Understanding Expectations with Multiple Controllers in an Augmented Reality Videogame

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ABSTRACT
Player experiences and expectations are connected. The presumptions players have about how they control their gameplay interactions may shape the way they play and perceive videogames. A successfully engaging player experience might rest on the way controllers meet players' expectations. We studied player interaction with novel controllers on the Sony PlayStation Wonderbook, an augmented reality (AR) gaming system. Our goal was to understand player expectations regarding game controllers in AR game design. Based on this preliminary study, we propose several interaction guidelines for hybrid input from both augmented reality and physical game controllers.

Author Keywords
Games; User Experience; Player Experience; Games User Research; Controllers; Augmented Reality; Wonderbook;

ACM Classification Keywords
H.5.2 [Information Systems]: User Interfaces; K.8.0 [General]: Games – Personal Computing;

INTRODUCTION
Users are highly engaged by products or services they desire. Games provide some of the most desirable technical platforms of Human-Computer Interaction (HCI). Therefore, studying user experience in games, or more aptly called player experience, can provide great insights about player expectations and desires [11]. As part of player experience research, we are using evaluation methods from HCI to try and find optimally engaging game designs and to evaluate player experiences [20]. In games, play and enjoyment are the primary goals of the interaction taking place. The accomplishment of tasks remains secondary to, or integrated with, these primary fun goals. Thus, while a task may motivate engagement with productivity applications, engagement with videogames must be motivated by attractive, engaging or pleasurable interactions [15]. One of the main components of any interaction with a system, is the way its user interface works. For videogames, the experience outside of a game has traditionally revolved around the buttons, sticks, and discs featured on game controllers. In particular, the buttons of traditional video game controllers (e.g., a joypad or a gamepad) allow a player's intentions to be translated and mapped onto physical actions and game interaction.

Videogames have moved beyond the screen. Traditional consoles had to adapt as mobile phones created player experience in everyday contexts. New virtual reality hardware like the Oculus Rift allow for new forms of output that do not even necessarily involve the television screen as an output medium anymore. In addition, augmented reality (AR) games and new physical controllers are commonplace now for the gaming consoles of this generation (e.g., Microsoft's Xbox One, Sony's Playstation 4 or Nintendo's Wii U). We believe there is huge potential in designing games for these new input and output modalities. For example, we imagine that these modalities can offer existing players more intuitive and satisfying interactions. They also potentially offer easier access to videogames for new audiences, who are less experienced with traditional control methods. However, current game designers are lacking focused investigations that can help to establish interaction design guidelines for these novel games. We address this lack by providing an initial study of players using the Sony Wonderbook augmented reality system.

RELATED WORK
Studies have investigated the influence of control schemes of different consoles on player enjoyment [5, 9, 13] and support user preference for traditional button-driven controls compared to more advanced control schemes. One strong proposed influence on player experience is the user's perceived preference for a product or technique. Users appear to be more effective at using an interaction technique they prefer. For example, Nielsen and Levy [14] found problem solving was greatly improved when participants used their preferred interaction technique over any other.

An essential feature of game design is to break down goals and add tasks for players that lead them from onboarding toward mastery. Games have a clear set of goals for the challenges they present. A consequence of such clearness is

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the expectation for immediate feedback while the player engrosses in feelings of flow and immersion [12], progressing from one challenge to the next – more difficult – one, in the process accumulating greater skills and abilities. Hence, a core part of player experience would then be the interface through which a player interacts with a game and with other players. Immediate feedback from this interface is crucial for the player. The lack of feedback may break the state of flow that keeps the player engaged. Often, a central part of game interfaces and therefore of player experience is the game controller. Games have evolved over time, and so have the input controllers they require. The interactions with games and their level of abstraction, or naturalness, have changed in an attempt to create more engaging and fun experiences.

Interactions can thus be of different nature [3, 16]. Some can be of symbolic nature, by abstracting and reducing game actions like jumping to something as pressing a button to jump. In contrast to symbolic interactions, it is also possible to have iconic interactions, where natural motion of our body plays a central role, like performing the same actions for playing a tennis videogame (e.g., in *Wii Sport*) as in real life. Hence, these distinct interactions might create different controller shapes or affordances, which affect player expectations in regards to how they may differently operate [8]. For example, the Sony move controller suggests the affordance of being gripped and potentially being swung (like a racket or a sword). In contrast, a hypothetical controller, shaped like a disc might suggest to the player it can be interacted with by wielding it like a shield or throwing it like a discus.

Skalski et al. [19] provide a comparison between various game controllers regarding the naturalness of the mapped actions and how this correlates to enjoyment. The more natural the game controller feels, the greater the enjoyment should be for the player. Research exploring the impact of controller naturalness has shown that – while players of racing game may report greater flow, presence, autonomy and intuitiveness for naturally-mapped controllers (e.g., steering wheels) – players may still perform better with non-natural devices, such as traditional controllers [10]. The connection between more naturally-mapped controller interface and greater immersion has also been found in the context of mobile videogames [2]. Nevertheless, the way we feel if a controller is natural is different for each individual, and natural motion might not work equally well [9].

According to Gregersen and Grodal [6], the theme of a game and its representation in the game controller is equally important as a part of the gameplay experience. Accurately representing game actions in the game controller is important, but recreating certain elements of the game's theme in the controller itself can further increase the interest and engagement in the game, while meeting player expectations [17]. An example for a case of harmonious use of theme and affordances is Ishii et al.'s PingPongPlus [7]. It is an augmented game of table tennis that is played with real paddles, providing accurate physical and intentional affordances. These affordances also fit into the theme of the game.

Sony PlayStation's Wonderbook controller is an AR book featuring pages with different fiducial markers (see Figure 1). It also uses motion input objects like PlayStation Move controller and/or the player's hand gestures to interact with it. Few researches have looked at similar interaction paradigms, which would use two controllers in a similar fashion that Wonderbook and Move controllers do it. For example, Rohs in handheld AR games [18], and Billinghurst et al in the MagicBook with handheld display, which created at the Sony Computer Science laboratories in 2001 [1].

Yet, as these interaction paradigms become more popular, key issues remain to be explored. It is not yet fully understood how players perceive and experience the affordances of multiple controllers used together in a game. It is also not clear how well the controller combination in Wonderbook articulates the available mapped actions. One unique aspect of the Wonderbook system is the use of a physical book as an interaction channel. There is a potential to assume interacting with the book (as a game input device) may create some expectations for users [4] as most can be assumed to have a long and established relationship with books. However, it is not clear whether users' established expectations would be met during their interactions within an AR game.

We report here a study to that explores these issues. As an outcome of this study, we propose early design guidelines for interactions with these types of controllers, based on the observations we collected from our participants. Should there be increasing interest in utilizing controller combinations such as this when developing games, the insight that this article provides can help improve player experience. Moreover, game developers and designers may also find these insights helpful when utilizing a combination of such input systems when designing a new game.

WONDERBOOK STUDY

We conducted a study of the PlayStation Wonderbook and the PlayStation Move controllers (see Figure 1).

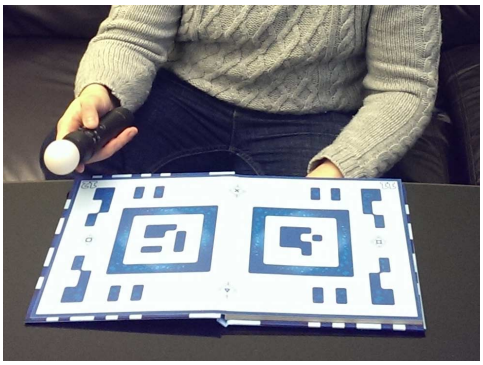

Figure 1. The Wonderbook and Move Controllers.

The Game: Book of Spells

Book of Spells is a game based in the *Harry Potter* universe that uses the Wonderbook and the PlayStation Move controller. The intent of the game is to make players feel as a part of the wizard world. The story itself is Miranda Goshawk's Book of Spells, an old textbook used to teach the readers a variety of different charms and spells. The Move controller takes on the look of wand, chosen by the player, and the Wonderbook takes on the look of the old spell book (see Figure 2). Players must learn each spell in the chapter and complete the chapter tests, which involve all the previously learnt spells, to advance in the game.

Figure 2. Book of Spells game screenshot, exhibiting the Wonderbook and Move controllers overlaid with 3D imagery.

The Controllers

As explained above, this game and its interactions are a hybrid combination of controllers. The Wonderbook acts as an interactive AR play mat, allowing the player to flip through the pages, rotate and fold the book while looking at the television to follow the gameplay (or its instructions). As the game uses the Playstation Move Camera, it is important for the player to keep the fiducial markers (Wonderbook) and the Move controller visible to the camera at all time.

In the case of the studied game, the Wonderbook adopts the appearance of an old spell book on the television, blending in with the theme of the game while hiding its more technological appearance (Figure 1 and Figure 2). Flipping through the pages of the books proceeds or retrocedes the level presented to the player, while moving it in certain angles allows the player to perform intended in-game actions, such as lifting the book to dry after soaking it with a water-making spell.

The PlayStation Move controller exhibits a wand-like appearance, which reinforces its integration into the theme of the game, features various buttons for input, while being motion-tracking capable. The players can interact with the Wonderbook through this wand, by pointing it at certain key directions exhibited in the game, while pressing specific buttons, or by flicking or drawing gestures. For most of these interactions, verbal, visual and haptic feedback is provided by the game.

The Participants and the Playtest

For the purpose of our case study, we recruited six participants [P1 to P6] who frequently played videogames and were familiar with the Harry Potter stories. Players were selected carefully so that none had used the Wonderbook before. They were recruited using our University's mailing list and their participation was voluntary. Individual user test sessions were conducted in our dedicated game laboratory. The participants played the game on a Sony PlayStation 3 connected to a 55" display. The participants were seated on a couch, while they had the Wonderbook resting on a coffee table directly in front of them. Video cameras captured the player, and real-time game footage was digitally streamed in a single screen for live viewing in an isolated observation room and recorded for analysis (Figure 2 shows a screenshot from recorded gameplay video and participants seating position).

Before starting the study, the players signed an informed consent form, and were provided with a brief explanation about the study. The players were asked to play both sections of the first chapter (about 45 minutes). They were told that the study is not about how well they can play the game and were asked to play the game as if they are at home in their own living room. Before the test started all the save files (from pervious study) were removed so each player would experience the game from the beginning (including a standard animated introduction about the Wonderbook and basic interaction as part of the game's loading process). After they finished both sections of the first chapter (all six players completed the test) the recording was stopped and the participant were asked questions (in the form of a semi-structured interview) about their experience with the game and controllers (e.g., features they liked and did not like). After this, the players were thanked for their participation and left.

Analysis

Two evaluators observed and analyzed the gameplay sessions separately, noting players' gameplay experience in regards to the observed interactions, the players' comments and their moments of notable satisfaction or frustration in a 'double-expert' approach. Their findings were collated and summarized with identical issues combined, providing our own list of findings.

RESULTS

We identify the following as overarching game design consideration in our findings:

- Accurate or inaccurate mapping of actions on the Move controller and the Wonderbook
- Positive or negative match between player expectations and game interactions
- Verbal communication's terminologies or language
- Storytelling

We observed that *accurately mapping* gestures to the Move controller was the most ambiguous area for the players. Some players had difficulty in performing the required motions, mostly caused by inaccuracy in tracking the spells gesture. This happened not only because players were executing the gestures too fast (or too slow) for it to be correctly tracked, but also because some required gestures were too complex for the players to remember and recall or they did not match to the players' expectation. Moreover, the camera angle required tracking of both book and controller on the same scene made it difficult for the players to cast certain spells or move the wand around to skip text. Finally, we observed inconsistencies in interactions between spells requiring flicking motions and those requiring reaching for objects.

Despite having more consistence performance in interactions when involving the Wonderbook (such as rotating, tilting or pointing to virtual object on the pages), similar issues were still observed across our players. For example, the game replaces the Move controller's image with that of a wand that is longer in size (as shown in Figure 2). This transfers players' focal point of interaction to the tip of the virtual wand and not the tip of the physical controller. We observed situations where this disparity led to some issues when players had to point to (interact with) virtual objects above the book's surface. There were also in-game situations where players had to use their hand to interact with virtual objects. This inconsistency between the sources of interactions also created issues for the players learning when to use their actual hands or the Move controller. Our result shows that in most cases players tend to try to use the controller until they are told otherwise explicitly.

Since our players were familiar with the Harry Potter universe, they had initial *expectations* about how a magic wand should work in game. *Expectations* were also present for how to interact with the book, as it is a well-known medium. For example, P4 felt that the books flipped imagery in the television screen was upsetting and caused a break in the believability of interacting with a real book.

Moreover, we observed several reactions in relation to *the match between players' expectations and in-game actions*. The value of matching player expectations in an in-game actions operated at mulitiple levels. At one level, when the actions required to complete a spell matched player expectations in terms of using real-world metaphors and existing knowledge/experiences that can help players understand game mechanics. For example in the water-making spell, where the players expressed satisfaction and pleasure. At another level of abstraction, players enjoyed the match between the game and their recollections of Harry Potter mythology from the books and films, for example, enjoying having to speak aloud a popular Harry Potter spell.

In contrast, when learning new incantations the game would sometimes recognize background noises as the correct pronunciation causing confusion and shattering expectations. Other ambiguities were also present in context specific situations. One of the players, P4, explicitly noted a false (or insincere) positive reinforcement within the game. When this player did not cast the spell correctly, the game positively reinforced this failure by saying "Well done! But try to do it again!". As another example, we observed participants frequently lifted the book towards themselves (instead of tilting the book towards the Move camera placed above television) to take a glance inside a virtual hole (as part of the game's storyline) (See Figure 3 below). Although they were interacting with the book in a different fashion, players reported that actions like this make this controller feel like something much more foreign than a traditional book.

Figure 3. Players need to tilt the book towards television

These types of issues can be seen as a consequence of controllers not matching with the players' *expectations* of using real-world metaphors and existing knowledge as explained earlier. The pre-conceived notion of how books, wands, or spells work influenced the expectations players had and shaped the way they interacted.

Various *mapped actions* used similar controller gestures, but different buttons, causing confusion among the players, and thus breaking the fun experience of the game. An example of this is that a button has to be pressed to cast a spell (as an action button) within a game scene, whereas a different button has to be pressed to interact with the book (as an action button), on a scene where no spells have to be cast. These feelings are attributed to the inconsistency of the actions that players have to perform, as well as to the lack of guidance provided by the game.

We also observed various issues related to how players perceived *language* in the given instructions during the game. For example, there is one spell within the game that creates light. Sometimes players had to cast this spell for the first time and were prompted to "turn on the lights". Given that this game uses computer vision technology to track both the book and the wand controllers, this instruction seemed to be confusing. Some players mistook this with having to turn on the lights of the room to improve the computer vision capabilities of the game.

Storytelling was equally considered to be an important factor, especially as the game involves a book as the controller. Even though the game relied heavily on trying to invoke memories of the books and movies only two participants showed any interest while the rest tried to skip through from reading story related texts (and narration commenting). P4, the player most interested in the story, turned off the narration commenting that if the game involves a book, it should be about reading and not having it read. P5 stated: "it would be more interesting and fun to have a spell sandbox, where player could cast the spells they wish"; instead of having limited interactions throughout the storyline.

DISCUSSION

This study was of an exploratory nature, trying to understand and provide initial guidelines for the design of games involving hybrid input from both AR and physical controllers.

Based on our results, we provide five primary points followed by detailed explanation for the implementation and integration of the two-part interaction paradigm, summarized in Table 1.

Guideline #1 - Interactions should be robust
Guideline #2 – Mapped actions should be consistent
Guideline #3 – Actions should match user expectations
Guideline #4 – Instruction Language should be clear and contextually supported
Guideline #5 – Storyline should bind the experience

Table 1. Proposed Initial Design Guidelines.

Guideline #1 – Interactions should be robust

We observed some situations where the interactions required by players were poorly supported by the technology and unsuccessful as a result. For examples, players had placed the book in certain positions that caused the fiducial markers to be blocked from the camera, causing the virtual imagery to disappear, leading to player confusion and broken gameplay. Similar issues were present when players had to perform a gesture with the Move controller in a way that was hard for the camera to track (e.g., in the edges of camera view). Exposing the players to these limitations impoverish the game experience and should be minimized by either changing designs (e.g., modifying the level design), or steering players away from these potential pitfalls (e.g., replacing these interactions).

Guideline #2 – Mapped actions should be consistent

By having an input system that consists of two controllers, we looked at how well the mapped actions of both were closely intertwined. Several issues arose due to irregularity in button mapping, and movement tracking with participants citing the use of the Move as inconsistent. We propose that the actions that are provided within a hybrid game are kept in a **consistent and natural** manner. They should not be a showcase of the technological capabilities, but should instead prioritize consistency as well as being directed towards players' expectations, another guideline that we propose.

Guideline #3 – Actions should match user expectations

Some of the mapped actions leveraged by the controllers, like brushing off dust from the virtual book, did not raise problems in the players' expectations. However, some interactions that involved moving or displacing the book, such as peeking at a virtual hole in the book, broke the players' expectations. Based on this we suggest that where games rely on player expectations it is important that these expectations be well established or commonly understood by players.

Guideline #4 – Instruction Language should be clear and contextually supported

Various interaction mistakes resulted from the poor prompting of actions. To increase the success of the game, these instructions should be understandable and contextualized. This requirement also extends to instructions regarding how to manipulate the controllers. By providing clear instructions that cannot be subject to multiple interpretations, player's dissatisfaction, confusion and frustration can be avoided. For example, as mentioned in the result section, players made some mistakes, in response to unclear language. This error could have been avoided by visually prompting the tilting motion. Designing games that rely on narrative, or on instruction and prompting, should not leave room for ambiguities and contextual interpretations.

Guideline #5 – Storyline should bind the experience

We recognize that storytelling is often a complementary element to player experience with this hybrid controller. Whenever the previous guidelines are met, the story of the game, and the recollection of memorable moments from another medium the game draws from, will increase both the success of the game and of the controllers. In the case of Harry Potter, which is a well-known story, whenever a recollection occurred, players exhibited joy and excitement.

LIMITATIONS AND FUTURE WORK

Future iterations could look at the variations of the interaction with younger players, larger sample size and in a more natural environment. We expect not only that they will interact differently, but also that they may show different interests in other aspects of gameplay. Looking at longer play sessions might identify different types of issues than those we observed.

The Wonderbook is supported by other games, which use it as the main controller. Our future interest is to study these new interactions, improving or enhancing our proposed guidelines. For future work, in order to create more general guidelines, it will be useful to analyze games, which use a similar controller combination, but do not use the Move

controller (e.g., in Diggs Nightcrawler), the Wonderbook or even neither. A game that uses fiducial marker cards with the Move controller would be another example. Nevertheless, with our preliminary study, we have proposed primary initial guidelines on which future research can build on.

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