Guidelines for the Design of Movement-Based Games and their relevance to HCI

ABSTRACT

Movement-based digital games are becoming increasingly popular, yet there is limited comprehensive guidance on how to design these games. In this article we discuss a set of guidelines for movement-based game design that were initially presented at CHI 2014 (Mueller & Isbister 2014). These guidelines were developed through reflection upon our research-based game development practice, and then validated and refined through interviews with 14 movement-based game design experts with experience in the academic, independent and commercial game development domains. In this article, we provide an in-depth contextualization and explanation of the research process that led to the creation of the final guidelines, and discuss what HCI researchers and designers might learn from the guidelines beyond entertainment contexts. The primary contribution of this research is a body of generative intermediate-level knowledge (Höök & Löwgren 2012) in the design research tradition that is readily accessible and actionable for the design of future movement-based games and other movement-based interfaces.

CONTENTS

1. INTRODUCTION

There has been a recent increase the number of movement-based games, i.e. digital games in which gross-motor bodily input influences the game's outcome (Mueller et al., 2011). This trend has been fueled by advances in sensor technology, incorporated in game console systems (e.g. Sony Eyetoy, Microsoft Kinect, Nintendo Wii and Sony Playstation Move), but also in mobile phones that can sense movement. Researching these games is important, as they can offer mental, social and physical health benefits (Gerling, Livingston, Nacke, & Mandryk, 2012; Graves, Stratton, Ridgers, & Cable, 2007; Isbister, Schwekendiek, & Frye, 2011) as well as entertainment opportunities (Benford et al., 2012), but also expand the design space for digital games (Mueller, Agamanolis, & Picard, 2003; Mueller et al., 2011). These games align with a larger trend in HCI around embodied as well as kinesthetic interactions (Dourish, 2001) that put the body in the center of the interactive experience. However, proponents of this trend have lamented that there is a limited understanding of how to design such experiences (Antle, 2009; Hornecker, 2010; Mueller et al., 2011). Researchers have pointed out that there has been progress on higher-level theory in the form of frameworks and abstract concepts (Mueller et al., 2011). However, what is still missing is intermediate-level knowledge in the design research tradition (Gaver, 2012; Höök & Löwgren, 2012; Zimmerman, Forlizzi, & Evenson, 2007) that designers can use in their practice for creating these systems (Hornecker, 2010). Such design knowledge could help game designers avoid previously identified pitfalls, and provide them with a structured approach to engage with movement-based game design, as well as opportunities to learn from other people's experiences. All this should result in higher quality games, advancing the field, and consequently supporting players in profiting from benefits associated with playing movement-based games.

Articulating best practices in this design domain also allows us to build connections to insights from other areas of design practice in our field. In this article, we will sketch out links between the final set of guidelines and HCI design practice outside the realm of movement-based game design. The research reported in this paper resulted in intermediate-level knowledge in the form of practical guidelines for the design of movement-based games (Höök & Löwgren 2012). To develop these guidelines, we engaged in a multi-step process. We began with reflection upon our own extensive game design and development practice, combined with our teaching and mentoring experience in guiding design of movement-based games. We generated an initial set of guidelines, which we then brought to our own research groups for discussion and reflection. After

discussion and subsequent iteration, we contacted 14 experts in movement-based game design from mainstream game companies, independent game efforts, and research-based game design who were not part of our own research teams. We shared our draft guidelines with them and conducted a series of interviews with these experts about the contents of the guidelines. We generated and reviewed the recordings using a grounded theory approach (Glaser and Strauss 1967), to help ensure that we were conceptualizing the guidelines in ways compatible with those of other practitioners. The final set of guidelines (included in this article, and also posted on the website), reflect the input of these experts. The result is a readily accessible and actionable body of generative intermediate-level knowledge for the design of future movement-based games (Höök and Löwgren 2012). We also propose what HCI researchers and designers might learn from the guidelines beyond entertainment contexts. Furthermore, we present insights from our approach to generalizing practical guidance from design-research practice and surfacing associated tacit knowledge (Polanyi & Sen, 1983) from expert designers.

2. MOTIVATION: GUIDANCE FOR GAME DESIGNERS IN A CHALLENGING DESIGN TERRAIN

Our primary aim in creating these guidelines was to communicate emergent best practices in the movement-based game design space, toward allowing others to leverage the considerable body of design work that has accumulated over the last 10 or so years, since the release of the first widely distributed commercial movement gaming peripheral device, the Sony Eyetoy, in 2003. There is a perennial challenge for game designers regarding knowledge transmission about best practices (Kremeier 2002). As is the case in the HCI field as a whole, game design has experienced rapid evolution as hardware and software capabilities have shifted. Some design principles in constructing good games remain constant, yet new problems and opportunities emerge. Movement in particular introduces some radical shifts in what it means to interact with a game, both for players and for spectators. For example, traditional game controllers use buttons and joysticks that allow for very precise and rapid ongoing input to the game, whereas motion controllers are subject to recognition errors and delays. Traditional game controllers are typically used by players in a seated position, not moving much as they focus on hand-eye coordination and fine motor control. Movement-based game controls require broader motion from players involving more of the body, often in a standing position. This kind of motion makes gameplay inputs and actions more visible and apparent to spectators, and thus can change the spectator-gameplay relationship.

Commercial games built to exploit movement detection hardware have been widely divergent in how well they achieve the goal of both novel and enjoyable gameplay (Totilo 2013). Clearly there is room for improvement in the design process, toward creating more reliably engaging movement-based games (Nielsen 2011). Game designers share knowledge about best practices in a novel design space through 'post-mortems' (descriptions of how a game design and development process went) and other kinds of case studies, often in the form of talks in venues such as the Game Developers Conference (GDC), the Montreal International Game Summit, and smaller events such as the Practice conference and Project Horseshoe. There have been a number of these sorts

of personally presented case studies about movement-based game design (e.g. Bock 2011, Hackett 2013; Sawano 2008), but in the 10 years since movement platforms first hit the consumer household market, there has not yet been a more general presentation of best practices for designing these kinds of games in the venues where game designers seek information. This is understandable, as practicing game designers are usually under enormous time pressure, and are not typically rewarded or encouraged as part of their work duties to publicly convey design best practices. In fact they may be discouraged from doing so as part of the industry's desire to keep design knowledge in-house as a form of competitive 'edge'. Talks in venues such as GDC serve the double purpose of promoting the game that is under discussion, motivating the game company to allow the sharing of substantial design insights in order to allow for visibility of the game at the conference. Unfortunately, attendance at these conferences can be expensive for designers (a GDC all access pass cost $1975 in 2013), limiting the audience for these talks. Some of the conferences have archives of recorded talks, but typically charge a fee for access (for example the GDC Vault: http://www.gdcvault.com). So this form of knowledge transmission does not reach as far as one would hope, within the game design community. An informal survey of practicing game designers conducted by Isbister in 2014 on Facebook indicated that designers rely primarily on conversations with other game designers to help them in their work. Secondarily, they look to writings and podcasts available on the internet (mostly by other practicing game designers). They do also consult books about game design, but only one of those who responded consults academic papers (papers from conferences and journals). This corresponds with Schön's (1987/2009) framing of design practice as a form of master-apprentice relationship that occurs in face-to-face conversations. The internet writings and podcasts that game designers rely on are reflections by designers on design, often quite tied to specific design problems they are facing at the moment (for example Dan Cook's www.lostgarden.com, or the amalgamated writings of various game developers on #AltDevBlog: www.altdev.co/category/game-design/).

In contrast, academic researchers and game design educators are invested in and rewarded for producing and communicating more generalized design knowledge in written form. Academic papers provide abstract frameworks that can then be applicable to game design (for example see (Benford et al., 2012; Benford et al., 2005)). Less theoretical guidance can come in the form of books that offer a set of perspectives through which to examine one's practice (Fullerton, Swain, & Hoffman, 2004; Schell, 2008). Recently, alternative formats have emerged that aim to narrow the gap between theoretical frameworks and design practice, for example design cards (Schell, 2008; Belman et al., 2011). Evidence suggests that these practice-oriented approaches can indeed facilitate the creative process (Hornecker, 2010).

Most of the practical guidance available from the academic and research community focuses on interactive systems in general or games in particular, but not on movement-based games specifically. Prior works argue that designing movement-based games is different than designing button-press games (Mueller et al., 2011). There have been attempts to highlight the challenges and opportunities for designers of movement-based games (Gerling et al., 2012; Márquez-Segura, Waern, Moen, & Johansson, 2013). However, they either focus on abstract frameworks (Loke, Larssen, Robertson, &

Edwards, 2007; F. Mueller et al., 2011) or emphasize individual aspects of movement-based gaming experiences, such as health benefits (Berkovsky, Coombe, Freyne, Bhandari, & Baghaei, 2010), affective responses (Bianchi-Berthouze, 2013; Isbister et al., 2011) or social benefits (Lindley, Le Couteur, & Berthouze, 2008). What is missing is guidance for how to design movement-based games, presented in a format that matches the practice-based focus of the game design field. Therefore, we set out to develop a set of such recommendations in a designer-friendly format, grounded in our own experience and that of other experienced movement-based game designers.

3. METHODOLOGY

We developed the guidelines in a multi-step process.

3.1 Reflection on our Design Practice and Relevant Literature

The authors have both been working in the area of movement-based game design and analysis since the early 2000s. Both of us have extensive publications and talks in the area (e.g. Isbister 2005; Isbister 2006; Isbister 2011; Isbister 2012; Isbister and DiMauro 2011; Isbister et al. 2011; Mueller et al. 2006; Mueller et al. 2008; Mueller et al. 2003; Mueller et al. 2011) and have active research groups building research-focused movement-based games (for example Isbister's Yamove! an IndieCade Finalist game in 2012, and I-dentity, a game presented by Mueller's group at CHI 2014—see our lab websites for more examples: gil.poly.edu and exertiongameslab.org).

As practicing game designers, we have had our games selected and showcased in a wide range of venues (IndieCade, Mindtrek, European Innovative Games Award, Fun and Games Award, Freeplay, IndieCade East, CHI Interactivity, Fun and Games, and the Digital Games Research Association (DiGRA) conference, among others). We have attended both academic and industry conferences and events over many years, hearing many of the talks and paper presentations cited in this article first-hand. In addition, we both teach the design of movement-based games, and mentor students and others in the creation of such games. Finally, we participate in jurying game competitions such as IndieCade and the Independent Game Festival and in conducting game jams.

We built our initial list of general principles concerning movement-based game design based upon this extensive body of first-hand knowledge about the practice of making movement-based games, as well as the theory behind it. Mueller traveled to NYC to conduct movement game design workshops and a talk at Isbister's lab, and we used this visit as a time to begin conversations about this project, which were continued in online discussions ongoing over the course of two years.

Our conversations focused on issues that had come up during design and development for us and our students in designing movement-based games, as well as issues that were surfaces in post-mortems and case studies in industry venues. We also drew upon the literature on movement-based game design (as outlined in the introduction and motivation sections of this paper). In the section of this paper that presents the guidelines, we present evidence from this initial research process for the relevance of each.

Once we had an initial set of considerations for movement-based game design, we reflected on the proper formatting of these considerations to maximize value for practicing designers. It is important to note that our ultimate aim is to propagate existing tacit knowledge among practicing movement-based game designers, so that others can apply it and not waste valuable time 'reinventing the wheel'. We are not aiming to provoke new insights in experienced designers, but rather hoping to capture their knowledge well toward sharing it with new designers, designers unfamiliar with this space, and others interested in best practices in movement-based game design.

There are various formats for conveying intermediate-level design knowledge—heuristics (e.g. Schaffer 2008), guidelines (e.g. Apple 2013), and design patterns (Alexander et al, 1977; Borchers, 2001; Björk and Holopainen 2005) being the most common ways to communicate actionable design insights. We modeled our points after the design pattern format, with some modifications. We elected to call the points guidelines instead of patterns, however, because they do not conform entirely to the formatting and content guidelines for patterns (Dearden and Finlay 2006). In particular, we do not propose a network of relationships among the points that we present to designers' attention, and the points are not all framed as broadly recurrent, timeless problems for players/users. Guidelines can be specific to a particular platform or application, but can also be general rules of thumb for practice more generally (Dearden and Finlay 2006). We felt this was a more accurate framing of the intermediate-level design knowledge that we had assembled.

3.2 Website and Internal Feedback

As was mentioned, game designers tend to share design practice information through conversation with one another, industry conferences, and online resources. They do not typically read academic papers. We decided the best way to reach practicing game designers with these guidelines was to make them available online. We worked up a website with an initial articulation of the guidelines, and then we workshopped this website within our respective research groups. We asked team members to read over the guidelines, and provide feedback about both contents and format. We then refined the guidelines website based upon this feedback. Our teams had suggestions for refining wording of guidelines for clarity, offered additional suggestions for exemplar games, and proposed clustering the guidelines into sub-areas to make them easier to scan and remember. They also recommended adding a 'Do's and Don't's section to each guideline. We incorporated these suggestions before sharing a more refined draft with our outside experts.

3.3 Feedback from Experts

In order to validate the guidelines, we sought the feedback of other experienced movement-based game designers. We were aiming for relevance of the guidelines for designers from the full spectrum of movement-based game design: commercial 'AAA' designers, 'indie' designers working on small-scale independent efforts, and academic/research game designers, who might also be teaching about movement-based

game design. So we set out to recruit people to interview from each of these groups, with an emphasis on selecting designers with quite a bit of experience under their belts (and successful movement-based games to show for this experience).

We had two primary questions in mind when approaching this stage of the work: did the designers feel this was a reasonably comprehensive and accurate set of guidelines that reflected how they thought about and engaged movement-based game design? And, did they feel the guidelines would be useful in communicating best practices to others, such as new designers on the team, or students? This helped us to frame a semi-structured interview process, and guided our analysis of those interviews.

We chose to conduct recorded interviews. Interviews with experts is a common HCI method (e.g. Sas et al. 2014; Zimmerman, Stolterman, and Forlizzi 2010), and one that the authors have used successfully in the past with game designers (Isbister, Flanagan and Hash 2010).

3.4 Participants

We recruited 14 movement-based game design experts. Four of the 14 had worked as designers or user researchers on games that spanned the full range of commercial console motion platforms—Sony Eyetoy and Move, Nintendo Wii, and Microsoft Kinect. These practitioners had designed or evaluated designs for leading successful titles for these platforms including Dance Central (1, 2, 3); Just Dance, the Michael Jackson Experience, Singstar, and others. All four of these interviewees had experience mentoring others in designing or evaluating movement-based game design in their workplace.

Four of the 14 interviewees we categorized as primarily 'indie'—designers who created games on a small budget released independently. We chose independent game developers who had released successful titles that were recognized through juried shows, game jams, and other independent venues. All four of these designers also participated in curation practice—creating and managing venues for indie game design, hosting game jams and communal playtests of movement-based games. This gave them additional experience in analyzing and evaluating movement-based games.

Six of the 14 we categorized as research-based designers—those working in academic labs or universities who produced movement-based games as part of their research practice. Our criteria for selecting these participants was that they had created movement-based games that were positively received in appropriate venues such as game jams and festivals, as well as published work focused on movement-based game design and evaluation. Several of these participants also engaged in curation of movement game venues, which added to their experience level with this type of game. All had experience mentoring others in designing and developing movement-based games, whether in a game production environment, or in an academic setting. Here are more details about the background of the interviewees in each category (note: none of these individuals are affiliated with either of the authors' organizations):

Commercial:

- Design lead, Dance Central 3 and designer, Dance Central 2 at Harmonix.
- User research lead, Dance Central and Kinectimals at Microsoft Game Studios.
- User researcher, Just Dance, the Michael Jackson Experience, Your Shape and Fitness Evolved at Ubisoft.
- User researcher, Sony's Eyetoy games, Singstar and Sports Champions at Sony.

Indie:

- Co-director of the Come Out and Play Festival; instructor of the Big Games class at the Interactive Technology Program at NYU; creator of many commissioned games.
- Director of Indiecade East; designer of Recurse, a commissioned movement-based game that is also released on the iPad.
- Creator of Indiecade finalist game Hit Me; Eyebeam fellow; instructor of Beyond the Joystick.
- Curator of physical game exhibitions including Street Level; game educator and co-founder of Kokoromi game collective.

Academia:

- PhD student in game design, Co-founder of w00t play festival, member of Copenhagen Game Collective.
- Associate professor in a design faculty, artist with many award-winning movement-based installations.
- PhD student in game design, co-director of indie game collective, curator of games arcades and exhibitions.
- Associate professor in a design faculty, coach of many student design projects involving tangible and movement-based play.
- PhD student on games and motivation, game jam organizer Games4Health Jam, organizer game jam at CHI.
- Recently finished PhD on dance game interfaces, designer for Microsoft Studios.

3. 5 Procedure

We sent each of the experts the web link to the guidelines before the interview. We asked them to examine the guidelines in their own time and reflect on them. Several experts took notes during this process that they brought along to the interview, which we conducted either in person or via Skype. We used a semi-structured interview format, working from general questions (What did you think of the guidelines?) to more specific questions about each guideline (contents and format). We included questions about comprehensiveness (Anything missing?) and about transmissibility (Would these be helpful in working with students or inexperienced designers?). Each interview took approximately an hour. In-between interviews, we met and discussed feedback we had received so far, and continued to modulate and shape questions and subsequent dialog with our experts, following the grounded theory approach (Glaser and Strauss 1967).

Conducting interviews was divided between us roughly evenly. We reviewed the recordings of one another's interviews, and made detailed notes on our own and the

others' interviews. After reviewing all interviews, and making these notes, we worked together to categorize feedback in the following ways. For each guideline, we noted whether the interviewee thought it appropriate and accurate (or not), and noted any suggestions for changes to the guideline (wording, examples, combining of guidelines or separation into multiple guidelines). We also noted any suggestions for additional guidelines not included, and comments about the clustering of the guidelines. We noted interviewee perspectives on usefulness and transmissibility of the guidelines (Would they share with students/mentees? What might they change to make them more useful?). We used our notes to assemble a list of changes to make to the guidelines. All changes made were issues brought up by multiple interviewees (details in next section). The final set of guidelines, based upon this feedback, can be found at http://movementbasedgames.wordpress.com.

3.6 Analysis and Discussion of Feedback

Our first concern was whether the guidelines were appropriate and accurate. All 14 of those interviewed said that the guidelines were definitely appropriate to movement-based games, and that for the most part they accurately reflected insights from their own practice. A sample positive comment: "This absolutely confirmed with what we found in our playtests." When asked which guidelines did not accurately reflect insights from their practice, interviewees called out particular guidelines that did not fit the kinds of games that they made. For example, 'Intend Fatigue'. Three interviewees who worked on commercial movement games intended to be easy and accessible reported that they typically tried to avoid fatigue for players. They were not *averse* to this guideline—in fact, two of the three expressed interest in the guideline in terms of generating design ideas. They simply were not familiar with using this element in their design practice.

The only guideline that was called out by several interviewees as needing revision/modification in order to best reflect practice was 'Focus on the Body'. The commercial game developers/researchers (those working on titles such as *Dance Central* and *Just Dance*) pointed out that many players in their target audience felt shy or awkward when they tried out these dancing games. They strongly felt that attention to the screen could be leveraged to reduce social anxiety in new players, and encouraged us to rework this guideline (which we did).

Some interviewees felt strongly that particular guidelines were the most important. These preferences seemed to reflect the particular kinds of games that they designed. For example, one indie developer especially liked the guidelines 'Exploit Risk' and 'Support Self Expression'. These are both qualities that he has included in his own movement-based games, and that he sees as promising directions for future work. A developer who worked on the *Dance Central* franchise reported that 'Exploit Risk' mapped well to the success of the 'high five' move used to start dance competition rounds in the *Dance Central* games. He noted that physical contact with your opponent feels risky in an interesting and compelling way that many find memorable about gameplay. Another commercial game developer who had worked extensively with the Kinect movement game platform called out 'Embrace Ambiguity' and 'Consider Movement's Cognitive Load' as essential guidelines given the difficulties and mistakes he saw in developing

games for this new platform. The only suggestion we got for an additional guideline was something addressing the non-gameplay elements of movement-based games. That is to say, the user interface for selecting a game, selecting actions, changing game states. This is an important topic, but we decided it was outside the scope of the guidelines project, which is focused on core game mechanics. There were no requests for re-clustering of the guidelines. There were also no requests to change the basic formatting of the guidelines. However, most of the interviewees were interested in having even more examples of games that did a good job with each guideline (multiple examples is of course a common strategy in presenting results of design research (Gaver 2012)). They also expressed interest in finding a way to include playable game examples in the website. We added additional example games after the interview process. We have not yet added playable games, but would like to do so.

One of our academic interviewees requested more precision in the guideline language, however all of the other experts thought the language was appropriate and noted that having some openness to interpretation allowed them to more readily adapt the guidelines to their own design practice and mentoring. Seven experts pointed out that they had either themselves created or observed games in which at least one of the guidelines was not followed, yet resulted in engaging gameplay. As such, they were concerned that others might follow the guidelines too strictly. In response, for the final website we added a sentence on the front page: "The guidelines are like rules in any creative field: of course you can also break them, but first, you need to know them before you can break them." Overall, we had many positive comments about the usefulness and timeliness of the guidelines. Here are some examples: "This is great." "I love these." "This is super useful." "It's great that someone is finally doing this." "We would have loved that when we did [commercial title]." Some noted the benefit of having a language to articulate issues to other stakeholders, for example "This could have helped me when I was previously trying to argue for a design decision with the marketing department."

Our next research question was whether our interviewees, all of whom had experience mentoring others, would find these guidelines useful in sharing design insights and knowledge with less experienced designers. We were interested in anything that might make the guidelines more useful for this purpose as well. All 14 people interviewed said these would be useful for designers less experienced than themselves. Some pointed out particular guidelines they would be eager to share. For example, a commercial game developer working with Kinect called out 'Consider Movement's Cognitive Load' and 'Celebrate Movement Articulation' as two principles he'd had a hard time explaining to his team, that he could use these guidelines to share more effectively. Those who taught in classes said that they could see using the guidelines in the course of teaching, but not as a replacement for hands-on instruction. Most felt the guidelines would not be an appropriate stand-alone tool but should be used in conjunction with actual play and design experiences. That is to say, the guidelines could help put language on design insights, but could not necessarily prevent bad design decisions without some additional guidance. In this context, the request for playable examples also came up—giving mentees or students games to play, and discussing why they work well, was a common theme in the interviews. Working designers mentoring others said they

might use the guidelines as a form of checklist to see if staff had considered the key aspects during a design process.

It is important to note that although one or two of the designers found an unfamiliar guideline generative for them (for example the 'Intend Fatigue' and 'Engage Risk' guidelines, for commercial developers who had not thought about these before), they did not for the most part find *surprising* information in the guidelines. One person noted that they were "following them anyhow" and another noted that they were using these rules of thumb "intuitively" anyway. The guidelines were not revelatory to these experienced designers—rather they resonated with the experience that they already have. This corresponds to our desire to craft information that allows for encapsulating and articulating experienced designer insights, to share with less experienced designers. The guidelines are not intended to be revelatory to those who have already learned these things through trial and error.

Overall, the guidelines that we crafted, and vetted among our own teams, largely seemed to these experienced designers to be appropriate, accurate, and of potential value in communicating with less experienced designers. We made modifications as discussed above. What follows is an overview of the guidelines as they were presented to the experts. To see the final modified guidelines, the reader can access the website: http://movementbasedgames.wordpress.com.

4. GUIDELINES

4.1 Structure

As was previously mentioned, we based the structure of the guidelines loosely on design patterns from pattern languages (e.g. Alexander et al. 1977; Borchers, 2001; Björk and Holopainen 2005). Alexander's patterns, the original inspiration for use in design work, were very broad and universal problems related to inhabiting buildings and communities, and were meant to be linked together as a language that could be used to think well about designing buildings as well as larger frames (communities, cities). They ranged from very concrete and related to buildings—'raised walk', 'accessible green'—to very general life issues to consider in design such as 'life cycle' and 'mosaic of subcultures'. It was quite important to Alexander and colleagues that these be thought of in relation to one another. Patterns were adopted by software engineering and then by the design community with CHI (Borchers, 2001), and additionally by the game design community (Björk and Holopainen 2005). As these adoptions occurred, changes took place in the formatting and framing of design patterns. Borchers' patterns include the following elements: title, context, problem, solution, examples, references, as well as a diagram or illustration. References in this case mean references to other patterns in the pattern language, to help contextualize it. Björk and Holopainen have the following elements in their game design pattern template: name, core definition, general description, using the pattern, consequences, relations, and references. In this case relations serve the purpose of references in Borchers' patterns, and references mean 'related previous works that have either been a direct inspiration for the pattern or contain descriptions of the main aspects of the pattern.' (p. 39, Björk and Holopainen).

As we said before, we do not yet have a theory or framework for how these guidelines relate to one another in a design language. Thus we decided to avoid using the design pattern nomenclature. However, we liked the specificity and concreteness that patterns afford the learner, in contrast to guidelines and heuristics which can sometimes be stated in such generalized terms that it is hard to apply them if you are not already an expert (they serve more as mnemonics aiding recall, rather than as teaching tools). The final structure of our guidelines was as follows. Each has a short title, a one sentence description followed by a few more details in a separate header, followed by multiple positive examples from games, followed by strategies for designers, and finally a section titled do's and don'ts (asked for by our own research teams). We did not include the consequences/references/relations elements from the other taxonomies as we have not yet established a set of interrelationships among the guidelines in this way, but the remaining elements are all in place, albeit with slightly different names. We also clustered the guidelines into three themes: movement requires special feedback, movement leads to bodily challenges, and movement emphasizes certain kinds of fun. Perhaps these can be seen as precursors to the establishment of a language of interrelationships between the guidelines. We were asked by reviewers of this article about why we did not include negative examples: situations where the guideline was not followed that caused trouble. There is some work in the HCI community around the notion of AntiPatterns (e.g. Brown et al. 1998). As Dearden and Finlay point out (2006), though, the HCI community as a whole has not taken up AntiPatterns with much enthusiasm. And, as they put it, "The validity of AntiPatterns in Alexandrian terms can be debated, since patterns are, by his definition, concerned with capturing good practice." (p. 14, ibid). We stuck to the positive example format and framing in our own work, and this seemed to resonate with those that we interviewed. None asked for or suggested negative examples as a way to improve the guidelines.

In this article, we have added a section not present in the website for each guideline: References and HCI relevance. These additions are meant to help scholarly readers who may have more general HCI interests and background to see the research context and potential use value of these guidelines in their own work.

4. 2 Introduction

Though we did not create a coherent 'language' among the guidelines, we did work to contextualize what the guidelines covered and how they were meant to serve aspiring designers. The following text appeared on the home screen of the website (fig. 1) that we presented to our experts:

Physical movement is becoming increasingly important when it comes to digital games, taking games beyond gamepad, joystick and mouse & keyboard interactions. We call these movement-based games, meaning digital games where the game outcome is to some extent informed by gross-motor bodily movement (think Kinect, Wiimote and Move controller-based games, but also location-based and fitness games on mobile phones). It is challenging to design great movement-based games, and there has been so far little guidance for aspiring movement game designers. This leaves the design process to trial and error, meaning designers may be wasting time trying out strategies that do not work

so well. To remedy this, we have put together this set of design guidelines for movement-based games. These are based on our own experience, on research we have done on movement-based games, and on game designers' expert opinions we gained through interviews about these guidelines.

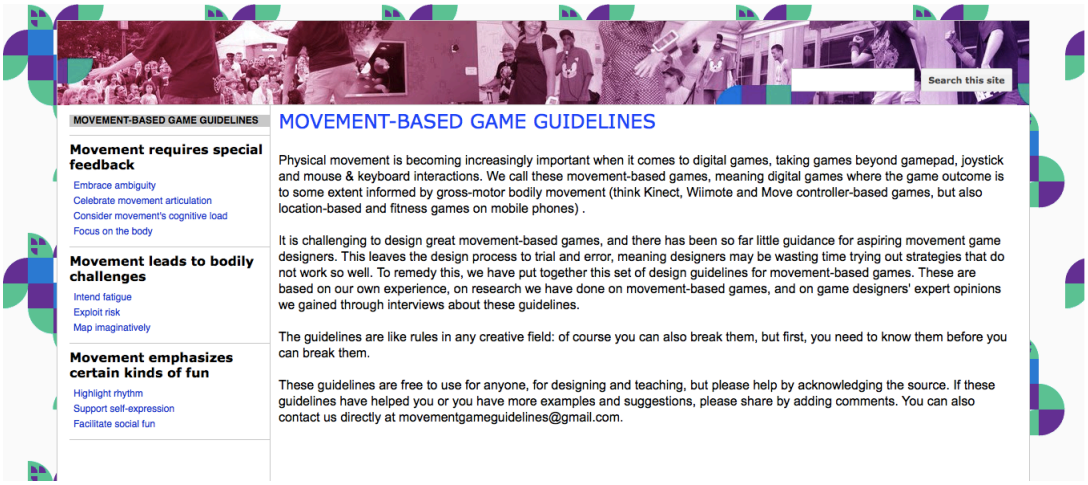

Figure 1: Movementgameguidelines.org

4.3 First Guideline Cluster: Movement Requires Special Feedback

4.3.1 Embrace Ambiguity

Instead of fighting the ambiguity of movement, embrace it.

Ambiguity in movement-based games arises from the fact that no two movements are the same, and most sensor data is messy. Trying to force precision may only frustrate the player, and make the limitations of the sensor obvious in a very un-fun way. So instead of trying to remove this ambiguity, work with it: players enjoy surfing uncertainty and trying to figure out optimal strategies in a somewhat messy system.

Example: Kinect Adventures. In *Kinect Adventures* (contributors), leaning to the side to control the raft is ambiguous. The sensor and the leaning are not precise; for example, does the twitching of your hip matter: would the sensor pick it up, and does it matter for controlling a raft anyhow? However, this feels okay during play, given the nature of rafting on water. The player expects the water to move the raft around unpredictably to a certain extent anyhow, and applies his/her own movement to add to this action, rather than aims to control it fully. Compare this to a car racing game, where players would expect to be able to precisely control the car, and probably get frustrated if their bodily actions do not result in exact outcomes.

Example: Pixel Motion. Pixel Motion (see Supplementary Data, Figure 1)'s movement sensor is a surveillance camera that picks up overall motion flow patterns instead of tracking individuals. This allows for a group interaction with a 'more the merrier' feel to it. Anyone in the camera's field of view can join in 'wiping' pixels off the

video feed by moving around within the play space. The lack of system coupling with individuals means that people watching feel more free to jump in and interact, which helps everyone succeed. The game takes advantage of the sensor ambiguity to encourage group play.

Strategies for Designers

- Get to know the limits of your sensors, and use these limits as a design resource.
- Construct the player's actions in a way that gives room for sensor error without drawing attention to it.
- Avoid game mechanics that require precise control.

DOs and DON'Ts

DO use the ambiguity of movement and sensor data to enhance the game. DON'T use buttons instead of the final movement-sensor during the early development phase (even if it seems easier), as you will miss the opportunities arising from dealing with ambiguity.

References and HCI Relevance

This guideline draws upon Isbister's experience building *Yamove!* (Isbister 2012) and *Pixel Motion* (Robbins and Isbister 2014), and upon Mueller's experience building *i-Dentity* (Garner et al. 2014) among other games. In addition, we benefited from reviewing design recommendations from Márquez-Segura et al. (2013) concerning artful use of sensor capabilities and limitations. HCI research has previously highlighted the potential of ambiguity to contribute to an engaging experience by giving the user opportunities to "fill the gaps" (Gaver, Beaver, & Benford, 2003). We draw on this idea and remind designers that movement is inherently ambiguous due to the many degrees of freedom inherent in movement. This, combined with the fact that most movement-sensor data is far from precise (Benford et al., 2005), makes for experiences filled with ambiguity. Designers can try to reduce this ambiguity, for example reducing complex movement to simple gestures (Berkovsky et al., 2010) or refining sensor capabilities (such as done with the Wii MotionPlus); however, we encourage engagement with ambiguity as a resource for design as well (Gaver et al., 2003; Márquez-Segura et al., 2013). This guideline has some relevance beyond games and entertainment, as movement control schemes are being deployed outside the gaming area. For example, Kinect-sensed movement can be used to select music and control its playback on the Xbox; shaking an iPhone can undo text entry. We believe it can be important for HCI designers to be aware that movement and associated sensing technology, such as accelerometers, gyroscopes and GPS, are inherently ambiguous when compared to traditional button presses. As with games, designers can aim to improve the accuracy of these sensing systems. However, due to the many degrees of freedom in body movement, there will always be ambiguity "left" in the interaction. In response, designers of non-game interactions should also consider embracing this ambiguity rather than trying to address it exclusively via engineering efforts. In line with the notion of seamless design (Chalmers et al., 2005), we advocate to see this not as a limitation, but rather an opportunity for design.

4.3.2 Celebrate Movement Articulation

Celebrate how well players articulate movement, and the joy of movement, by giving feedback on movement quality moment-to-moment. *In button-press games players receive feedback on if they pressed a button and when. However, with movement-based games, it is not just about if and when, but also how movement is performed. Also, you are not always performing movements to achieve an outcome. Sometimes the movement can be enjoyable on its own (whereas pressing a button is not usually a noteworthy pleasure for the player). Therefore celebrate the joy of movement and its articulation by providing players with feedback on the quality of their movement. This feedback has to be instantaneous, so that players can improve their movement articulation moment-by-moment.*

Example: Dance Central 2. Dance Central 2 celebrates movement articulation in the form of bright smooth streaks when the quality of a move was "flawless".

Example: Remote Impact. In Remote Impact (Florian Mueller, Agamanolis, Gibbs, & Vetere, 2008) (Supplementary Data, fig. 2), players have to hit their remote partner's shadow, projected on a mattress-like interactive surface, to hit points. But the quality of the hit also counts: harder hits score more points. Players can see the quality of their hit reflected immediately through observing the score.

Strategies for Designers

- You do not need to judge the articulation, you can just provide feedback by highlighting players' articulation to allow them to reflect on and learn from it by themselves.

DO's and DON'Ts

DO provide feedback if and when movement occurred, but also on how. DON'T worry about judging the how, players can figure it out themselves as long as they get feedback.

References and HCI Relevance

This guideline was developed based on Mueller's experience building *Remote Impact* and other games, and Isbister's work on the game *Scoop!* and research on movement and emotion (Isbister 2011; Isbister & DiMauro 2011; Isbister et al. 2011). Research on affect in games demonstrates that certain movements can facilitate positive emotional effects (Bianchi-Berthouze, Kim, & Patel, 2007; Katherine Isbister, 2011; Katherine Isbister et al., 2011; Zangouei et al., 2010). For example, raising your arms after a successful game action can enhance positive emotions. However, there is still much to be explored about how variations in movement qualities affect players' enjoyment and wellbeing (Isbister & DiMauro, 2011), and it is clear from designers' reports (e.g. (Isbister, 2012; Márquez-Segura et al., 2013)) that conscious and creative variation in movement is interesting and enjoyable for players. Thus we recommend that game designers nurture players' articulation of movement to promote positive affective responses and heightened enjoyment of the movement experience. The widespread emergence of the Kinect sensor installed in living rooms suggest that more and more

home entertainment systems will be controllable by hand movements. We believe the idea of celebrating movement articulation could also be beneficial in these non-game applications. However, we note that current developments in this domain often focus on identifying a set of gestures to control the home entertainment system. These gesture systems focus on triggering a specific command if a specific gestures was executed in a prescribed manner, concentrating on the outcome of the gesture. For example, if a gesture was completed successfully, the next music track is played, if not, nothing happens. As such, these gestures function as button-replacements, where the gesture system knows only two states: executed correctly or not, resulting in on/off commands. In contrast, we argue towards making use of *how* such a gesture movement is articulated, and consider this as part of the interaction. For example, a home entertainment system could sense nuances of *how* the user makes a conductor movement, and in response, not only select a classical piece of music, but also adjust the audio level accordingly: the more pronounced the movement, the more intense the volume, linking the articulation of the gesture to the execution in an engaging and also useful way.

4.3.3 Consider Movement's Cognitive Load

Moving can demand a lot of mental attention, creating high "cognitive load", especially when learning new movements, so do not overload the player with too much feedback. *Developing movement skill requires not only bodily, but also cognitive attention, with attention being a limited resource. Initially, players will need to focus on learning a new movement (so focus the feedback on this), while when getting better at the movement, they can devote more cognitive attention towards more complex and nuanced forms of feedback. For example, first time you try to pat your head and rub your belly at the same time, you probably cannot do much else, but when you get better at it, you can probably do something else simultaneously, such as having a conversation.*

Example: Dance Central 2. Dance Central 2 (contributors) provides multiple layers of feedback to players. Beginners can focus their limited attention on imitating the avatars. More advanced players can use the diagrams and score details to refine their moves.

Example: Ninja Shadow Warrior. In Ninja Shadow Warrior (Abe) (Supplementary Data, fig. 3) players are ninjas that need to fill out object silhouettes together to hide from evil, by "becoming" objects. Figuring out the best positioning of multiple bodies takes a lot of attention, so the computer feedback is kept to a minimum (just an overlay of the players' video stream onto the shape they are attempting to fill).

Example: Pac-Manhattan. Pac-Manhattan ("Pacmanhattan,") is a large-scale urban game that utilizes Manhattan's grid to recreate a game of Pac-Man. As players run around the grid, their cognitive attention is focused on moving, so wirelessly connected controllers take care of navigating them and most of the rules.

Strategies for Designers

- Start by providing feedback on the movement itself, without too much worrying about scores, multipliers etc.

- Provide several forms of feedback, but do not require players to engage with all of them: it is better to let players choose which ones to engage with based on their cognitive abilities, and shift their attention as their mastery grows.

DOs and DON'Ts

DO reduce cognitive complexity when moving: for example, if your player can usually remember 3 rules, as soon as she/he moves, she/he will only remember 1. DON'T forget that once players learn new movements, they might need to re-learn old ones as they integrate these new skills.

References and HCI Relevance

This guideline draws upon work done by the Microsoft Games User Research team when they were participating in the development and refinement of Kinect games (as conveyed in the interview we conducted for this research, as well as in prior communications and presentations), as well as existing research literature focused on games. Even button-press games require considerable cognitive effort, because of their interactive nature (Sweller, 1994). Learning new movements requires a great deal of concentration and focus, which can compete with the attention needed to parse feedback (Spelmezan, Jacobs, Hilgers, & Borchers, 2009). Research done in VR environments that require movement confirms that movement kinematics can be affected by increasing cognitive load (Kannape et al. 2014). For this reason, we suggest that movement game designers take into account the additional learning and cognitive load demanded from the player when designing feedback systems. Though there has been quite a bit of work in HCI about cognitive load in general, there has been no work (to our knowledge) about the intersection of movement and cognitive load in interaction. As gestural interfaces are adopted more broadly, it is important to understand how they may impact cognitive load for users. One thing this guideline points out is that movements do not always require the same amount of cognitive load. For example, there is a difference between learning a movement and being proficient at it in terms of the cognitive demand it requires: for example holding a tennis racquet for the first time requires more cognitive demand than if a professional player holds one (Gallagher, 2011). This suggests to us that HCI can learn from movement in games to consider this change in cognitive demand depending on people's proficiency of movement. The challenge for interaction designers though is to determine how proficient users are with their movements in order to determine how much cognitive load is required (and hence how much cognitive load is available for other user actions). For example, operating a mobile phone app on a bicycle requires different cognitive demands whether the user just learned how to ride a bike or is an avid cyclist.

4.3.4 Focus on the Body

Focus on the body, not just the screen, when designing player feedback. *In movement-based games, the body is a major focus of attention: audiences enjoy watching moving bodies, and players listen to their own bodies via proprioception. Do not distract players from this focus on the body by drawing too much attention to the screen.*

Example: i-dentity. The game *i-dentity* (Garner et al. 2013 and 2014) (Supplementary data, Fig. 4), in which players hold a Sony Move controller each and have to find out whose movement is sensed while moving in sync, and whose controller lights up simply at the same time, focuses on the players' bodies, not a screen (there is no screen).

Example: Dance Central. Dance Central uses the screen as a primary focal point for players, who follow the moves of charismatic and attractive on-screen dancers. The game has wide appeal to players who might otherwise feel self conscious about dancing in front of others. Dance Central still has a strong body focus, but in this case, it is the spectators who focus on the moves of the players. The choreography is appealing and engaging to watch as well as to master.

Strategies for Designers

- Think past screen-based feedback. You can use audio and haptics, as well as other players to offer feedback.

DOs and DON'Ts

DO start imagining what your game would be like without a screen. DON'T forget that for players who feel self conscious or reluctant to move, diverting attention away from the body might be beneficial to reduce the barrier to play.

References and HCI Relevance

This guideline draws upon Isbister's work on *Yamove!* and Mueller's work on *i-dentity*, and makes use of insights from Márquez-Segura et al. (2013). This guideline also draws upon extensive recent work in the indie gaming community (for example Kaho Abe's games—see http://kahoabe.net, games from the Come Out and Play Festival: http://www.comeoutandplay.org, and Douglas Wilson's games (Wilson 2012).) The body is at the center of the interaction in movement-based games (Mueller et al., 2011), yet many current games draw player attention primarily to what is happening on the screen rather than players' bodies. Some indie developers have critiqued the prevailing reliance of current game design on screen focus. Indie examples (Wilson, 2012) help to show this is a missed opportunity to positively contribute to the play experience, for example by turning any bodily movement into a spectacle that attracts audiences (Sheridan & Bryan-Kinns, 2008). It's important to note that this was the one guideline that several of our industry interviewees pushed back on. They pointed out that many people in their target audience can be quite shy about engaging in movement in front of others, and that bringing everyone's attention to the screen can mitigate this shyness and awkwardness. This led us to revise this guideline in our final set, making note of this caveat. In considering non-game HCI contexts, there is relevance to situations in which users engage in full body movement in the presence of others with whom they are trying to build or maintain rapport. Coordination and connection among those in a room becomes more difficult if everyone's attention (including the user's) is continually drawn to the screen as the user engages the system through movement. It is possible that a movement-enabled system could provide other forms of feedback to the user—for example audio cues, haptic feedback and other signals from a wearable component—to allow the user's attention to remain on others in the room.

4.4 Guidelines Cluster Two: Movement Leads to Bodily Challenges

4.4.1 Intend Fatigue

If you use fatigue as a game challenge, make it intentional rather than incidental. *Movement results in fatigue. On the one hand, it can be a welcomed challenge for players if they have to manage this fatigue (for example in endurance sports), on the other hand, fatigue can negatively affect engagement. Therefore, intend fatigue when using it as a game challenge, but avoid it when it is not part of the game.*

Example: Hanging off a Bar. In Hanging off a Bar (Mueller et al., 2011) (Supplementary Data, Fig. 5) fatigue is intentional: the challenge for the player is to hang onto the bar as long as possible, the only opportunities for recovery are rafts to jump onto when they pass by.

Example: Nike+ Kinect. Nike+ Kinect (contributors) demands a simple movement action (high knees), but turns it into a challenge of managing fatigue by asking the player to move as long as possible.

Example: Wii Party. In contrast, Wii party games (contributors) are all very short to reduce the chance of fatigue occurring.

Strategies for Designers

- Minimize chances of fatigue by creating short game cycles.
- Minimize chances of fatigue by varying movements.
- Distract players from fatigue, for example through music.

DOs and DON'Ts

DO use the management of fatigue as a game mechanic. DON'T assume players know how to manage fatigue, support them in figuring it out.

References and HCI Relevance

This guideline was based on Mueller's experience in creating and supervising the creation of many many exertion games, and on Isbister's experience in developing *Yamove!* and *Scoop!* Research highlights that managing fatigue can be an engaging game mechanic (Mueller et al., 2011). Of course, not all movement-based games need to engage this game mechanic, for example a party game designer may avoid fatiguing players. Yet designers should remember that movement can fatigue players, and if this fatigue is not managed and is not contributing to the game, it can distract from the experience (Gerling et al., 2012). This guideline has relevance outside games to interaction designers who are crafting movement-based interfaces with broad body motions or postures that can create fatigue, which they should manage. Fatigue can be intentional and desired for non-entertainment applications; sports training apps and rehabilitation are obvious examples, but there are also email systems that require users operating them with feet (step-interfaces) (Meyers, Brush, Drucker, Smith, & Czerwinski, 2006) in order to tire them out to provide new experiences and facilitate health benefits.

4.4.2 Exploit Risk

Exploit physical risk sensibly. *Movement, especially in everyday indoor environments, has an inherent sense of risk associated with it: there is risk of injury, risk of breaking furniture, risk of hitting another person. However, with risk also comes a sense of thrill, which can contribute positively to the game experience.*

Example: JS Joust. In JS Joust (Supplementary Data, Fig. 6) (Fabrik), players try to jostle each other's Move controller out of a perfect level position. There is the risk of jostling the other player's body also, which adds to the thrill of the experience.

Example: Hit Me! In the game Hit Me! (Abe) (Supplementary Data, fig. 7), players have to press a button on each other's heads to win. Jumping and striking the other person on the head feels risky, but the helmets mitigate the potential for injury. The game creates a strong feeling of being 'in your face' with another player, while making it less likely that anyone will get hurt.

Example: Bubble Popper. In Bubble Popper (Toprak, Platt, & Mueller, 2012) (Supplementary Data, fig. 8), players have to hit bubbles before their partner does: the game exploits the risk of body contact, blocking and pushing each other out of the way as an engaging game element.

Strategies for Designers

- Make players aware that they are engaging in a risky activity.
- Consider the environment when exploiting physical risk.
- Let players' movements interfere with each other to facilitate body contact, which has physical risk associated with it.

DOs and DON'Ts

DO put the player's safety first. DON'T assume players will be fully aware of any emerging physical risks as they might be distracted by engaging play.

References and HCI Relevance

This guideline draws upon Mueller's experience in creating multi-player exertion games such as Bubble Popper, and upon the extensive work of the indie game community in exploring physical risk and co-located gaming (e.g. the two examples *JS Joust* and *Hit Me!* above). HCI research has previously highlighted the potential for risk to positively contribute to the interactive experience (Klemmer & Hartmann, 2006; F. Mueller et al., 2011), as people might experience "feelings of thrill [arising] from a combination of fearful anticipation, followed by an extreme physical sensation, and then the euphoria of relief at having survived" (Benford et al., 2012). This guideline reminds non-game designers that interfaces do not need to be risk-free, in fact, there can be benefits to facilitating physical risk, such as the heightened experiences mentioned above (Benford et al., 2012).

4.4.3 Map Imaginatively

Map movements in imaginative ways. *The computer allows mapping movements in many imaginative ways, in particular in ways that are not possible in real life, offering players fantasy-fuelled opportunities they do not have otherwise. Mapping does not need to be literal or slavishly true-to-life.*

Example: Puss in Boots Kinect. In Puss in Boots Kinect (contributors) a player's wild arm and foot movements result in elegant, swash-buckling sword-fighting actions. This feels plausible and engaging when one is playing as a fairy-tale cat!

Example: Wii Tennis. Wii Tennis (Nintendo, n.d.) maps every simple up-down arm movement into a successful tennis serve, fuelling the player's fantasy of being a successful and accomplished tennis player.

Strategies for Designers

- Map movement in a non-linear fashion, for example in a tennis fantasy game a weak forehand movement results in a strong hit.
- Add additional virtual movement to mapped movement.
- Engage "avateering": make the player's movements look better than they really are.

DOs and DON'Ts

DO engage your creativity in the mapping process. DON'T use this guideline if you want to simulate a real-world sports experience, such as designing a golf simulator.

References and HCI Relevance

This guideline draws upon Isbister's experience in creating *Yamove!* and *Pixel Motion*, in addition to research literature on movement and games. Playing movement-based sports games is not the same as engaging in the equivalent sports activities (Graves et al., 2007). This guideline reminds game designers that this is rightfully so, as most movement games are not intended to be highly accurate simulations of a real-world physical activity. If we only focus on simulations, we miss an opportunity to engage players' fantasy, one of the key reasons why people play digital games (Lazzaro, 2008). We believe this guideline has relevance to non-gaming interfaces that aim to support and enhance users' emotional experience of an interface, and their sense of personal identity and empowerment. For example, subtly amplifying the results of gestures upon an interface, to make users feel and seem more powerful in a public setting.

4.5 Guideline Cluster Three: Movement Emphasizes Certain Kinds of Fun

4.5.1 Highlight Rhythm

Help players identify rhythm in their movements. *Movement is rhythmic: the head bopping when dancing, footsteps when walking, even when playing tennis there is a rhythm to the arm swinging back and subsequent follow-through. Movement can be rhythmic on an individual action level (tennis swing), but also the overall movement experience often follows a rhythm of high and low-intensity actions. Movement becomes easier with a beat, so support players in identifying a rhythm to their movements.*

Example: Mary Mack 5000. Mary Mack 5000 (Abe) (Supplementary Data, Fig. 9) is a technologically-enhanced twist on the classic schoolyard hand clapping game, highlighting the rhythm in movement through the clapping that results from players having their movement in sync.

Example: Dance Central 2. Dance Central 2 (contributors) offers an audio beat for players to identify a rhythm in their movements.

Strategies for Designers

- Play music for players to help them identify a beat.
- Visualize previous and upcoming movements so players can identify a rhythm in their movements.
- Think of haptics not only as a feedback mechanism for action, but also as a rhythm aid.
- Use other players to help a player identify a rhythm in his/her movements.

DOs and DON'Ts

DO see movement in games not just as a string of independent actions, but as a sequence of rhythmic actions that, with a beat, get easier. DON'T forget that engaging competitive gameplay can emerge when allowing players to try to throw their opponents off their beat.

References and HCI Relevance

Isbister's game *Yamove!* relies on artful use of rhythmic movement. Research has previously highlighted the key role rhythm plays when it comes to movement, for example, in sports science, the use of rhythm through music can enhance performance and enjoyment of physical activity (Karageorghis & Priest, 2008). Movement can be enriched by adding music; however, this guideline also reminds designers that movement itself often has a beat to it, and by highlighting this through appropriate feedback, the movement experience can be enhanced (Park et al., 2013). Highlighting rhythm of movement can also be beneficial in non-game contexts, of course in particular when it comes to music-based applications. However, we believe highlighting rhythm could also be useful when it comes to designing interfaces for learning new movements such as in sports and rehabilitation programs. Furthermore, it has previously been suggested that transmitting the rhythm of movement could also support the execution of workout exercises in a distributed coaching scenario (Sheridan & Mueller, 2010).

4.5.2 Support Self-Expression

Support players in expressing themselves using their bodies. *We communicate a lot about ourselves in how we move. Thus playing a movement-based game is always a form of self-expression, especially with other people around us. Take advantage of this to increase fun for players.*

Example: Guitar Hero. In Guitar Hero, lifting the guitar activates rock-star mode, motivated by the opportunity to earn more points. Guitarists lift their guitars to show off, not to play better. So building this movement into gameplay enhances a person's ability to show off and be more of a spectacle.

Example: Just Dance 4. Just Dance 4 (contributors) has a freestyle moment that provides players with snapshots of any crazy moves they do.

Example: JS Joust. JS Joust (Fabrik) leaves the rules wide open about how players can achieve the game's goal (slapping the other players' Move controllers), supporting the players in expressing themselves through their movements.

Strategies for Designers

- Allow players to perform different kinds of movements to achieve the same outcome.
- Encourage players to try out these different movements.
- Celebrate self-expression by showing players the result of their self-expression, for example in forms of photos of their movements as trophies.
- Offer opportunities for secondary performances - movements that do not contribute directly to the goal of the game - such as the lifting of the guitar in Guitar Hero.

DOs and DON'Ts

DO see movement as a form of self-expression that can make your game more fun. DON'T forget that self-expression is not only concerned with the player him/herself, but also other players and any audience.

References and HCI Relevance

Isbister's game *Yamove!* allows players to create their own improvised movements. Movement is not only a form of game input, but also supports people in their self-expression, for example the showy lifting of the guitar in *Guitar Hero* (Bianchi-Berthouze et al., 2007). In particular, secondary performance or "gestural excess" (Simon, 2009), that is movement that does not directly contribute to the outcome of the game, can allow players to express themselves, which can contribute positively to the experience (Bianchi-Berthouze et al., 2007; Isbister, 2012). Good design creates opportunities for self-expression to occur through game mechanics such as the in-game reward opportunities when lifting the guitar to "show off". Supporting self-expression through movement can be a useful strategy for interaction designers to use to generate more satisfying and rich affective experiences for users: we believe by supporting self-expression designers allow users to form a more emotional connection to the device they are interacting with. Technology users often customize devices in ways both supported by and external to their devices (e.g. mobile phones—Blom & Monk 2003). As movement can support affect (Bianchi-Berthouze, 2013; Bianchi-Berthouze et al., 2007; Isbister, 2011), we believe with the advent of movement-sensing technologies in more and more products, interaction designers have a further opportunity to support self-expression and as a result support more affective connections between people and their devices.

4.5.3 Facilitate Social Fun

Facilitate social fun by making movement a social experience. *Moving with others is fun. Movement is typically visible to others and easily becomes a performance, whether we intend it or not. Therefore, design for multi-player, including other players and an audience.*

Example: Yamove! *Yamove!* (K. Isbister) (Supplementary Data, Fig. 10) is a b-boy style dance battle game. Players compete in pairs, aiming for high intensity, in-synch and diverse dance routines. Each player wears an iOS device strapped to the forearm. The game is hosted by an MC and scoring is based on accelerometer data from the devices. *Yamove!* illustrates that a game can facilitate social fun for players, moderators, and spectators alike.

Example: Musical Embrace. In *Musical Embrace* (Huggard, De Mel, et al., 2013; Huggard, Mel, et al., 2013) (Supplementary Data, fig. 11), players have to navigate a virtual world by embracing a sensor-augmented pillow together: their performative movements make for a great spectacle for the audience, who cheer the players on.

Strategies for Designers

- If you plan to design multi-player and single-player modes for your game, consider starting with multi-player.
- Make the game a spectacle: encourage movements that are, by nature, a spectacle others enjoy watching.
- Turn bystanders into players: allow the audience to easily join the game.
- Make the game easy to learn by observing, so that spectators figure out what is going on quickly and want to try.

DOs and DON'Ts

DO engage other players and audiences by turning the movement into a performance. DON'T forget that movement in spaces where others do not know that there is a game going on, such as public spaces, might create socially awkward situations.

References and HCI Relevance

This guideline drew upon our work creating *Yamove!* and *Musical Embrace* as well as other games. The inclusion of movement (in contrast to playing the same game with button-presses) can change the character of the experience from playing to win to playing to socialize (Lindley et al., 2008). This is a result of the positive affect resulting from body movement (Isbister, 2011; Lindley et al., 2008) as well as the performative character of movement that can draw audiences (Sheridan & Bryan-Kinns, 2008; Harper & Mentis 2013). We found in our teaching practice that it is easier to design for multiplayer first, then single player second when it comes to movement-based games. This contrasts common game design practice, where development tools often suggest starting with single player first, as multiplayer support can be more difficult to implement. We believe non-entertainment systems that engage movement should also be designed with multiple users in mind from the start. We understand that unlike in games, where there are often multiple players engaging at the same time, in non-entertainment systems there is often only a single user operating an interface. However, this guideline can remind designers that when it comes to movement, social aspects are

much more pronounced, meaning that, for example, when designing a single-user interface, any by-standers are much more aware of the actions exhibited by the user (because flailing an arm is more visible than a button press), affecting the social experience for both the user and the by-standers to a higher degree compared to mouse and keyboard interfaces.

5. LIMITATIONS AND FUTURE WORK

We focused on movement-based games, rather than movement-based play. We see games as more formal, with rules and goals (Salen & Zimmerman, 2003), and play as a larger design space that encompasses games. We began with the smaller design space, but we find movement-based play a fascinating area, in particular in light of the movement-based play that emerged in the 1970's under the term "New Game Movement" (Fluegelman, 1976) that we believe holds tremendous potential when thought of in combination with digital technology. Our personal experience and the experience of the experts we interviewed steered our thinking towards games played in living rooms, arts venues and conference exhibits. We note that emerging location-based games, played over large areas, are also movement-based. We acknowledge that there is not much specific guidance for these types of games in our guidelines. However, we believe some of our guidelines (in particular Intend Fatigue, Consider Movement's Cognitive Load and Exploit Risk) are easily applicable to these location-based games, suggesting that our work might also be useful when designing these kinds of games.

It would of course be ideal to observe use of the guidelines in practice, in mentoring situations, to gauge their usefulness. One reviewer suggested applying the guidelines to several existing movement based games to see whether they apply. We are considering combining such an approach with use of game review scores (such as those aggregated on Metacritic) as an additional way to validate the broad applicability of the guidelines. We are tracking website traffic to the guidelines site, as a measure of interest. We also plan to conduct follow-up interviews with our experts as to whether they have used the guidelines in their own mentoring practice. This will help us better understand how and when the guidelines work, and provide insights about how they need to be developed further. We anticipate the need to periodically revisit the guidelines and examples in any case. Movement technologies will continue to evolve, and canonical examples of excellent movement games will continue to appear.

6. REFLECTIONS ON RELEVANCE TO THE BROADER HCI COMMUNITY

For each guideline, we provided suggestions for extension to HCI practice outside the realm of games. The most obvious application of this work is to non-game support of physical activity and interaction, for example in supporting sports training and dance instruction. However as movement-based systems become more broadly accessible, these guidelines can have relevance to future everyday activities such as gesture-based authentication systems (Karlesky, Melcer, & Isbister, 2012), and situations in which a movement interface is designed specifically to create a practical change in affect, for

example ‘power posing’ to reduce math anxiety in young learners (Isbister, Karlesky, & Frye, 2012; Isbister 2011).

Great movement game designers value above all the moment-to-moment experience of the players as well as the spectators. If the experience is not engaging to everyone involved, it is not a success and it will not be well received. Increasingly, HCI practitioners are working on applications that incorporate considerations of moment-to-moment experience as well as (and sometimes even in lieu of) task support, blending ‘do’and ‘be’ goals (Hassenzahl 2010). There is much to be learned from game designers about the nuances of supporting engaging moment-to-moment experience, and about managing emotions, expectations, and social interaction. We hope these guidelines have provided the reader with some concrete examples of applicable insights.

We believe it is also interesting and relevant to the broader HCI community that there is a seeming disconnect between practicing movement game designers and the research findings from our scholarly community that may be of use to them. These designers tend to rely on conversations with one another, and online writings from other designers, rather than reading academic papers that could be of value to them. There have been ongoing conversations within the HCI community about the gap between researchers and practitioners in the field as a whole, leading to the establishment of a CHI SIG devoted to improving the situation (Buie, Hooper, & Houssain 2013).

Perhaps our process could serve as one useful potential model for researchers hoping to better involve and activate practicing designers. We first worked to make explicit our own accumulated tacit knowledge concerning this design area, then chose a format (guidelines) and dissemination method (website) that were familiar and comfortable to this design community for sharing these insights. Then we interviewed expert practitioners to validate the guidelines, to ensure that both format and contents were useful. Conducting interviews aligns well with the way that designers are accustomed to exchanging ideas—we have used them before to bridge game design practitioner insights into research (Isbister, Flanagan & Hash 2010). We intend to track whether the guidelines in fact result in use value for working designers. If so, this may be a model of potential value to others looking to bridge the research-practice gap.

7. CONCLUSION

We presented a set of guidelines for movement-based game design that have emerged from our research-based game development practice. These guidelines have been examined and refined by 14 movement-based game designers with experience in academic, independent and commercial game design domains. Their positive feedback suggests that our process of engaging in design practice ourselves, analyzing and reflecting on existing games, and getting feedback from lab members and experts, can lead to practical guidelines that practitioners appreciate. The fact that the experts said they use some of the recommendations in the guidelines in their current practice and that the underlying findings match their experience suggests that we created guidelines with applicability beyond our own practice. By making the guidelines publicly available in

both paper and online format we hope to reach both academics and practitioners, furthering the practical potential of the guidelines.

We believe our approach of directly engaging with multiple accomplished design practitioners significantly strengthened the end result in terms of both clarity and applicability. This supports the notion that researchers should not only deliver results to practitioners, but also actively engage them in the knowledge production process (e.g. (Isbister, Flanagan, & Hash, 2010)). Just as we as HCI researchers value and prioritize engaging end users in evaluating experiences we design, we should also value and prioritize engaging expert practitioners in the evaluation of the usefulness of the tools for design our research generates. In our particular field of game design, the boundaries between what researchers, commercial game developers and independent game designers do are overlapping more and more, and we believe everyone can benefit from sharing work in progress and reflections about practice.

We encourage other HCI researchers to incorporate design practitioners in the development of practical guidelines in order to make conceptual thinking readily applicable to the target design community. In return, we urge practitioners to support researchers when creating these guidelines (as our experts did) in order to advance the development of knowledge. If we work together in this way, we can take better advantage of the strengths and knowledge of both communities to advance the field as a whole.

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