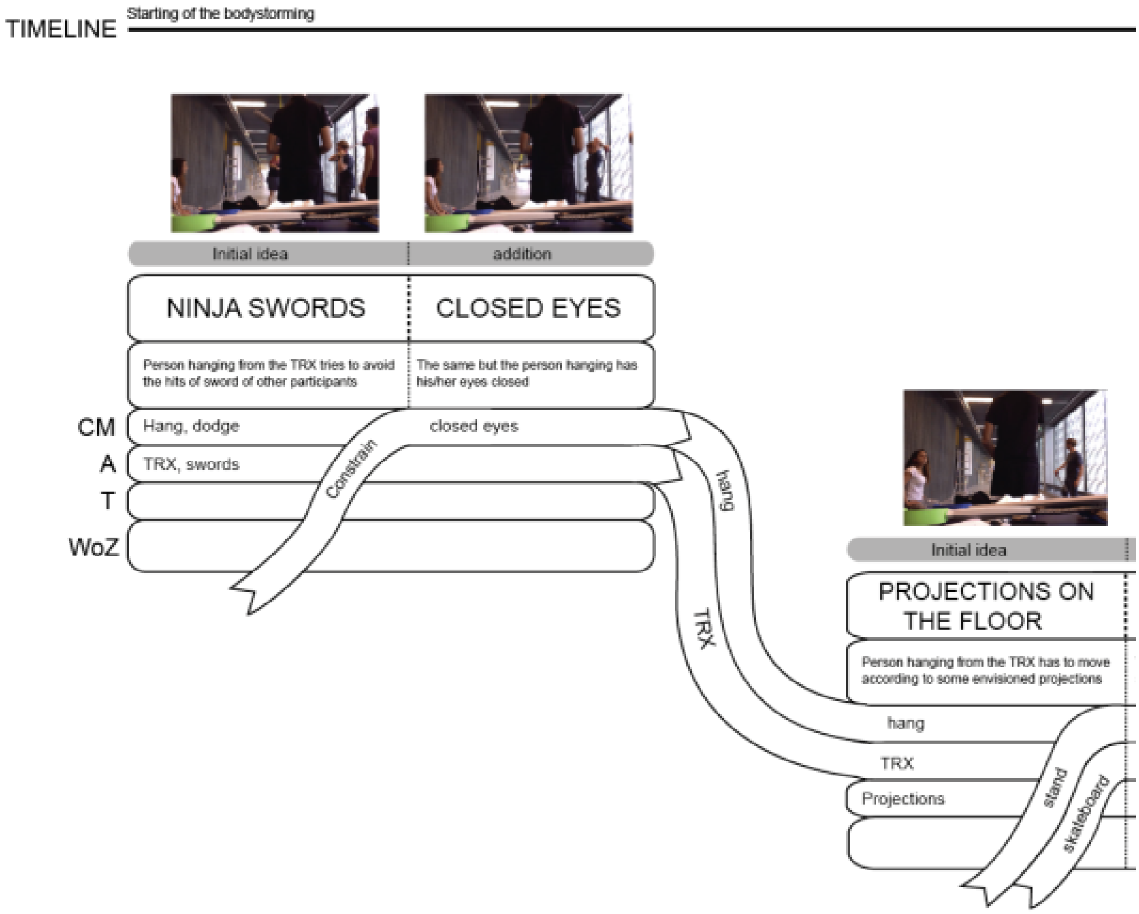
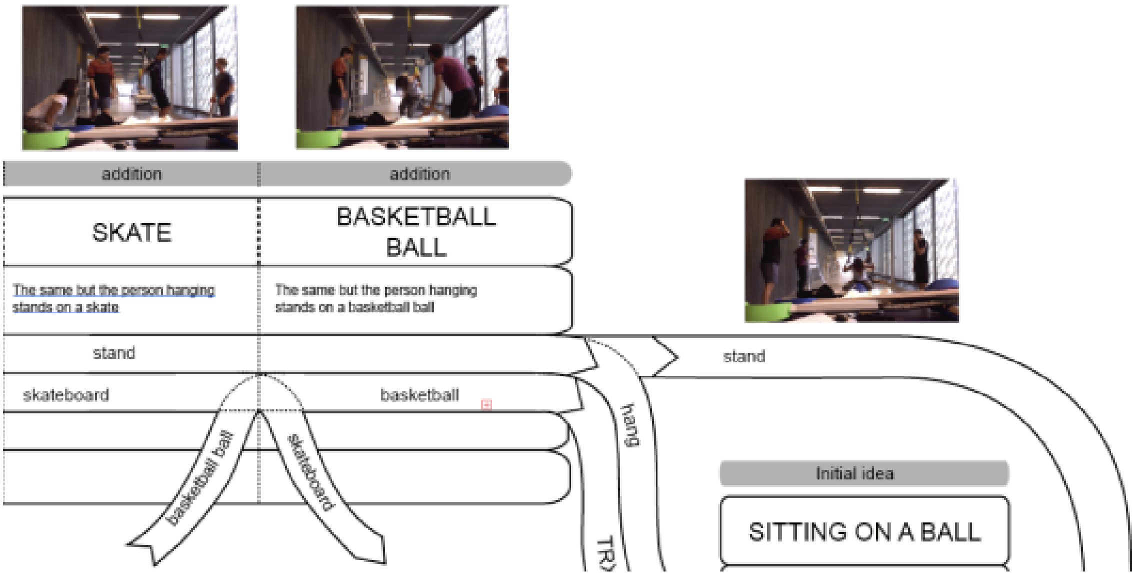
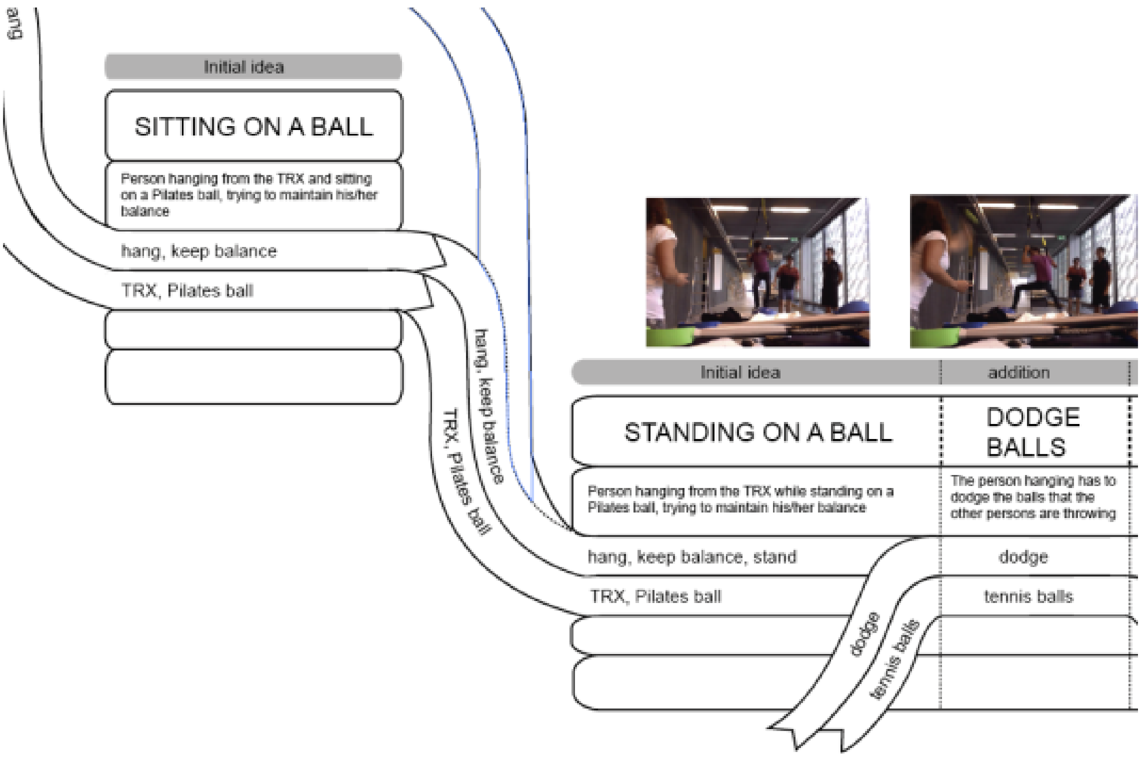
Human Technology
ISSN 1795-6889
www.humantechnology.jyu.fi

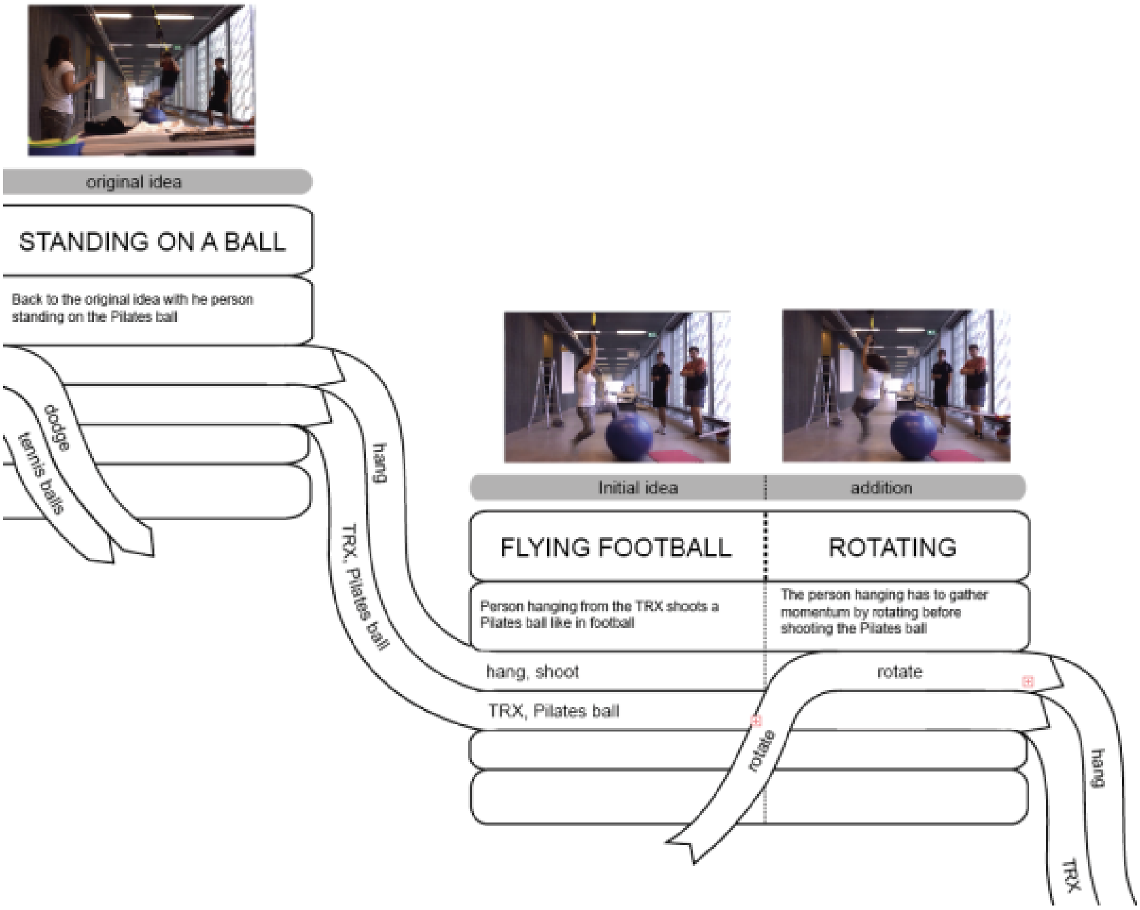
APPENDIX A: Close Up Views of the Bodystorming Braid

In this appendix we present a series of close up views of the Bodystorming Braid, which is to be read from left to right. Each unit represents an idea and its variations. The streams coming in and out represent how the physical core mechanics or artifacts have been introduced or dropped from the idea. In the images, *CM* stands for core mechanics, *A* for artifacts, *ET* for envisioned technology, and *WoZ* for Wizard of Oz technique. If not specifically dropped, a core mechanic or an artifact remained until there was a change of idea. When that happened, the core mechanic or artifacts that remained are those specified in the streams that unite one idea to another.

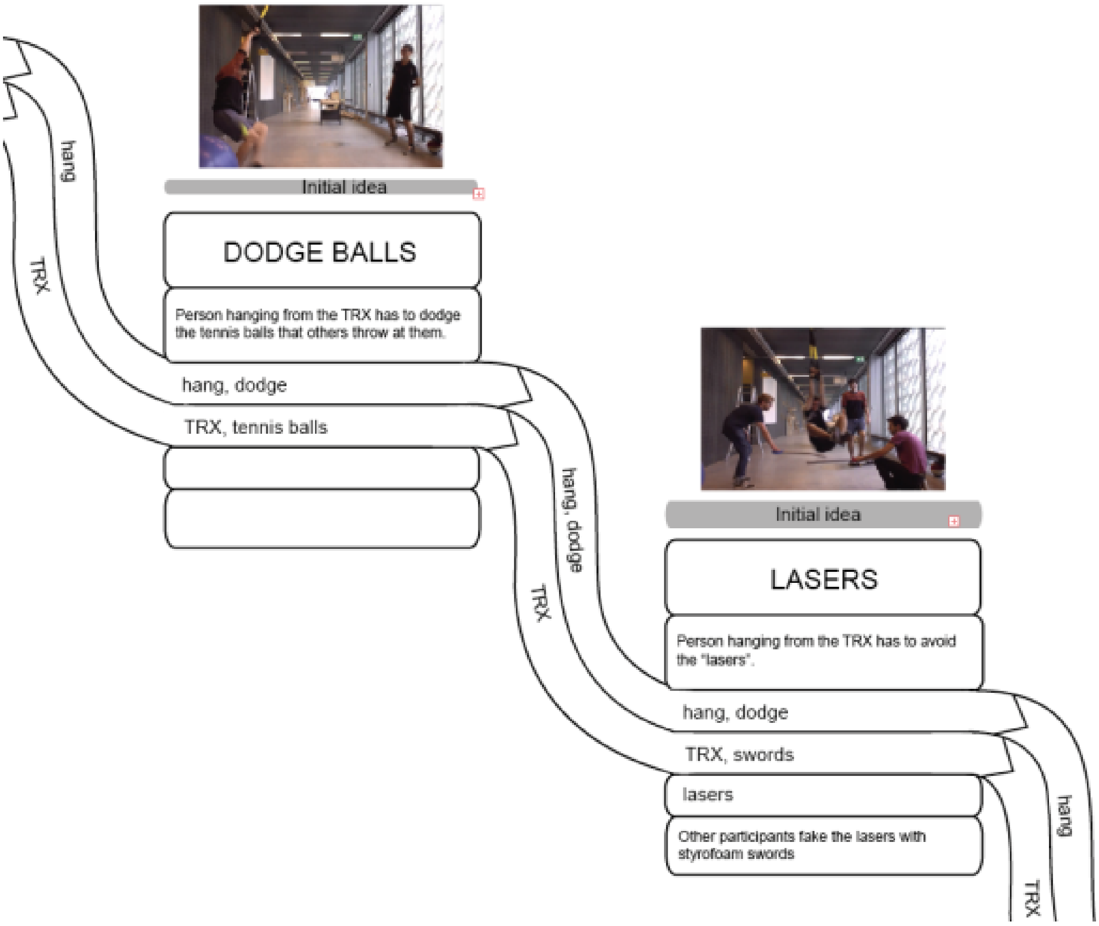


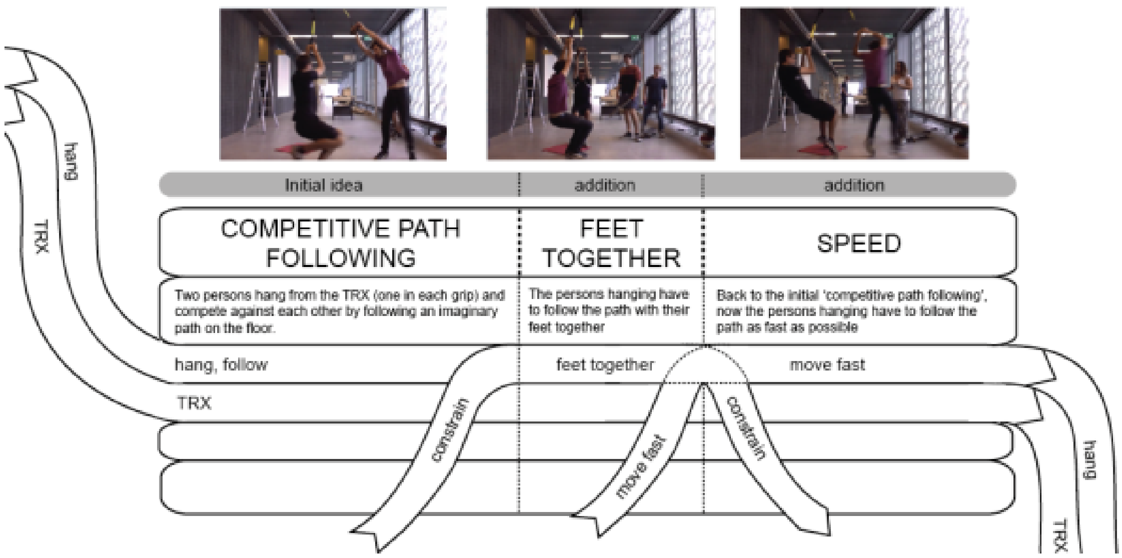

addition
addition
SKATE
BASKETBALL BALL
The same but the person hanging stands on a skate
The same but the person hanging stands on a basketball ball
stand
skateboard
basketball
basketball ball
skateboard
hang
stand
Initial idea
SITTING ON A BALL

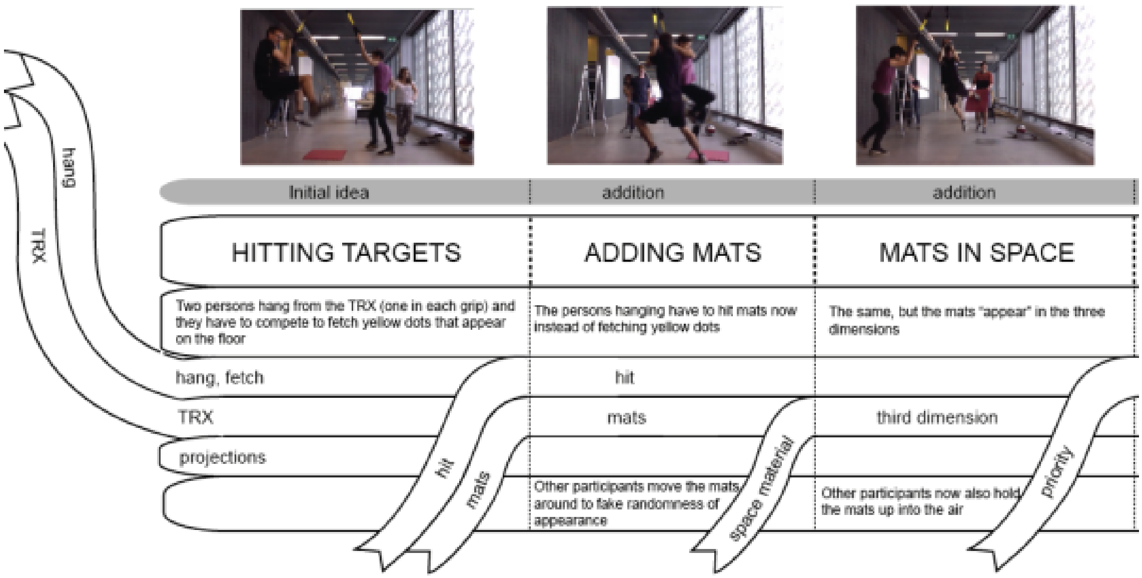

Initial idea
SITTING ON A BALL
Person hanging from the TRX and sitting on a Pilates ball, trying to maintain his/her balance
hang, keep balance
TRX, Pilates ball
hang, keep balance
TRX, Pilates ball
Initial idea
addition
STANDING ON A BALL
DODGE BALLS
Person hanging from the TRX while standing on a Pilates ball, trying to maintain his/her balance
The person hanging has to dodge the balls that the other persons are throwing
hang, keep balance, stand
dodge
TRX, Pilates ball
tennis balls
dodge
tennis balls



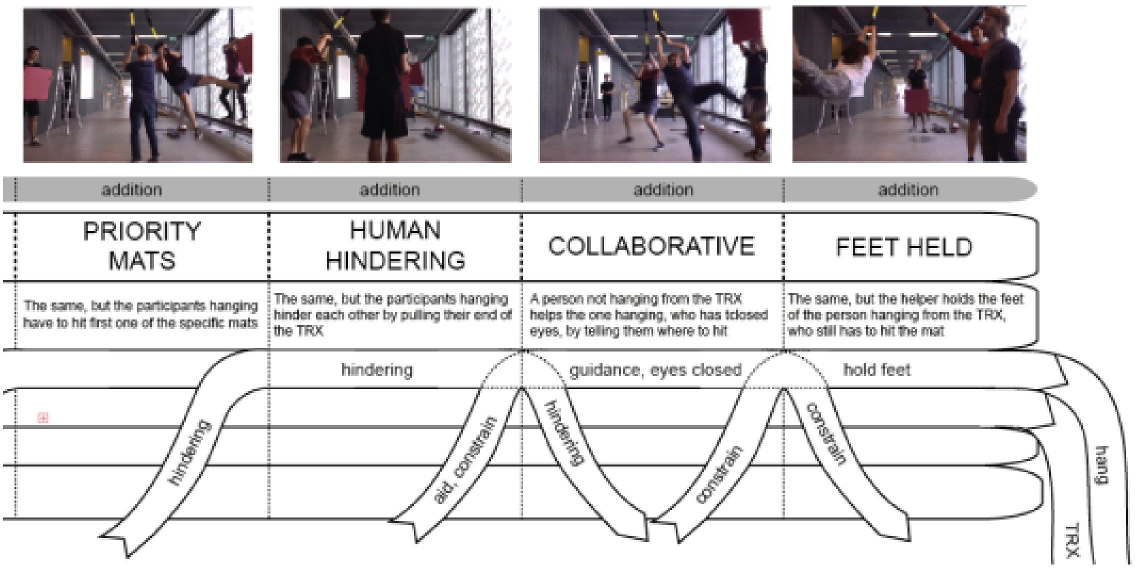
original idea
STANDING ON A BALL
Back to the original idea with he person standing on the Pilates ball
dodge
tennis balls
hang
TRX, Pilates ball
Initial idea
addition
FLYING FOOTBALL
ROTATING
Person hanging from the TRX shoots a Pilates ball like in football
The person hanging has to gather momentum by rotating before shooting the Pilates ball
hang, shoot
rotate
TRX, Pilates ball
rotate
hang
TRX


hang
TRX
Initial idea
DODGE BALLS
Person hanging from the TRX has to dodge the tennis balls that others throw at them.
hang, dodge
TRX, tennis balls
hang, dodge
TRX
Initial idea
LASERS
Person hanging from the TRX has to avoid the "lasers".
hang, dodge
TRX, swords
lasers
Other participants fake the lasers with styrofoam swords
hang
TRX

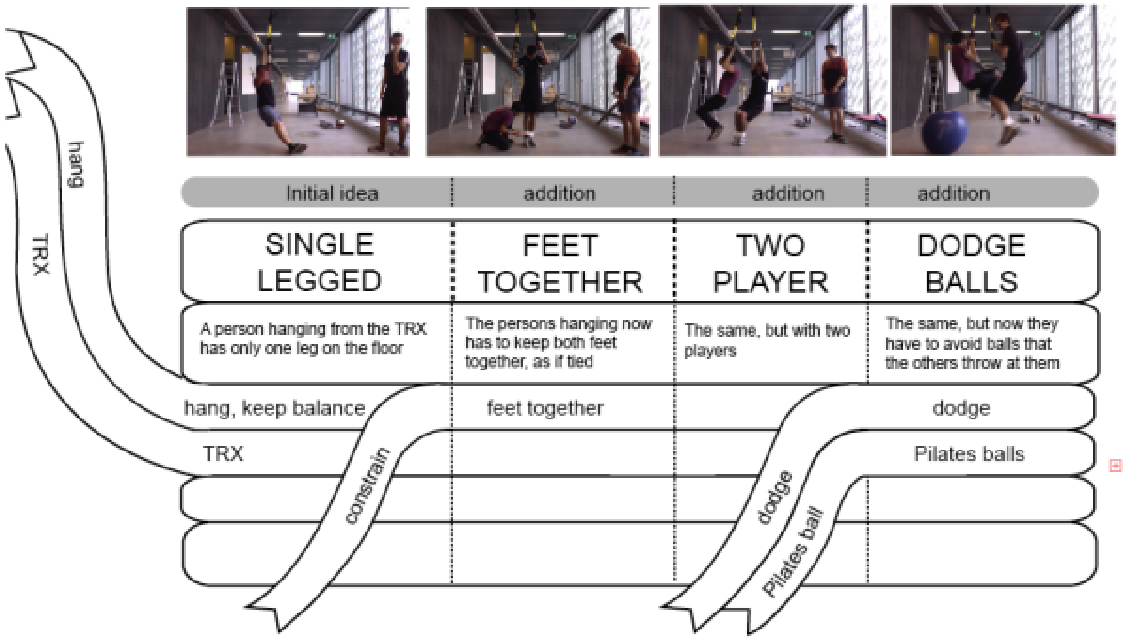

hang
TRX
Initial idea
addition
addition
COMPETITIVE PATH FOLLOWING
FEET TOGETHER
SPEED
Two persons hang from the TRX (one in each grip) and compete against each other by following an imaginary path on the floor.
The persons hanging have to follow the path with their feet together
Back to the initial 'competitive path following', now the persons hanging have to follow the path as fast as possible
hang, follow
feet together
move fast
TRX
constrain
move fast
constrain
hang
TRX



hang
TRX
Initial idea
addition
addition
HITTING TARGETS
ADDING MATS
MATS IN SPACE
Two persons hang from the TRX (one in each grip) and they have to compete to fetch yellow dots that appear on the floor
The persons hanging have to hit mats now instead of fetching yellow dots
The same, but the mats "appear" in the three dimensions
hang, fetch
hit
TRX
mats
third dimension
projections
Other participants move the mats around to fake randomness of appearance
Other participants now also hold the mats up into the air
hit
mats
space material
priority



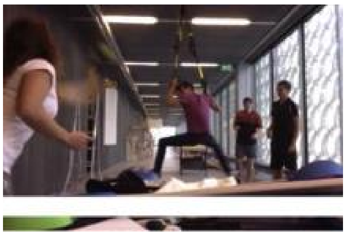
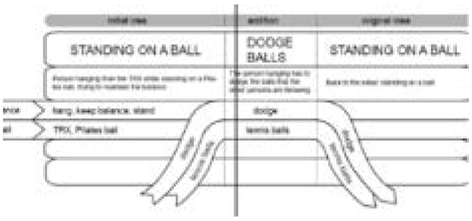
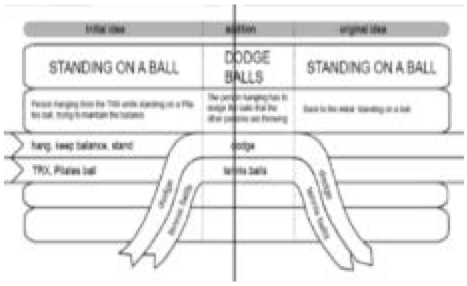
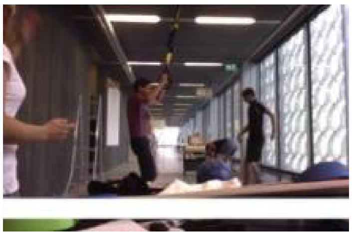
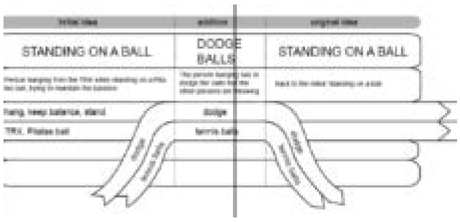
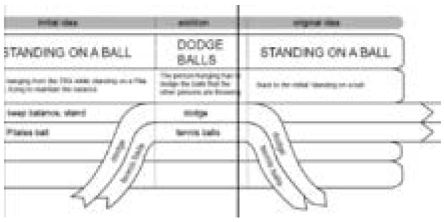
addition
addition
addition
addition
PRIORITY MATS
HUMAN HINDERING
COLLABORATIVE
FEET HELD
The same, but the participants hanging have to hit first one of the specific mats
The same, but the participants hanging hinder each other by pulling their end of the TRX
A person not hanging from the TRX helps the one hanging, who has tclosed eyes, by telling them where to hit
The same, but the helper holds the feet of the person hanging from the TRX, who still has to hit the mat
hindering
guidance, eyes closed
hold feet
hindering
aid, constrain
hindering
constrain
constrain
hang
TRX


hang
TRX
Initial idea
addition
addition
addition
SINGLE LEGGED
FEET TOGETHER
TWO PLAYER
DODGE BALLS
A person hanging from the TRX has only one leg on the floor
The persons hanging now has to keep both feet together, as if tied
The same, but with two players
The same, but now they have to avoid balls that the others throw at them
hang, keep balance
feet together
dodge
TRX
Pilates balls
constrain
dodge
Pilates ball

APPENDIX B: Excerpts of the Interaction Analysis Performed

This table presents an excerpt of the interaction analysis performed on the video recorded of the HangXRT workshop. Through this excerpt, we aim to provide a glimpse into the type of analysis performed. The complete analysis cannot be included for space reasons.

The table provides three elements of the analysis. In the left column is the researcher-generated description of what was transpiring during the excerpted time period. The center column provides an image of the workshop depicting the activities and vocalizations on the video. The right column presents an image from the Bodystorming Braid (see Figure 1 and Appendix A), allowing for a quick glimpse of what is happening in the overall scheme of events, specifically regarding additions and removals of core mechanics and artifacts. Each description log depicts events that typically happened simultaneously.

DESCRIPTION	VIDEO AND SPEECH	NOTATION WITH BODYSTORMING BRAID
00:33 P1 throws the tennis ball at P4. P4 tried to keep his balance, while looking at P1 but moved. P2 and P3 observed P4.		
00:34 P1 was returning to her initial position while laughing. P4 moved to avoid being hit with the tennis ball. P2 went to pick up the tennis ball. P3 observed P4.		
00:35 P1 looked at the others. P4 stepped off the ball. P2 picked up the tennis ball. P3 stopped the Pilates ball with his foot.		
00:36 P1 stepped out of the picture. P4 pointed at the Pilates ball, looking at it and uttered a commentary on the situation. P2 and P3 looked at the Pilates ball.		

APPENDIX C: Comparison of Methods and Techniques

This table presents a comparison of the embodied methods found in the literature and in relation to the five principles that we propose: (a) Employ an activity-centered approach; (b) Use the physical and spatial context as a design resource; (c) Use nonscripted hands-on activities, harnessing the participants' free ways of acting as a design resource; (d) Use both movement and play as a method and design goal; and (f) Facilitate a sensitizing and design-conducive space, working at the same time towards problem understanding and a solution.

	As stated by	Approach	Goal	Physical engagement	Resources used
Using gestures	M. M. Bekker et al. (1995)	Product-centered	Communicating user behavior	Enact foreseen user actions	Not stated
Enactment in Interaction Design	Arvola & Artman (2007)	Product-centered	Communicating brainstormed ideas	In one of the examples, improvised role playing	Drawing sketches
Service walkthrough	Blomkvist & Arvola (2014)	Example provided: product-centered	Evaluating prototype	Role-playing	Lo-Fi prototypes, context as a backdrop
Using drama and props in UCD	Brandt & Grunnet (2000)	Activity-centered for artifact creation	Understanding an activity to support product development	Role-playing, staged	Objects
Experience prototyping (EP)	Buchenau & Suri (2000)	Activity- and artifact-centered	- Understanding existing user experiences and context - Exploring and evaluating design ideas - Communicating ideas to an audience	Some of the examples provided are staged, some are not staged and others are not specified	Some of the examples make use of props, artifacts, social and physical context and/or prototypes
EP examples	Role playing a train journey experience	Activity-centered	Exploration of users and user needs	Role playing, staged (similar to use-case) theater)	Physical and social context
	Controller for an immersive environment	Artifact-centered	Explore and evaluate design ideas	Not staged	Props (to evaluate which experience was better)
	Experiencing an airplane interior	Artifact-centered	Early exploration of ideas: exploration of artifact for which is being designed	Staged	Physical and social contexts, props
	TV channel changing experience	Artifact-centered	Exploration of functionality	Not staged	Artifact being explored
	Children's picture communicator	Artifact-centered	Evaluation	Not staged	Artifact being explored
	Digital camera interaction experience	Artifact-centered	Communication of artifact functions to stakeholders	Not staged	Prototype
	The kiss communicator	Artifact-centered	Communication to clients	Staged	Video to show what the artifact would do
Sound embodied	Franinović et al. (2007)	Activity-centered for artifact creation	To explore new role for auditory display in everyday objects	Playing active situations with objects	Everyday objects as probes, voice, video to present scenario