Isomorphic Game Interaction Technique Patterns for Single Button: Definition and Evaluation

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ABSTRACT
Awkward control schemes or nonsense button-mashing are common complaints from gamers worldwide. Assigning actions to buttons can be a complicated task for the game designer due to the limited quantity of buttons available on the joystick used in the current generation of video games. Along the years, the industry has increased the number of buttons in the controllers, but despite this a more permanent solution is still required as one cannot simply keep adding new buttons. Note that there are only ten fingers to operate them, Therefore, studying new ways for game designers to make intelligent use of the available buttons and analog sticks is required in order to create more enjoyable interactions for games. In this paper, we investigate third-person view games with a humanoid avatar and propose an isomorphic approach with the objective of increasing the connection between the player and his character. We established three categories of action and, by crossing these; we created eight isomorphic interaction technique patterns. In addition to these, we also developed two prototypes. The first one applies the identified usage patterns whereas the second one presents a hybrid version. Next, we perform preference tests jointly with users in order to investigate the impact of our approach on user perception of the two games. The results have shown a higher level of approval towards the prototype that applied the patterns.

Keywords
Action mapping, interaction technique, design patterns

INTRODUCTION
The role of the game designer is to create experiences for its audience through the games it conceives. Games are not relevant unless they are both played and enjoyed (Schell 2008). Murray (1997) claims that part of the pleasure of playing games lies in the possibility of immersing oneself in fantasy environments and assuming different

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identities, each one with its own powers and abilities. For example, a player may be transformed into a medieval warrior or a space marine, as well as the having the sensation of agency when executing an action and seeing the results of one´s decisions and choices. Commonly, this participation takes place through a joystick and the doubling between the real and the virtual actions contributes to the player's engagement (Westcott 2009). Nevertheless, differently from production software that attempts to reduce the workload of the user, games should make their experience more complicated over time in order to maintain player interest (Lazzaro 2004). Therefore, the game designer can explore interaction possibilities that would be unacceptable in the context of production software. Authors such as Gregersen and Grodal (2009) and Jenson and de Castell (2009) claim that action mappings are often arbitrary as that the game designer assigns interaction techniques such as push buttons with the thumb to virtually jump or swing the arms.

Although a player´s experience is unique and non-transferrable, and the game designer indirectly designs those experiences, he must have tools to guide the players during their journeys (Schell 2008). As reported by Costikyan (2006) and Church (1999), it is of interest to the game design community to build a formal language that facilitates communication between its members. And yet, the inability of the modern controller button to support embodied interaction remains a significant limitation to the medium's growth as asserted by Griffin (2005). He also suggested that there must be a revision in the button usage and one possible way to achieve this is through the development of a button system that maintains the generality and clarity of modern controller buttons while providing a tangible structure suitable for both supporting playful interaction with the hands and capturing the resulting input (Griffin 2005). This research addresses the problem raised by Gregersen and Grodal (2009) and Jenson and de Castell (2009) by proposing the use of isomorphic interactions for the definitions of the control scheme. In other words, we believe that keeping some motor congruence between the real actions with the one shown at the screen will improve the player's experience. In order to sort and arrange the formal elements, we decide to categorize the actions and formalize this solution according to interaction technique patterns, since we understand interaction techniques as defined by Hinckley (2003) and the language of patterns aims to provide a structure to the accumulated knowledge and to create solutions to known issues (Alexander, Ishikawa and Silverstein 1977). For this case study, we examined the digital button, because it is an interaction device that requires greater abstraction for complex actions as it sends the smallest amount of information to the system. Furthermore, we evaluate the impact of the application of these patterns in the player's experience using a game prototype developed exclusively for this research.

The remaining sections of this paper are outlined as follows. Section two discusses related works; in section three, we show the methodology used to create the patterns. Section four presents each of the identified patterns whereas section five describes the evaluation experiment. Finally, section six concludes our contribution and lists possible future works.

RELATED WORKS

The possibilities of using a button as an interaction device have also been the subject of the work by Green (2005), however, his research only describes these possibilities in an abstract way, such as in the following: "Keep button pressed = Activate action A. Release button = Activate action B". On the other hand, our research adopts an analysis centered on user experience, giving meaning to different forms of interaction, rather than abstractions like "Action A" or "Action B". Therefore, we try to identify the actions taken

within the games and the transactions associated with them. For example, to make an actor perform the action of jumping, the player must press a button. On the basis of the survey of these associations, we are able to structure the knowledge surrounding interaction techniques, as depicted in more detail in the results presented in section 4.

Digital buttons interaction techniques were also investigated by other researchers including Rekimoto, Ishizawa and Schwesig (2003). They focused on the development of new hardware, called PreSense keypad, an input device enhanced by touch sensors, enabling three state interactions with buttons. Each of these buttons can sense, in addition to regular "out of range" and "pressed", a third touched state between the regular ones. The authors also propose a series of interaction techniques and combinations, from using the touch property for previewing the outcome of actions to gestures techniques such as round motion over the keys.

In turn, the user's motivation factors during calibration procedures were approached by Flatla et al. (2011). The gamification concept is brought to this pre-game task seeking to turn this step into a more pleasant moment. In order to accomplish that, the authors propose a calibration framework including: calibration types, core tasks, game mechanics and game design elements. Finally, an evaluation was performed with three scenarios using paired comparisons between versions of the same prototype, the first was gamified and the second had a traditional calibration style. The experiments showed a significant difference in the player's enjoyment favoring the gamified prototype.

The Game Ontology Project proposed by Zagal et al. (2005) is also focused on identifying formal elements of digital games. Ontologies are intended to verify the existence of real or abstract elements, categorize them, and identify their relationships. However, the ontology describes only the existence of elements and not how to use them. Furthermore, it offers little information concerning action mapping. There is only one proposed entry, Synchronized Button Press, which is currently a draft and not part of the official ontology.

In the context of digital game design, the research on design patterns was performed by Björk and Holopainen (2004). This research established eleven categories of patterns and distributed approximately 300 patterns within these categories. Even with the eleven categories and a vast collection of patterns, the authors still consider the library incomplete and encourage other authors to identify new patterns. Extensions can be found in works such as the research by Folmer (2006) that has contributed a description of 26 new patterns for usability in games, and Hullett (2012), which identifies 10 patterns for level design in first-person shooters. Despite the existence of this vast library of elements, we are still unable to find any patterns regarding either player's interaction or action mapping.

METHODOLOGY FOR PATTERN DEFINITION

The focus of this research is to identify and structure isomorphic interaction techniques for a single button to increase the sense of agency of the players. In order to achieve that, real time, action and adventure games in which a player controls a human or humanoid avatar were selected for the purpose of this study. The analysis involved several game platforms, including different generations of consoles such as Sega Genesis, Super Nintendo Entertainment System (SNES), PlayStation2, Xbox, Nintendo Game Cube, PlayStation3, Xbox 360, PlayStation Portable (PSP) and Nintendo DS. During the research, distinctions between a two dimensional and three dimensional game

environments showed no significant impact in our observations of the actions of the characters in the games, so this item was discarded from being a point of analysis.

The study followed the inductive methodology of research that is divided into three phases, namely: observation of phenomena, discovering the relationships among them, and generalization of the relationships Jonker (2010). Following these phases, the first step in the research consisted of recording the actions taken within the games alongside the configuration of the controls assigned to each action. Thus, a group of over 50 actions and adventure games were selected, including: Sonic - The Hedgehog (Genesis), Blackthorne (SNES), God of War (PS2), Uncharted - Drake's Fortune (PS3), Assassin's Creed (Xbox360), and New Super Mario Bros (NintendoDS).

Next, in order to determine which characteristics define the relationship between the type of interaction technique applied to a particular action of a game character and the way the user perceives the outcome, we compared different actions from the same game. For instance, we will take the game *Assassin's Creed 2* (Ubisoft 2009) as a practical example as a baseline for the analysis by the other selected games.

Initially, between the Simple Attack and the Sequential Attacks, it can be noticed a difference in the effort demanded by the character to perform these actions, which reflects directly in the action's result, as the Sequential Attack can break enemies' defenses. This extra effort is also demanded for the player, in a way that he must pay attention and train the timing to press the button, in order to execute the action properly. Taking Simple Attack as reference point and comparing with the Block action, we can establish a difference between the duration of both actions. The first is almost instantaneous whereas the second one lasts as long as the player wants. Last but not least, the Counter Attack dynamics offers to the player a contextualized action, which the player has access to only when the A.I. (artificial intelligence) controlled enemy chooses to attack, differently from the Simple Attack where the player can perform at any time. Finally, we can summarize the three identified characteristics, Effort, Duration and Context, into a three dimensional structure, as shown by Figure 1.

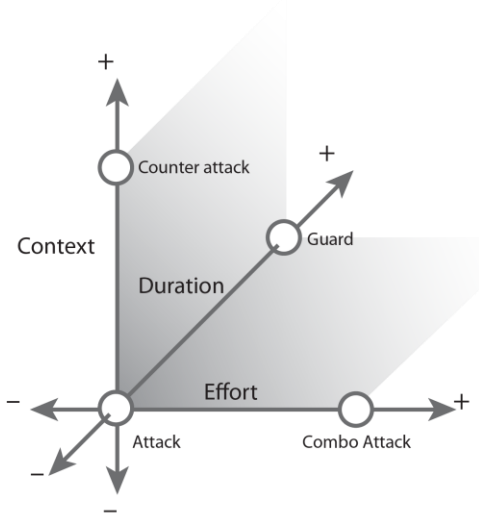

Figure 1: Relationships among actions.

INTERACTION TECHNIQUES PATTERNS IN GAMES

This section presents the patterns defined in our research, following the template described by Björk and Holopainen (2004), containing its description, using the pattern, consequences of their application, and examples.

Press Pattern

Description: The player presses and releases the button quickly.

Using the pattern: This interaction technique pattern should be used with a low effort action for the player character, with instantaneous response regardless of the context.

Consequences: Due to its versatility, this pattern is the most appropriate to different actions, such as making the avatar jump or attack.

Example: In the game *Prince of Persia: The Sands of Time* (Ubisoft 2003), the player's avatar charges with sword blows with the simple press of a button.

Rhythm MultiPress Pattern

Description: The player presses the button in a specific rhythm so that the actions in the sequence have their results changed.

Using the pattern: This pattern should be applied to modify, usually amplifying, the actions of the character in the game. By requiring the player to press buttons in a predetermined pace the player's character follows a different flow of actions. Normally this stream can be chained together in different combinations of actions which will continue as the player keeps the pace of pushing the button in the right rhythm.

Consequences: The designer must ensure that the response is clear to the user so that the player realizes that he is pressing the button in the correct rhythm.

Example: In the game *Darksiders 2* (Vigil Games 2012), the player's character, known as Death, can deliver different strikes according to the rhythm the player presses the "X" button in the control configuration for Playstation 3, as detailed in Table 1.

Combat move	**Commands**	**Combat move**	**Commands**
Cross Slash	X	Harvester Slam	X,X,X, delay, X
Return Slash	X,X	Razor Wheel	X, delay, X,X
Double Slash	X, X,X	Razor Strike	X, delay, X,X,X
Twin Humanities	X,X,X,X	Harvester Spiral	X,X, delay, X
Razor Slash	X, delay, X	Harvester Whirlwind	X,X, delay, X,X

Table 1: Combat moves for the main character of Darksiders 2.

Hold Pattern

Description: The player must press and hold the button. While the button state is changed, the action will remain enabled and if the button is released the action must cease immediately.

Using the pattern: This pattern should be used to replace low stress load, prolonged and accessible actions regardless of the context.

Consequences: When using this pattern, the game designer should adjust the layout of the joystick functions so that the restriction of movement caused by holding the button pressed does not cause discomfort to the player.

Example: In the *Uncharted* series (Naughty Dog 2007), to make the character take aim with his weapon, the player must keep a button pressed. This kind of action should not be considered a simple change state action and can be important to the gameplay. For example, in the Uncharted series, the player is rewarded with a trophy for defeating 20 enemies without aiming, due to the additional difficulty in not using the aiming action.

Hold and Release Pattern

Description: The player must press and hold the button down for a defined period of time and then release it to trigger the action.

Using the pattern: This pattern should be used to represent a long-acting action that requires extra effort from the player's character.

Consequences: The time that the button is pressed should be proportional to the intensity of the resulting action. There is always a limit for this intensity and time though.

Example: In the game *Megaman X 2* (Capcom 1995), the player can hold and release the button, causing the character to fire beams with different energy levels.

Precision Press Pattern

Description: The player presses the button at a given moment in a specific context to activate a different action.

Using the pattern: This pattern should be applied to instantaneous, low-effort and special context actions. The rule that modifies the environment should be clear and previously presented to the player and also be prepared in advance. In such a scenario, the user can wait for the right moment to press the button and successfully activate the Precision Press action.

Consequences: The game designer must determine which penalty the player should suffer in the event of failure of trying to run the Precision Press pattern. This would require the player to analyze the risks of their choice.

Example: In the game *Assassin's Creed 2* (Ubisoft 2009), Ezio, the player's character, when being attacked, has the ability to execute a special defense that will leave the opponent momentarily helpless if the button is pressed at precisely the moment when the opponent strikes.

Quick Time Event (Q.T.E.) Pattern

Description: The player is prompted to press a button in a specific context in a short period of time.

Using the pattern: This pattern should be used to represent actions that require extra effort from the player's character for actions that require quick reflexes in critical moments.

Consequences: When creating a scene that uses quick time events, the game designer should consider the possible division of the player's attention, as the player should keep their attention on events that take place both in the foreground, where the cue to push the button will appear, and in the background, where special animations are being shown. Therefore, the player can issue the required commands while being able to understand what is happening in the scene.

Example: Madison, one of four controllable characters from *Heavy Rain* (Quantic Dream 2010), should avoid being stabbed by a burglar/assassin at her apartment on a series of risky maneuvers that require agile reflexes in order to survive. The player must press the button in a short period of time for the action to be successful, see Figure 2.

Figure 2: Madison must survive the burglar's attacks.

Time Limited Hold Pattern

Description: The player must keep the button pressed for a predetermined time so that the action is executed.

Using the pattern: This pattern should be applied for long run actions with low effort in a specific context in the game environment. It can serve as a preparation or to represent the time that an action requires, however, the positive result is achieved only at the end of the time previously stipulated. In some cases, time can serve to check whether the user selected the correct action or not.

Consequences: It is important to understand the difference between this pattern from the Hold Pattern. While in the Hold Pattern, the action remains active throughout the time that the button is pressed, the action of "Time Limited Hold" is only triggered when the timeout is reached. If the character suffers some type of interruption, the action will be canceled and the player must repeat the entire procedure.

Example: In multiplayer mode, to activate a system in a computer terminal, the characters in *Dead Space 2* (2011) shall keep a button pressed for about 10 seconds.

Pump Pattern

Description: The player must rapidly and repeatedly press the same button to execute an action.

Using the pattern: This pattern should be used to represent a prolonged action, which demands a great deal of effort by the player's character. Usually such action is available only in a particular situation. The amount of effort delivered by the character must be compatible with how many times the player must press the button in order to be successful in his attempt.

Consequences: Due to the effort required by the pumping, the player may have difficulties performing other concurrent activities.

Example: In the game *Asura's Wrath* (CyberConnect2 2012), the main character faces an enemy many times his size in a contest of strength. The player must pump the button in order to defeat the enemy, illustrated by Figure 3.

Figure 3: Asura challenges a much bigger foe.

EVALUATION

In order to investigate the impact of applying the patterns described previously in the theoretical research regarding the player´s experience, we chose to use a quantitative sensory evaluation method as described by Kemp, Hollowood and Hort (2009). This method intends to evaluate the users' perception of a particular product, developed to measure the preference or acceptance of a product, and creates a hierarchy among the samples. However, the test does not reveal if the user really likes the product. During the research, we raise the hypothesis that the user's fun experience is improved by the correct application of the isomorphic interaction techniques and patterns into the games, by improving the sense of embodiment between the player and his avatar. As we are not interested in investigating the quality of other elements such as game balance or the amount of content available, this method was considered suitable due to the nature of the problem investigated.

As described by the authors (Kemp, Hollowood and Hort 2009), the test procedure consists of three steps; first, the researcher presents two or more product samples, identified only by codes, to users. To avoid any kind of identification of the products, the codes are composed by random combinations of three letters. Afterward, the volunteers

have access to products and can make free use of these for a predetermined time. At this stage, it is recommended that the prototypes are provided in random order to avoid influencing the user's perception. Finally, the participants must fill a closed questionnaire about their preference considering some specific product attributes and usage aspects..

Although Juul (2010) warns that hardcore players do not have to precisely match the following characteristics, their stereotypical description can be summed up as: prefer emotionally negative fictions, have played a large number of video games, will invest large amounts of time and resources toward playing video games, and enjoy difficult games. Since most investigated games were targeted to the hardcore audience, we created a prototype following the characteristics outlined by Juul (2010), as a first attempt to validate the interaction technique patterns.

As an object of research, a side scroller game with a medieval dark fantasy theme was developed, as shown in Figure 4, in which the player could perform eight different actions, besides the actions of walking and jumping. The eight actions were defined according to the categories of effort, duration and context, in order to adapt to the isomorphic interaction technique patterns and the theme of the game described in the game concept. These are: attack, 3 hit combo, guard, throw spear, reflect projectile, activate lever, escape from spider web, defeat the Ghost King.

Figure 4: Prototype's screenshots.

The prototypes were developed in the C# programming language supported by Microsoft XNA Game Studio 3.5 (Microsoft 2006) along with the Platformer Starter Kit. Such technologies worked as rapid prototyping tools providing sprite animations, collision handling and physics features, allowing the development team to focus on the interaction technique patterns implementation.

The first prototype mapped the eight actions in the appropriate isomorphic interaction techniques pattern. A second prototype was created by mixing the interaction techniques while still keeping the game as fairly playable as possible. Both prototypes' action mapping is described in Table 2. They were identified by the code GCO and MWV, respectively, as required by the paired comparison.

Action	Interactions for Prototype GCO	Interactions for Prototype MWV
Walk	Hold	Press
Attack	Press	Hold

Escape from spider web	Pump	Quick time event
Guard	Hold	Press
Reflect Projectiles	Precision Press	Time Limited Hold
Hit Combo	Rhythm MultiPress	Hold and release
Throw Spear	Hold and release	Rhythm MultiPress
Rotate Lever	Time Limited Hold	Precision Press
Defeat Ghost King	Quick time event	Pump

Table 2: Prototypes' action mapping.

After playing both versions of the game, the participants answered a questionnaire on which the prototype was the most fun. We chose to ask what prototype was more fun to avoid using a more technical language that might confuse users. Since the prototypes are distinguishable only by their applied interaction techniques, we may assume that the difference between the provided fun experiences will be directly related to the use or not of the patterns.

Also, another questionnaire was created in order to outline volunteer's profile and deeply investigate the impact of the user's perception about the interaction techniques patterns. The questionnaire was composed by five parts, initially questions about personal information such as age and gender, followed by preferred game themes and genres. Afterwards, they were questioned about their game knowledge, if the user read reviews or walkthroughs. Next, some questions about their dedication for the game's universe, for example, how many game consoles they have at home were also included. And finally, they were asked about their attitude towards difficulty, if they prefer to be challenged or just play as an uncompromised distraction.

RESULTS

An experiment was conducted in order to validate the hypothesis that users will recognize our interaction pattern as being more natural. It was established for this experiment a 90% confidence level (or 0.1 significant level) and a 10% error. For this scenario, the sample size needed was 57.

According to the results shown in Table 3, all the interaction techniques patterns have been confirmed except for the "quick time event" technique. Thus, a more detailed analysis was performed in order to identify the nature of such result.

Action	Interaction technique	Miss	Miss (%)	Significant level	Result
Walk	Hold	2	0.035	< 0.001	✓
Attack	Press	3	0.053	< 0.001	✓

Escape from spider web	Pump	8	0.140	0.030	✓
Guard	Hold	13	0.228	0.070	✓
Reflect Projectiles	Precision Press	10	0.175	0.048	✓
Hit Combo	Rhythm MultiPress	17	0.298	0.099	✓
Throw Spear	Hold and release	2	0.035	< 0.001	✓
Rotate Lever	Time Limited Hold	9	0.158	0.040	✓
Defeat Ghost King	Quick time event	26	0.456	0.130	✗

Table 1: User testing results

In an attempt to investigate which factors influence the misses' amount, a linear regression model using stepwise technique was applied to the data. The generated fit revealed that only five variables has some influence on the misses' amount , they are: preference for "strategy" games, preference for "first person shooter" games, have "watch TV" as hobby, have "study" as hobby and miss the interaction "escape from spider web".

Note that the preference for the genre "action and adventure" is not statistically significant for the model, although 43% of users have mentioned this kind of game as their preferred. We can understand this as evidence that the player's repertoire on action and adventure games does not influence their perception about the application of interaction technique patterns.

The model was adequate according to the F test (p-value <0.001) and the coefficients are shown in Table 4. The obtained fit did not present pathologies such as outliers, leverage points and influence points. Even with these results, the adjusted R2 was equal to 0.4122, i.e., the model can explain about 41% of cases. The R2 low value is an evidence that preference for "strategy" and "first person shooter" games, miss the interaction "escape from spider web" and have "watch TV" and "study" as hobbies, although statistically significant, have little influence on the perception of isomorphic interaction techniques studied.

Other relevant information about the fit was that the coefficient of "escape from spider web" being approximately 2 (Table 4). This can be understood as the following. If the player misses the choice "escape from spider web" he is quite likely that he will miss another answer.

Variable	**Coefficients**
Escape from spider web	1.9541
Preference for "Strategy" games	0.7366

Have a hobby “Study”	– 0.8012
Preference for “First person shoot” games	– 0.5303
Have a hobby “Watch TV”	0.4724

Table 2: Fit coefficients: Errors x User profile

From this observation, a more careful study was performed using the chi-square independence test to find out which other dependent variables have this behavior. In this kind of test, to consider that there is dependence among the variables, the p-value must be greater than 0.05 (95% confidence). Dependencies with other interactions are listed below at Table 5.

Action	**Dependencies**
Defeat the Ghost King	1
Combining powerful hits	1
Reflect projectiles	0.1367
Block with the shield	0.07008
Attack with the sword	0.3703

Table 3: Dependencies: "escape from spider web" X others variables

This analysis can be interpreted with the following. When the user misses the "Escape from web spider" interaction technique, it increases the chance of also missing the actions "strike with the sword", "block with shield," "reflect projectiles "," combining powerful blows " and " defeat the Ghost King ". For example, those who miss “escape from spider web” had 37% chance to miss “Attack with the sword” too.

An empirical analysis about the user’s misses during the prototype evaluation was performed. In this analysis, they were allowed to discuss their choices for each of the prototype’s interaction techniques. The argument often used by the users was that the best way to play is the way that allows them to win more easily or with less effort. For example, to “defeat the Ghost King”, this group of players preferred the “Pump” interaction, despite recognizing it as unnatural. This way, they did not need to pay attention or have reflexes to perform the action.

Although the interaction "Quick Time Event" was considered as being more natural by the majority, with the “Pump” interaction players rely exclusively on their own effort. In that way, they did not need to look at the screen to see what was happening, the effort is to just keep pressing the button as fast as they can to ensure victory. In the same line of thought, to the action "reflect projectiles”, a small group of players chose the interaction technique “Time Limited Hold”, so they did not need to watch the projectile and just hold the button long enough for the action to charge and be performed without chance of error.

Regarding the action "Hit combo", the users chose to use “Holding and Release” technique, so the player could stay in a safe place until the enemy approaches, releasing the sequence of blows automatically. For the action "Defend with shield," some players realized that the character defended no matter which direction the attack came from, these players chose the “Press” technique, because they could even move hands away from the controls and wait for the best moment to attack. For “Attack” action, a few players chose the interaction “Hold”. The player would be spared the effort of pressing the button many times as well as maximize the amount of attacks per second, because the system would repeat the action as soon as the previous attack was over. Therefore, we can understand that this group belongs to the player profile known in the literature as Achievers for Advancements and Mechanics (Yee, 2006), which care less about playing and more about analyzing rules for optimal character performance.

Another analysis was performed to understand the relationship between the game genre preferred by the user and the experiment completion time. The odds ratio was estimated using logistic regression. For this regression, it was decided that a "slow player" needs more than 40 minutes to finish the experiment. Table 6 shows the results.

	Genre	**Odds Ratio**		**Genre**	**Odds Ratio**
1	Action and adventure	0.33	6	Fighting	9.01
2	Racing	0.91	7	Sports	10.74
3	First Person Shooter	1.09	8	RPG	22.88
4	Music	4.88	9	Puzzle	33.13
5	Strategy	5.77	–	————	———

Table 6: Odds ratio: Genre X Time.

Note that "Action and Adventure", "Racing" and “First Person Shooter” players have more chance to be faster than the others. However, the players from other genres have more chance to finish the experiment after 40 minutes. For example, “Music” players have approximately five times more chance to be considered slow players than fast ones. It is noteworthy that the genres that have the best results are those that require greater skill orientation and navigation by the game environment ("Action and Adventure”, “Race" and "First-person shooter"). In turn, at the end of the list, there are games that require more strategic thinking such as "Sports", "RPG" and "Puzzle".

Lastly, it was performed an analysis about the relationship among the personal interests and the conclusion time of the experiment, however no statistical relationship about these variables was revealed. It can therefore be understood as an indication that the knowledge about digital games has no impact on the actual skills of the players.

In order to investigate the failure for the Quick Time Event interaction technique in the first experiment, a second test was put to run. The scene was rebuilt with longer intervals among each event, an extra event was added and the animations were remodeled. The test was conducted with 46 volunteers, all of them participated in the first experiment, we divided them into two groups, and we selected 23 that missed the answer and 23 that

answer correctly. With the corrected scene, the result changed in favor of the proposed pattern, as seen in Table 7.

Action	Interaction technique	Miss	Miss (%)	Significant level	Result
Defeat the Ghost King	Quick time event	7	0.1555	0.935	✓

Table 7: Results for the second Quick Time Event experiment.

CONCLUSIONS

Even though a player´s experience is unique, particular and non-transferable, it is necessary as well as feasible to infer user's behavior in order to foresee error events and even to provide a greater gaming experience. Due to the increasing market competition related to digital games, it is also possible to notice the growth of player's demand for games which offer higher levels of fun, in such a way that even the least important error may lead to public depreciation of a given product causing players to migrate to another similar game.

With regard to the game design process as a whole, this research had its focus on the problem specification for interaction techniques, which are applied to the game controls scheme definition. Such approach is important since it aims to improve both understanding and formalization of the interaction-planning task between player and game. Supported by this method, the process of decision-making undertaken by the design team in order to associate a meaning or action to a given device will become more effective and efficient. Consequently players will associate more easily commands they want to execute to the interaction devices as well as to the feedback displayed on the game environment, providing a more pleasurable experience.

The inductive research methodology has achieved its purpose and it is fundamental for defining analysis parameters of the players' avatars actions inside each cataloged game world as well as for the modeling of players' activities related to the interaction device chosen as research object. The 54 game samples were considered sufficient for extracting the information needed for performing this research. Observing the interaction techniques became redundant after approximately the 20th game analyzed, therefore the remaining elements on the control group were used to verify registered associations on the first samples. Next, the pattern language was considered adequate for describing the interaction techniques functions, this way creating a neat association between tasks executed by the players and its meaning inside the game world.

In a broader view, adopting the pattern language brought visible benefits for this project, since the extension of a well-established game design library facilitates the understanding and appliance of the obtained results with this work on other research performed by professionals which already make use of game design patters for their games. The patterns are thematic free, allowing the game designer to decide if an action should be easy or difficult for a character to perform.

Despite the possibility of appliance of the proposed patterns for most of the analyzed games, some minor exception could be observed as in the *God of War* (SCE Santa

Monica 2005) series. In these games, the main character Kratos may open chests placed along the levels, however for this particular case is applied the interaction technique of Time Limited Hold for a given action that could be easily performed with Press.

By analyzing the context, the player's avatar action would not have a long duration, inasmuch as the character has godlike powers and the chest has no special feature for greater locking. Nevertheless, the contents of chests vary from blue or green essences in cycles of a few seconds, and to inform the player of its current state, the chest brightens in a corresponding color. Changing the interaction technique in this case proves to be a wise decision of the design team, since it favors the player who takes time to check if he is opening the chest with the correct color, or whether he should stop the operation.

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