Extracting Design Guidelines for Wearables and Movement in Tabletop Role-Playing Games via a Research Through Design Process

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ABSTRACT
We believe that wearables and movement are perfect fit for enhancing tabletop role-playing (TTRPG) experience, since they can provide embodied interaction, are perceived as character-costumes, enhance ludic properties and increase the connectedness to the imaginary game worlds. By providing these improvements, they can increase the immersiveness and player/character relationship which are critical for an ideal TTRPG experience. To investigate this underexplored area, we conducted an extensive research through design process which includes a (1) participatory design workshop with 25 participants, (2) preliminary user tests with Wizard-of-Oz and experience prototypes with 15 participants, (3) production of a new game system, wearable and tangible artifacts and (4) summative user tests for understanding the effects on experience with 16 participants. As a result of our study, we extracted design guidelines about how to integrate wearables and movement in narrative-based tabletop games and communicate how the results of each phase affected our artifacts.

Author Keywords
Wearable Computing; Role Playing Games; Participatory Design, PnPRPG; Guidelines; Exertion Games; Game Design; Game Research; Tangible Interfaces

ACM Classification Keywords
H.5.2 Evaluation/methodology - Input devices and strategies - Interaction styles - User Centered Design

INTRODUCTION
In TTRPG, although some physical artifacts like boards, character or object figures may be used, the state of the game is usually imagined by the players based on their verbal explanations. These games usually consisted of players (usually at least 2) and a moderator/storyteller (usually referred as game master). Game Master's duty is to moderate the game, tell the story, form the imaginary scenery of the game and decide the outcomes of the players' actions. Players proceed through an imaginary game world according to the story, which the Game Master created, by making various decisions.

With the development and the commercialization of embodied and tangible interaction systems in games, augmenting analog tabletop games became a trending topic in game research. These games, in the scope of Computer Augmented Games (CAG), led researchers to explore different modalities that can be used to augment tabletop games. TTRPG is among the popular games for augmentation and offers more distinctive characteristics by being narrative-oriented and requiring long-term engagement. There are many examples aiming at enhancing TTRPG experience in several aspects like improved sensory feedback, speeding up uncaptivating game processes and implementing new mechanics with opportunities granted by the computational power [3,20,30,33]. These improvements also work for leaving more space for role-playing by debilitating the conditions interfering with it. Moreover, increasing sensory experiences fosters the atmosphere, again resulting in a better experience [31]. Still, how to incorporate wearable devices and movement-based play in TTRPG was not studied in a deeper level although previous studies suggest that these concepts may perfectly fit TTRPG environment since 1) wearables can be designed in a way that do not directly interfere with players' concentration [44], 2) can increase the connectedness to imaginary worlds by perceived as costumes [22,41] and 3) movement-based play can let players enact their characters with their bodies [41].

We believe, to test these arguments, we need to incorporate a research through design method where we include users in the design process from the very beginning to design and produce an artifact that integrates wearables and movement-based play into TTRPG in the *right* way. Therefore, we executed a five-pillared research process which includes a (a) participatory design workshop, (b) design of a new games system (WEARPG), (c) preliminary user testing of WEARPG with experience prototypes [9] and Wizard-of-Oz (WoZ) method [2], (d) development of wearable and tangible devices included in WEARPG

CHI 2018, April 21–26, 2018, Montréal, QC, Canada

ACM 978-1-4503-5620-6/18/04…$15.00
https://doi.org/10.1145/3173574.3174087

system, (e) user testing of the working prototype to understand its effect on immersion and player/character relationship and forming design themes drawing upon our experience in this research process. In the following parts of this introduction, we will go into more detail about each part of our process.

Our first study, participatory design workshop (Phase 1), included 25 participants from 5 different audiences which are TTRPG players, game masters, cosplayers, jewelry designers and interaction designers. In this study, we wanted to (1) see users' reactions on positive and hindering parts of the wearable idea, (2) learn their preferences about the game actions to perform with this device, (3) understand their desires about the interaction techniques which refers to input and output methods (4) see their visual design decisions and (5) understand Game Master's role in controlling these devices. Although this phase did not include the exploration of movement-based gameplay, we saw that gestures and movement can be adopted by players as two projects in the workshop speculated using them in the gameplay. Upon this phase, we obtained design implications which can lead us in the design process of a new game system and the wearable devices.

We evaluated the design implications which are related to game design and designed a new game system, namely WEARPG, which can incorporate movement-based gameplay and arm-worn devices in TTRPG (Phase 2). We designed a quick start guide which introduces the basic rules along with an experience prototypes [9] which would let us to test the new system by using WoZ method [21]. We executed preliminary tests (Phase 3) in this phase by including 15 participants in the process. This part resulted in new design implications which are related to game research. It also gave us clues about how to improve the system before beginning to implement a working prototype.

After this phase, considering the design implications obtained from our first and second studies, we designed and implemented an arm-worn device called Elemental Gantlet (Phase 4). We also designed another tangible device which is called Luck Stone which can replace the dice in TTRPG since our previous studies indicated that dice constitutes a very important part of the TTRPG experience.

At last, we tested our artifacts with 16 players (Phase 5). In these tests, players played the game, half without wearables and movement-based gameplay system and half with wearables and movement-based gameplay system. They filled questionnaires aiming at measuring their immersion and player/character relationship level after each condition. Moreover, we made an in-depth semi-structured interview with each player to understand their opinions and experience about the game with open-ended questions.

Our research encapsulated formative and summative user inclusion for the production and the test of a new game system and artifacts. In total, 53 participants contributed to this project in different states. In this paper, (1) we *articulated our design process in detail* for other designers and researcher to incorporate it for similar problem framings as this is one of the requirements of the research through design [48]. Moreover, the amount of work invested in developing this system, artifacts and the feedback from our users led us to form (2) *design guidelines* about the integration of wearables and movement into the narrative-oriented long-term augmented tabletop games. Our guidelines can be fruitful for the designers of such tabletop games and other types of long-term digital games which are narrative-weighed. We also need to emphasize that this paper does not focus on the detailed outcomes of research phases but how each phase is related to each other and how the outcomes affected the design decisions in the process.

BACKGROUND

Related Work

Studies done on computer augmented games (CAG) relate to our work even if they do not include wearable devices. CAG refers to physical games which are supported by electronic devices or gadgets. STARS Platform [30] is one of the first examples which examines the integration of computers into non-digital table top games. STARS Platform, similar to our idea, designed to be adaptable for different kinds of games and include many types of interactive devices. However, it did not involve users in the design process and did not mention guidelines for design and implementation. A study by Bergström and Björk pointed out 6 different CAG cases and extracted 8 dimensions which defines the game design space for CAG [3]. These dimensions form constructive insights and define the design space of CAG in a convenient way, however they are not design guidelines. A similar study also defines a design space with broader terms as a result of design workshops with users [36]. Apart from these design oriented research, a project called Undercurrents aims to create a digital tool for table top role playing games [4]. This study shows similarities to our work, since it aims at implementing digitalized tools to tabletop games and it is shaped on intensive user feedbacks. Moreover, even though they are not design guidelines, design requirements for the project are explained systematically providing insights for the implementation of such systems. However, it differentiates from our work since it is not based on wearable gadgets and the specifications do not propose clear paths to follow as guidelines.

Several studies have considered integration of arm-worn wearable devices to role playing games. *Thumin Glove* [43] is an example designed for Live Action Role Playing Games (LARP) and its purpose is informing the player when they get close to the hidden objects around. *Lightning Bug* and *Human Pacman* use wearable gadgets as active quest objects which connect players to the games' fictional

world and investigates relation of wearables with games [15,22]. Although these projects form remarkable examples for usage of wearable devices in physical games, Thumin Glove is specifically designed for LARP which does not put players around a table and is played outdoors or in wide areas. Other examples serve only specific game scenarios. LARP already immerses players kinesthetically, therefore these studies do not propose additional control methods for embodied interaction. Different from these studies, our study aims at developing a device specifically for TTRPG that facilities movement in gameplay and be adaptable to different game scenarios, story lines and events.

Previous studies also suggest that wearables can strengthen the bond between player and the imaginary world which is an essential quality for TTRPG. *Hotaru* [1] examines wearables as costumes and question how they can foster the connectedness to imaginary worlds. Moreover, Isbister coined the term interdependent wearables and defined it as a strong concept for play [23]. Tanenbaum et al. also claimed that wearable devices can mediate one to feel as another character [41]. In this direction, they also developed a game called Magia Transformo [25,39] where players wear costumes and perform bodily play for generating spells. Supported by these projects we believe that connectedness to fictional world and characters in TTRPG can be bolstered by wearables.

Other than these, there are many work which examines the role of the movement in games. Previous research indicates that movement can increase the engagement with the game [5,24]. Other than that, many other work researched how to integrate movement into the pervasive games such as Pirates! [6], Pass the Bomb [35], i-Dentity [18] JS Joust [45]. The aim of these experiments is to transfer the game boards of digital media to the real world [6,15] and make the physical existence of players affect the game world or build game rules upon it.. Moreover, Mueller and Isbister put forth design guidelines for movement-based games, yet the games they examined were mostly casual and did not include long-term gameplay times or were not narrative based [34]. Nevertheless, none of these projects focused on a tabletop setting. Furthermore, they do not consider integration of wearables and movement-based play in progressive games with a dynamic story telling.

Overall, although ample amount of research has been done on computer augmentation for role-playing games and movement-based games, the ones which focuses on wearable devices are only a few and the ones which include wearable devices did not administer user oriented views and is not focused on deriving design guidelines. Moreover, movement-based games mostly focused on short-term and action-based play. Therefore, design knowledge about integrating movement-based gameplay to narrative-based, long-term play lacks in the field.

WEARPG: NEW GAME ENVIRONMENT DESIGN

WEARPG is a RPG system, which relies on wearable and tangible props that provide movement-based gameplay. Although, there are many popular RPG systems that emphasize different aspects [19,29,38,42,46,49], we designed a new game system to have a controllable environment for further modifications and break the bias of players towards their previous game knowledge in our user tests. WEARPG is based on a tesla and steampunk hybrid fantasy world where five elements of air, water, fire, earth and electric dominates the life (download the quick-start guide here). Characters in this word can use these elements to gain powers. Each character can choose two of these elements as the primary and the secondary. Based on this setting, WEARPG is constructed on four pillars. These pillars are: (1) Movement-Based mini games (2) Elemental Gauntlet, (3) Luck Stone, (4) Game Master Console.

Movement-Based mini games encapsulate seven different games which refer to basic movements in the game which are *power, reflex, precision* and *concentration. Power* games are required when the fictional character perform a physically demanding task like swinging a sword. It has two different versions. First one requires swinging the arm as strong as possible while the second one works by squeezing the Luck Stone, which is the augmented die, as hard as possible. *Reflex* games are to be played in situations where the pace is essential. Dodging from an attack or catching something thrown can be the examples. First reflex game is about moving the Elemental Gauntlet in the right timing just after a haptic feedback. Other one requires grabbing the Luck Stone as soon as it turns into the players' main element color. *Precision* moves were designed for situations like shooting an arrow or lock picking where hefty hands are essential. First version of precision games is aiming by using the LEDs on Elemental Gauntlet, while the other is rotating the hand really slow to find the right spot. The last game type, *Concentration* game, is for where focus is needed. Examples can be casting a spell or focusing on something for remembering it. This type has only one game and it requires rolling the Luck Stone in hands in a certain speed and maintaining that speed. Each game has 5 difficulty levels from easiest to hardest. GM decides which difficulty level will be played depending on the character skills and condition (injured, crimpled etc.)

Elemental Gauntlet (EG) is the arm-worn device *(*Figure 1*)*. It is comprised of three modules which are Interface Module, Processor Module, and two Haptic Modules. It accounts for automatization of calculations and character creation. With EG, one can perform the elemental ritual by attaching elemental stones to device to define their character properties. Moreover, it also measures the motion and facilitate the movement-based play. It is also the main interface which leads players during mini-games and shows information such as mana level. GM also can use it by lighting it in different colors or sending haptic feedback.

Luck Stone (LS) is an assistive device for randomization *(*Figure 1*)*. Previous work in this area puts forth the importance of such auxiliary objects [14,37] and one another work claims that designers of augmented TTRPG should consider how to incorporate valuable items such as dice in relation with the interactive devices [13]. Therefore, we introduce the LS into the game which has a role in some of the mini games and in the randomization. Still, different from a conventional die, LS has a dynamic chance adjustment system. Your success in the movement-based mini games affect the outcome of the LS. For instance, if a player is successful at playing a *power* game, then the Luck Stone will have more green (standing for "success") sides.

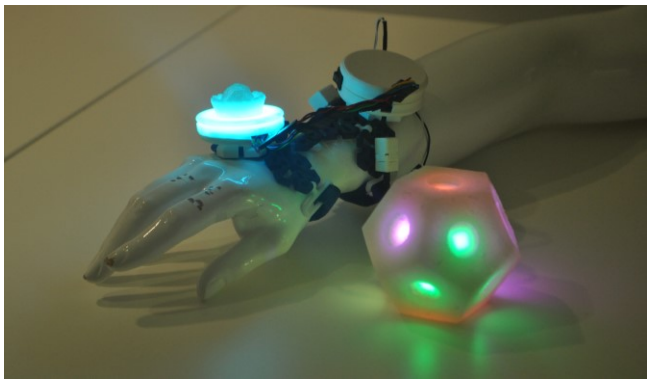

Figure 1: Elemental Gauntlet and the Luck Stone

RESEARCH PHASES

One of the expected outcomes of a research through design process is the articulation of the research process so that it can be replicated by other researchers for similar problem framings [48]. Therefore, in this section we explained the methods used in our research process (Figure 2) and how the outcomes of these studies affected our design decisions.

Participatory Design Workshop (PDW)

For examining the use of wearables in TTRPG, we integrated users in the design process from the very beginning with a participatory design (PD) workshop [13]. Our aim was to engage users with this underexplored topic to elicit better constructed opinions and ideas. PD is a widely adopted method for eliciting design ideas from the users, understanding them and producing design implications which will serve to the broad-range of fields [17,26,28]. PDW is conducted in two consecutive days and participants worked on the subject for 18 hours. The first day of the study focused on the generation of the concepts which was about the possible ways of using a wearable device in TTRPG. In the second day (Figure 3), participants worked on the visual design by building non-working prototypes and detailed the interface and the interaction styles by role-playing a game session with these prototypes. They also prepared Video Sketches [47] to easily communicate their concepts and their usage during the gameplay. After the hands-on work, we also initiated a brief discussion about their opinions about the system which we like to design. Our expectations from the workshop were to (1) see users' reactions on positive and hindering parts of the wearable idea, (2) learn their preferences about the game actions to perform with this device, (3) understand their desires about the interaction techniques which refers to input and output methods (4) see their visual design decisions and (5) understand GM's role in controlling these devices.

25 participants which are *TTRPG players, game masters, cosplayers, interaction designers and jewelry designers* took part in the workshop. TTRPG players and GMs were our main users. Cosplayers have practical knowledge in making costumes of fictional characters. Interaction designers were to assist projects in terms of interaction techniques while the jewelry designers helped in the visual design. We included jewelry designers since the wearable device design were mostly related also with smart jewelry.

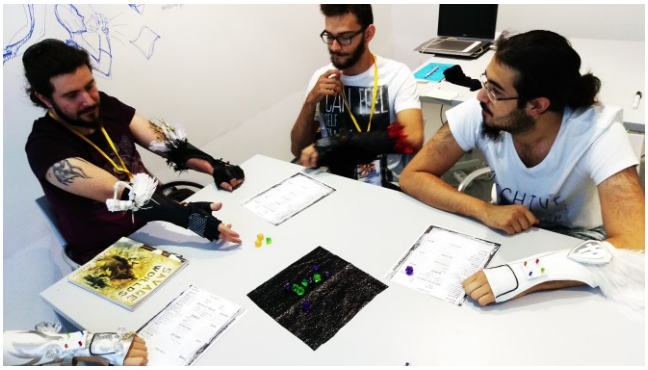

Figure 3: A scene from the Participatory Design Workshop

Design of the Game System

PDW granted us the knowledge about how to integrate wearables into the game. Moreover, results indicated that movement-based gameplay can be a novel addition that can also be favored by players. Therefore, by benefiting from the implications, we designed a new game system called WEARPG [10,11] which is based on movement-based gameplay provided by wearable devices. Details of the design process is explained in the *Outcomes and Design Decisions* section.

Figure 2: Research Phases of the Study

Preliminary Play Tests

We conducted player experience tests with 15 players to understand how the new game system (WEARPG) with movement-based play via wearable devices would change the experience of players [12]. We organized game play sessions with three different TTRPG groups. Each game session lasted around 4 hours and was moderated by the game masters. We used the Wizard-of-Oz (WoZ) method in these game sessions. Players wore experience prototypes [6] made of sponge (Figure 4). These props did not function at all, yet the participants conducted the elemental stone integration ritual by attaching token props to their devices (without any feedbacks). Moreover, we explained the possible interaction method which will work after the implementation. In our pilot studies, the Luck Stone was not also functional similar to wearables. However, the lack of feedback after the activation moves hindered the experience of the players. Therefore, we used a Sphero which is a programmable ball and printed a dice shell for it with a 3D Printer (Figure 8). Sphero has a simple programming interface and by this we were able to program some of the activation moves. The ones that we could not program, such as the "power move" which requires squeezing, controlled by us during the gameplay. These moves, as expected from the WoZ, did not function as precise as they should be, yet the applications were enough to facilitate the movement-based play. Each game session concluded with a semi-structured interview which aims to gain us insights about (1) hindering parts of the game environment which is supported by wearables, (2) benefits and detriments of the movement-based game mechanics and rules, (3) effects of the new interaction style on the player experience and (4) the adaptibility of this new environment on other RPG systems.

Implementation of the Prototypes

Upon our user studies with the preliminary version of WEARPG, we were motivated to implement a working prototype of arm-worn devices (Elemental Gauntlet) and the augmented die (Luck Stone). We also developed a Game Master (GM) interface which can be operated from a computer that allows GMs to control the Elemental Gauntlets and the Luck Stone. Development process of our artifacts and design decisions are explained in the *Outcomes and Design Decisions* section.

Summative User Tests

For understanding the effects of wearables and movement-based gameplay, we organized gameplay sessions with 16 participants. In this study, we aimed to understand how gameplay experience will be affected by wearables supporting movement-based play. Therefore, we conducted a within-subject study where players play the game without WEARPG in the first half and with WEARPG in the second. Same game master with 13 years of experience told the stories throughout the whole testing with the purpose of standardizing the story-telling quality which is quite important for the role-playing game experience. We made participants fill immersive experience questionnaires in the first and the second phase of the sessions. We also conducted in-depth semi-structured interviews with each participant. Interviews were conducted with each participant in the same room that the game was played. All interviews were video recorded, transcribed and coded by two independent coders. The agreement between the coders was %68 and the disagreements were overcome with repeated discussions on the data before starting the analysis.

Sixteen participants (2 female, ages ranged between 19 and 45, *M*age = 26.5, *SD* = 6.30) were included in the analysis. The call for the study is posted in social media groups and university clubs related to role-playing games. Participant candidates applied with a submission form by which we have taken their demographic information and experience in role-playing games. Participants varied in their experiences from 1-year experience to 10+ years of experience. Therefore, we were able to collect feedback from players with various experiences.

Figure 4: Experience Prototype of the Arm-Worn Device. (Left) Before Elemental Stone Ritual (Right) After Ritual

Outcomes and Design Decisions

Participatory Design Workshop

Participatory design workshop yielded in 5 different device concepts (Figure 5). By examining these concepts, presentations of players, focus-group interview data at the end and our observations during the workshop, we extracted design implications for guiding our design process. We applied 5 of these design implications to our final design. These are summarized below:

(PD1) Peripheral Interaction: Results from the first workshop indicated that players usually decided to use feedback modalities which can be understood perceptually without the need of investing direct attention to device. These modalities were haptics, plain colors, LEDs and sound. Players usually avoided using complex information or visualizations and used displays only for displaying basic information such as character properties. Some players also indicated their worries about the distraction possibility and articulated that they used perceptual methods to prevent it.

(PD2) Interactive Auxiliary Props: Players loaded many functions to devices, still they did not give up using other kinds of props such as boards, figures and dice. Especially dice came out as an important element and even one group kept dices although wearable devices also had dice-rolling ability. Two other groups augmented the dice or assigned dice rolling gestures for the devices. Therefore, in our final design we also implemented a randomizer. This was not a mere addition which looks like an eclectic element, but wearable devices and the augmented dice has several different interactions which complement each other.

(PD3) Removal of Uncaptivating Processes: Actions which interrupt the flow of the game story such as long times that are passed for dice calculation are considered as uncaptivating processes [16]. Therefore, calculations, such as determining the effects of skill modifiers on the value of the dice, were all assigned to devices by players. We also sped up these processes in our final design.

(PD4) Becoming the Character: Many of the groups introduced device concepts that are customizable and upgradable according to the character properties. Devices had different forms depending on the character features (more bulky and glorious for strong/barbarian characters, more sleek and tiny for fast/rogue characters). Two groups also proposed that devices can be upgraded visually and functionally as the character gains experience and levels up.

(PD5) Introduction of New Mechanics: With the integration of the computational power, it is expected to introduce new game mechanics to analog games [7]. Participants also proposed new mechanics transferred from movement-based games and computer RPGs.

(PD6) Scalable Actions: One of the groups in the workshop introduced movement-based game mechanics. They only assigned gestures to main actions such as melee attack (i.e. hitting with a sword), ranged attack (i.e. shooting a bow) or creating spells (sending a fire ball). They also defined finishing moves to defined states such as moments when an enemy is about to die. This approach inspired us to design different types of games that can be adaptable to different context and actions.

These six points helped us to shape our game system and prototypes. Following, we explained the design of the game system and how it is affected from these implications.

Design of the Game System

Game system represents the set of rules and mechanics in which the other components become meaningful. Game system determines the relationship between components, how they are connected to game rules and the meanings of the actions in the imaginary world of the game. Drawing upon the implications in PDW, we designed WEARPG game system. WEARPG aims to provide a more narrative-oriented experience by leaving calculation side to computers and encouraging players to enact their characters with their bodies. Details about how to play WEARPG and the information about different elements can be found at the *WEARPG: New Game Environment Design* section.

We can divide our game system (excluding Elemental Gauntlet and Luck Stone as they are explained in the *Implementation of the Prototypes* section) into two as the character creation system, action system which encapsulates the movement-based games.

Character Creation System: Character Creation was basically based on elemental powers. Our initial intent was to create a system where we can easily create a visual and physical connection to the imaginary world through elemental stone props which will be attached to Elemental Gauntlet (arm-worn device) (PD4). Contrary to more abstract concepts such as the race (elf, dwarf, orc etc.) or the class (fighter, assassin, ranger etc.) we created a system which affects the appearance and the physical abilities of the fictional character at the same time. In this system,

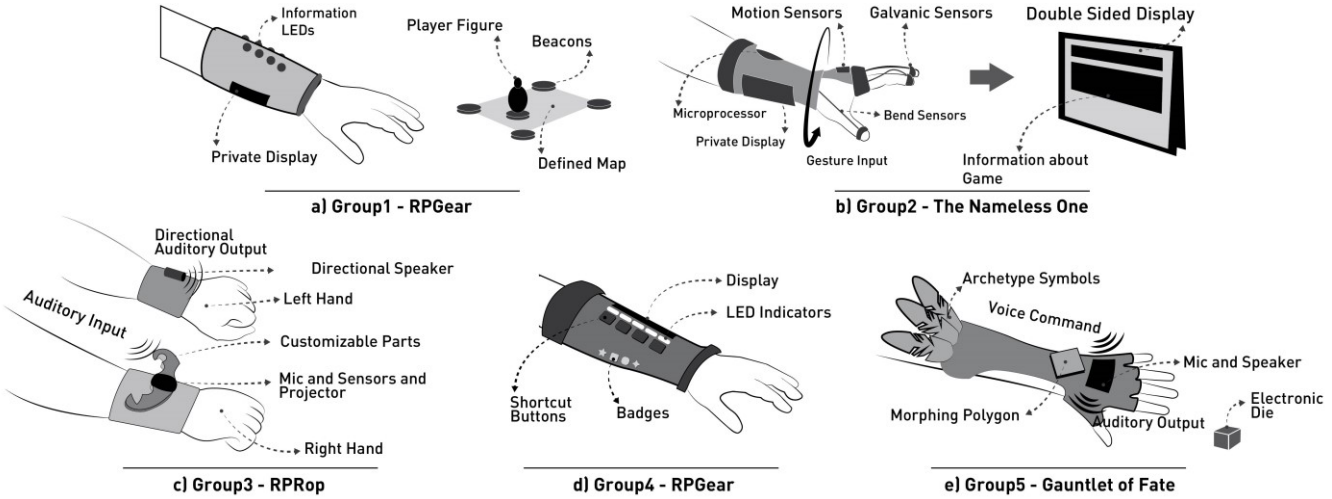

Figure 5: Five Wearable Device Concepts Proposed by Participants of Participatory Design Workshop

players choose a primary and a secondary element stone which determines the physical abilities. Moreover, the primary element also determines the overall look of the character as described in the quick-start guide.

Movement Based Games: Another important aspect of the game system is the introduction of the movement-based games. These games are the most distinctive elements which differentiate the WEARPG from other role-playing game systems. We were encouraged to implement this concept due to the implication from suggesting that players are open to *exploration new gameplay styles (PD5)*. While designing these games, we inspired from a genre what is called dexterity games. Dexterity games are physical games which rely on the physical abilities of the players. However, as can be understood from the name, they rely on only specific skills which can be counted as precision and reflex. However, role-playing games can yield many different scenarios as the only restriction is imagination. Therefore, our aim was to create a game set which can be applicable to many different scenarios. To satisfy this condition, we designed 7 different mini games which can adapt to different types of scenarios (PD6) which would require power, concentration, precision and reflex.

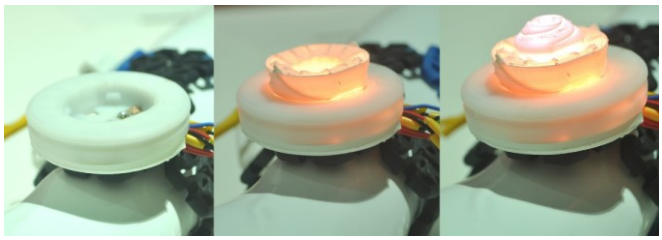

Figure 6: Elemental Stone Ritual

Preliminary Play Tests

Testing the system with experience prototypes and Wizard-of-Oz method earned us new insights about how players would receive the new features and how should they be improved. In this stage, we obtained three more implications which shaped the last version of movement-based games and again helped us in shaping the wearable and tangible prototypes.

(PP1) Providing non-repetitive performances: Playing the movement-based games in the same way may bore players in the long term. Therefore, these games should provide bodily performances which should feel less repetitive. This can be either done by implementing games which will let different types of bodily performances or placing them in the story in a non-standard way.

(PP2) Movements adaptive to different players: Since the movement-based games depend on the physical skills of players, it would be a problem if the real skills of players overwhelm the imaginary skills of the fictional character. Thus, it reveals that movement-based games should be designed in a way that prioritize the skills of the imaginary character and make it harder to be successful, for example in a power game, if the player role plays a weak character.

(PP3) Device Belongs to the Fictional World: During our tests, we observed that placing the device as a narrative element increased it believability by players. Therefore, in our final design we fictionalized interactions that reference to the events in the imaginary world.

Implementation of the Prototypes

Preliminary play tests showed that players' reactions to the concept was quite positive. Thus, we developed a working prototype that can be tested with players. In this section, we explain the design decisions behind Elemental Gauntlet (arm-worn device) and the Luck Stone (augmented die).

Elemental Gauntlet: The first feature of the Elemental Gauntlet is the *elemental socket (*Figure 6) where the elemental stone ritual is executed. This part can detect different elemental stones and react to them by illuminating in the color of the attached element stone. Elemental socket is the tangible reflection of the character creation method in the game system. Players attach elemental stones to the socket to create their fictional characters. This ritual is the part of the game story (PP3), dramatically speeds up character creation calculations (PD3) and forms a visual connection with the fictional character (PD4).

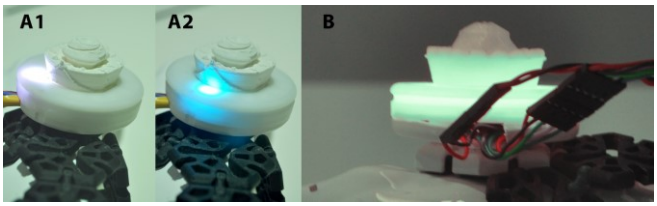

Figure 7: (A) Interface for Precision Game - (A1) Out of target, (A2) On the target, (B) Interface for Reflex Game

Other part of the Elemental Gauntlet is the *interface.* It is an input device which detects the movements of the player and the output device which provides haptic and visual feedback. Our design decisions mainly affected by the design implication (PD1) which suggests that non-distracting interaction techniques should be incorporated. Firstly, we designed a LED indicator around the elemental socket. This part indicates different kinds of light feedback according to the characteristic of the game. For example, it turns into a targeting game (Figure 7) where players need to move a single led to left or right to aim at an imaginary target in the precision game. In another game which is the reflex game, it flashes in red or green after the player makes the move to indicate the success rate of the action. Other than the games, it is also used to give information about character properties such as the health or mana level of the character. All in all, the input and the outputs used in the Elemental Gauntlet do not require a direct attention during the game and are usually perceptual by also being supported by the haptic feedback. Moreover, interaction

with the device is limited and only possible when game master allows player to do so. We gave all these design decisions to maintain the interest of the player in the game and prevent them to be distracted

Luck Stone: Luck Stone is a randomizer which replaces the dice in the conventional role-playing games. At the beginning of this study, we did not speculate a tangible device which is a companion to the arm-worn devices. However, our implication (PD2) indicated that players tend to keep tangible objects such as figures or boards in the game system. Among all tangibles, dice is the most crucial one as it is also considered as a collection item. Upon these observations, we decided to add a supportive device which will provide randomization in a tangible way. Luck Stone is a hybrid randomizer which takes advantage of both tangible aspects of a die and the computational power provided by the augmentation. Moreover, since the design implication indicated that the relation between the interactive system and the auxiliary device should be formed, we designed several different interactions between the wearables and the Luck Stone such as communication during the movement-based games or chance manipulation according to the result of the movement-based game. In the design process of the Luck Stone, we tried to provide a close experience the dice which is a bouncy object. Therefore, in the last version both for gaining it bouncy properties and protecting electronic parts we designed a silicone cover (Figure 8).

Updates to Movement-Based Games: After the *preliminary play tests,* we got implications which led us to alter the features of the movement based games. How they are played remained mostly the same, but we added new features per feedback of users. First, we explored ways for making the games adaptable to different types of movements and feel less repetitive (PP1). As seen in Figure 9, concentration game can be played in several different ways. Other addition was a difficulty system. Difficulty system does not allow players' physical skills to overwhelm the characters' skills and therefore assign different difficulties to each player, adaptable to their fictional characters (PP2). For example, with this system, power games will be much easier for players with a powerful character compared to players with a weak character. Thus, even if players who role play a strong character are not strong enough, they will not perform bad in power game as it will be considerably easy for them.

Summative User Tests

We tested the last version of the game system with the working prototype to understand how it affects the player experience and get detailed feedback about the working and the hindering parts. As a result of our studies, 11 out of 16 participants reported a perceived increase in player/character relationship (PCR) and 12 of them reported an increase in immersiveness due to the wearable devices. 13 and 11 players articulated a boost in PCR and immersiveness respectively due to the movement-based games. Our questionnaire results also indicated a boost between the first and the second phases of gameplay in terms of PCR and immersion. Therefore, this study showed that our alterations in the game worked in the intended way. Due to the detailed feedback of users generated from the 13-question semi-structured interviews at the end of each play session, we extracted design themes which indicate the parts that can affect the gameplay in positive and negative way. These themes are indicated below:

Materialization: We saw that the wearable device and the movement-base gameplay can work in a way which materialize the imaginary world in the real life. Players reported that the Elemental Gauntlet felt like a part of their imaginary characters. One of the players said, "I felt as if my arm was in another world!". Same was applicable for the movement-based gameplay. 8 players indicated that movement-based games helped them to literally felt what their fictional characters was feeling.

Being in Control: Integration of the computational power helped us to add a chance manipulation mechanic to the game, which the results of the movement-based games affect the outcome of the dice. 11 players explicitly appreciated this feature as they felt more in control on the fate of their characters compared to the conventional RPGs, which are mostly dependent on pure chance.

Movement-Based Gameplay Placement: Although movement-based games were favored by players, their placement in the game flow reveals to be an important

Figure 8: Evolution of the Luck Stone, (A) Luck Globe with Sphero, (B) Luck Stone without the silicone cover, (C) Luck Stone with the silicone cover

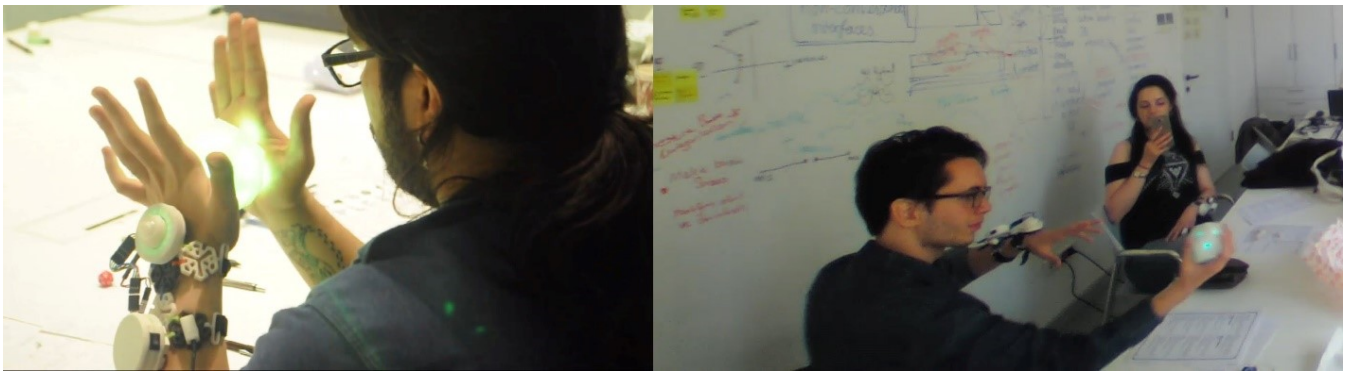

Figure 9: Two different ways for playing the Concentration Game

element about their effect on the game. In our sessions, Game Master did not dictate players to play movement-based games before each action and let the result of mini games affect the outcome of the Luck Stone for several turns. Therefore, placement of mini games affected their impact on the game and if they were dictated before each move, they could have turned into uncaptivating processes.

Shift Between Genres: Six players mentioned the similarity between WEARPG and Live-Action Role-Playing games. Moreover, the new mechanic which provides players more control is a standard for computer RPGs. Therefore, our studies revealed that integration of computational power can introduce mechanics from other types of genres and create a bridge between them.

These design themes highlighted the common points that players raised. By adding this knowledge to the outcomes of the previous phases, we formed design guidelines which can help designers and researchers in the field.

DESIGN GUIDELINES

As a result of our extensive research through design method which included 53 participants in the process and yielded many different design implications and themes along the way, we extracted generalizable design guidelines. These design guidelines can help designers and researchers in integrating (1) movement-based gameplay into narrative-oriented games which require long-term engagement, (2) designing computer augmented tabletop game mechanics and (3) designing peripheral devices in a way that can increase the player experience.

Create Hybrid Game Mechanics. Integration of computational power is expected to introduce new game mechanics to analog games [7,30]. Our approach which led us to design the Luck Stone shows that these new game mechanics should also be "hybrids" meaning that they should benefit the properties of the digital and analog. Luck Stone was appreciated by players since it gave them the taste of the tangible feelings from the analog RPGs with an innovative twist that allows them to control their chances. Therefore, while designing mechanics for computer augmented games, designers should check what they got from the analog and what they got from the digital.

Limit the Interaction with Peripherals. Either it is in console games or in tabletop games, the real game does not take place in the peripheral devices. For example, Cairns et.al. indicate that the engrossment to the game is provided when players forget that they are using a controller [8]. However, other studies also indicate that wearables can form a bridge between the real world and the imaginary world and increase the connectedness to these worlds [41]. In our game, we limit the interaction with wearables to maintain the attention of players to the real game environment which is constructed by the Game Master and the other players. They were allowed to use the devices only when it is their turn. With this decision, wearables were still effective in the gameplay but did not distract players. Similar "limited interaction" rules can be applied to different peripherals to create the ideal experience.

Lead to Worth-Watching Moments. In group play, it is important to maintain the interaction between players. Limiting the interaction with the devices was one decision to administer this. Other than that, players concentrated on the other players' actions since movement-based play leads to much more bigger body movements rather than just rolling the dice. Therefore, several players explicitly articulated that they shared the excitement of players who plays the movement-based games at that moment.

Form imaginary performances. One of the design themes was *materialization.* We designed moments which will led to performances that makes players to relate their actions to the events in the imaginary world. For example, in the elemental stone ritual, we want them to feel that these stones granted the power to their wearable devices. Other than that, this also can be observable in the movement-based games. One of the players said, "I literally felt that as if I am casting a spell". This feeling provided only by the movements we designed but also by the feedback of the devices (in this game, Luck Stone keeps getting brighter if the player can play the game in a successful way).

Form tangible connections to game mechanics. Although our work focused on wearables and movement-based gameplay, another important part of our game is the Luck Stone. Luck Stone is a tangible device which works as a mediator between the imaginary world of the game and the game mechanics. Therefore, while wearable devices were mostly the tangible representation of the imaginary world, Luck Stone stands as the physical abstraction which represents the game mechanics and render the Elemental Gauntlet meaningful in the game by connecting it to mechanics and rules. Besides, while tangible interfaces are mostly the physical representations of the digital in the real world, Luck Stone is a physical object which is meaningful both for its digital and physical properties. In hybrid games, how tangible game props are related to other peripherals and the game mechanics should be well analyzed.

Do Not Add New Uncaptivating Processes. Our study shows that playing of movement-based games before every action may render them uncaptivating. Also, integration of computational devices may create other processes such as calibration of motion sensors. Designers should make sure that the new devices added to the game do not create new uncaptivating processes while removing the others.

DISCUSSION

Although our design process focuses on TTRPG, we believe that our setting can address different areas of HCI which involves wearables and movement, tangible user interfaces and interaction with devices in group dynamics. Following, we exemplified design cases in which our guidelines can be useful for (a) other HCI fields, (b) other gaming settings and discussed (c) the limitations. We need to point out that these cases are not for limiting the guidelines to specific contexts. Instead, we wanted to give an overview of the applicability of them to other fields and exemplify how some of them can inspire designers. Moreover, they are more about designing interaction aesthetics, rather than defining new functionalities.

Sports training cases in HCI are relevant examples as many examples involve wearables and movement. For example, [27] presents a foot-worn device which is designed to keep the walkers' motivation at an ideal level. When looked through the lens of *forming imaginary performances,* our feedback design for movement-based games can provide a new playful approach to designers of this project where they can motivate the walker by transforming him into an imaginary “fast walker." Similarly, *limiting the interactions with peripherals* can be useful for defining interactions with wearables and tangibles in a meeting setting [32] where in-group dynamics are important. In our case, GM is in control, while in a meeting, GM may be substituted by a moderator or a presenter to explore possible interactions.

Our guidelines can also be useful for integrating wearables and movement into other game settings. For example, wearables are also speculated to extend the interfaces in the displays to the players’ body [40]. As a design case example, an arm-worn device can glow in blue when a power-up of a player is available. When the player holds the activation button in the “game controller”, the blue light of the wearable starts to dim and vibrates continuously as the player consumes the power-up. This specific case shows how *tangible connections to game mechanics can be formed* through game controllers by supporting *the imaginary performances* of the players via wearables.

These artifacts and results are our interpretation of the obtained data and limited to our focu-s on increasing immersion and player/character relationship. Therefore, game system and props and thereby the lessons learnt could have been different, if we choose another path by focusing on different aspects such as customizability or new functionalities for TTRPG. Our aim with this paper is to demonstrate our design process in detail so that other researchers can replicate the process or draw upon the different information (i.e different approaches in PDW) to reach different outcomes.

CONCLUSION

With this project, we propose the first example of the articulation of a research through design process for designing wearables and movement-based gameplay for TTRPG. For doing so, we undertook an extensive research design process involving 53 participants in the process and communicate the methods and the outcomes of our study in different phases. We also explained how these outcomes affected our design decisions while designing the WEARPG game system and our artifacts which are the Elemental Gauntlets and the Luck Stone. As a result of our study, players indicated that the wearables and movement-based gameplay increased their player/character relationship and immersion experiences. Therefore, we believe that researchers can replicate our design process to introduce new game systems or peripheral devices to computer augmented games and to other narrative-based games which require long term engagement.

Other than that, as a result of our research process, we produced generalizable design guidelines that can be incorporated in the game design process. These guidelines can help designers in integrating new modalities to games, designing peripheral devices which will be used as supportive controllers and designing game mechanics for computer-augmented analog games.

ACKNOWLEDGEMENTS

We are very thankful to John Zimmerman, Staffan Björk, Tilbe Göksun and Aykut Coşkun who guided this work through all phases. Moreover, we also want to thank all volunteer participants who contributed to this project.

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