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Fun and Pleasure in Interactive Technology

by

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Abstract

This thesis explores some of the qualities that make an interactive product enjoyable to use. Four categories of enjoyment attributes are discussed: challenge, curiosity, people & characters, and sensory appeal. These categories are explored through a prototype that was tested in a user study, and are discussed in relation to relevant theory, empirical studies, and product examples. The responses from participants in the user study suggest that the novel controller interface (i.e., the Critter Controller) enhanced the fun of the prototype game because it added challenge, curiosity, and sensory appeal to the game, and because it related to the character featured in the game. More generally, interaction designers can leverage these four categories to enhance the fun and pleasure of using an interactive product. Finally, this thesis considers fun and relaxation as two separable types of enjoyment that one can potentially experience when using a product.

Acknowledgements

I would like to thank my supervisor, Scott Smallwood, and my examiners, Maria Whiteman and Geoffrey Rockwell. I would also like to thank the participants who took part in my study for volunteering their time. Finally, I would like to thank my family and friends for their support as I wrote this thesis.

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Introduction

Research question and relevance

What makes an interactive product enjoyable to use? Recently, researchers and designers in the field of Human-computer Interaction have shown a renewed interest in the topic of fun and pleasure in interaction design. As Ben Shneiderman (2004a) states, “The topic of fun-in-doing and emotional reactions for adult users has become hot. The interest stems from designers and researchers who are shifting their attention from desktop tools to new environments where discretionary users and non-professionals dominate” (p. 49). User enjoyment is essential for interactive games and toys, but it is also important for interactive tools and other applications since it encourages product use and feelings of satisfaction with the product. Shneiderman says that “Designers must address three almost equally important goals that contribute to fun-in-doing: (1) provide the right functions so that users can accomplish their goals, (2) offer usability plus reliability to prevent frustration from undermining fun, and (3) engage users with fun-features” (p. 49). Shneiderman's sentiments echo those of Patrick Jordan (2000), who says that user needs form a hierarchy: products must offer the right functionality, then offer usability, then offer pleasurable attributes. However, there is significant overlap between issues of usability and enjoyment, and separating one from the other is challenging. Definitions of usability such as those put forward by Jakob Nielsen (2012b) and the International Standards Organization (2010) include *satisfaction* as a component of usability, and both state that the user should find a product pleasant to use. Furthermore, as I will discuss in the last chapter of this thesis, aesthetically pleasing products are often perceived as being easier to use, so the pleasure attribute *aesthetic appeal* is tied to our perceptions of product usability. Similarly, John M. Carroll and John C. Thomas (1988) state that if a product is fun to use then the user is likely to perceive it as also being easy to use. They also state that if a user finds a product fun to use then they are more likely to use it often, increasing the user's proficiency at using the product and their ability to accomplish tasks with ease. Product usability and enjoyment are therefore interrelated, and this relationship must be considered in a product's design in order to achieve the best possible user experience.

I have chosen to discuss four factors that contribute to enjoyment in interactive products: challenge, curiosity, people & characters, and sensory appeal. There are a few reasons why I have chosen to discuss these four categories. First, I noticed these four topics recurring often in the literature on fun and enjoyment in interactive products. Secondly, they all came up at some point during my user testing sessions with my prototype; challenge, curiosity, and sensory appeal were mentioned by multiple participants as factors that made the prototype enjoyable for them. A desire for social interaction in the prototype game was only mentioned by one participant in my study (Relaxing Rabbit was only a single-player game, after all), but because it was mentioned frequently in the literature I decided to explore it in greater depth to understand how it influences feelings of user enjoyment. Some participants in my study also expressed a desire to have an interactive relationship with the Critter Controller and the rabbit character featured in the prototype, and I began to suspect that simulated social exchanges with interactive characters were probably also an important source of user enjoyment, and an area worthy of exploration. Finally, I feel that the four categories together serve as an effective (though not necessarily exhaustive) set of guidelines (or *heuristics*) for considering enjoyment in interactive technology. While there are likely other enjoyment factors beyond these four, one could reasonably use these four as a good starting point for thinking about and evaluating why people find many interactive products enjoyable. As you will see in the examples discussed throughout this thesis, they also frequently overlap: challenges are often social (e.g., a multiplayer game), visually attractive stimuli often also peak our curiosity, challenges can also feature elements of curiosity, and so on.

Design of the prototype

The prototype consisted of a computer game called Relaxing Rabbit and a novel hardware controller interface called the Critter Controller. Relaxing Rabbit (Figure 1) was a single-player computer game in which the player had to try and score points by making their character, the rabbit, collect flowers while avoiding obstacles (i.e., fences) by jumping over them. Three carrots, representing the character's lives, were displayed in the bottom right-hand corner of the screen, and the player lost a carrot every time the rabbit hit a fence. When the player lost all three carrots, the game ended and a new screen appeared to show them their final score, and they were given the option of playing another round. The game only had a single level.

The Critter Controller (Figure 2) allowed the player to control the character's movements. The Critter Controller was a furry, plush device that roughly resembled the torso of a rabbit. It contained sensors that could detect when the user touched its back and the degree to which it was tilted left or right. Petting the back of the Critter Controller made the rabbit jump, and tilting the Critter Controller left or right made the rabbit move forwards or backwards on the screen. The speed at which the rabbit moved forwards or backwards was proportional to how far the device was tilted: the rabbit would move across the screen slowly if the controller was only tilted slightly, but would move quickly if the controller was tilted a lot. When the rabbit hit a fence, the Critter Controller would vibrate to let the player know that their character had lost a life. To help players understand how to use the Critter Controller, a brief instructional video that explained how to use the interface was included at the start of the game.

Player study with the prototype

After creating a working prototype, I had a hunch that the Critter Controller interface contributed greatly to the fun of playing the game. I suspected that most players would have much more fun playing Relaxing Rabbit with the Critter Controller than they would with a traditional hardware interface like a computer mouse. To determine if the Critter Controller was indeed an important component contributing to player enjoyment, I created a second version of the game that could be played with a computer mouse, and I conducted a user study in which participants tried playing the game with both interfaces. This user study allowed me to hear the participants' responses to the prototype, and allowed me to hear their comparisons of their experiences playing the game with the two interfaces.

I had the following inclusion criteria for participants in my study: participants had to be eighteen years of age or older, had to have sufficient motor skills so that they could use the Critter Controller, had to have basic computer skills (i.e., the ability to use a computer mouse), and had to be able to speak English. To recruit participants, I posted a status update on my Facebook profile stating that I was looking for volunteers to take part in the study. Six people responded, and I scheduled a date and time for each of them to do their user-testing session. I conducted the user-testing sessions in our department's research lab (i.e., the VITA lab at University of Alberta). During each session only the participant and the researcher (i.e., myself) were present. Each user-testing session lasted one hour.

Upon meeting up with a participant, we walked to the research lab, where I had a laptop set up for them to play the game on. After they had a seat, I handed them an information letter (which can be found in the appendix) that outlined the goals of the study, the procedures of the session, and other pertinent details. I then verbally explained to the participant how the session would be conducted: first, they would get to try playing the game with the Critter Controller, then they would get to try playing it using the computer mouse (or vice-versa – half of the participants tried playing the game with the Critter Controller before playing with the computer mouse, while the other half tried playing with the computer mouse before trying the Critter Controller). I instructed the participant to say what they were thinking and feeling out loud as they were playing the game, while I recorded the things they were saying using a pen and paper. This is called the *think-aloud* method, and is described by Jakob Nielsen (2012a) as a way of testing the usability of an interactive system: “In a thinking aloud test, you ask test participants to use the system while continuously thinking out loud—that is, simply verbalizing their thoughts as they move through the user interface” (para. 2). The think-aloud method allowed me to capture the participants' emotional responses (i.e., feelings of fun, enjoyment, and pleasure) to the prototype as they were experiencing it. According to Helen Petrie and John Precious (2010), “The *emotional think aloud protocol* is an effective method for eliciting participants' emotional reactions” (p. 3678). Once the think-aloud portion of the session was completed, I asked the participant a series of interview questions (which can also be found in the appendix of this thesis). The interview questions allowed me to capture the participant's reflections on the experience, and allowed me to probe what aspects of the experience they found most enjoyable. Once again, I recorded their responses using a pen and paper. Once the interview questions were completed, I walked the participant out of the building and thanked them for their participation. Once I had finished conducting all six user-testing sessions, the think-aloud notes and interview responses were analyzed in order to find themes or patterns. Some of the participants' responses (as they relate to the four categories being discussed) are shown in Figure 3.

Figure 1: Relaxing Rabbit

Figure 2: The Critter Controller

Figure 3: Players' responses to the prototype

Chapter 1: Challenge

1.1. Challenge: Findings from the user study with the prototype

Participants in my study said that the Critter Controller made the game more challenging, and therefore, more fun to play. Consider the following observation Participant 4 made during his think-aloud session: “The Critter Controller increases the difficulty, therefore making it more challenging, therefore making it more fun and rewarding when you do succeed.” Other participants made similar comments. Participant 2 said “I'm definitely having way more fun with the Controller. The controller might be more challenging, and that's why it's more fun.” Moments after Participant 5 began to play the game with the computer mouse (after having used the Critter Controller), she stated “Okay, it's going to be a lot more boring [with the mouse].” She offered the following comparison between playing the game with the Critter Controller and playing the game with the computer mouse:

> It [the mouse] feels a lot easier than the other controller because you're just leading it around with a cursor that you can see. It also doesn't buzz when you do something wrong, so I just have to assume I hit a fence. I'm already at my highest score on my first try with the mouse. It's now starting to be boring, before [with the Critter Controller] it was more fun than I thought it was going to be.

Participant 3 gave a similar comparison of the two interfaces:

> I guess with the mouse you are more used to it, but it's not the same game. Also you don't get feedback when you're dying. As far as moving from side-to-side, I am more used to the mouse, but it [the Critter Controller] is more fun than using a mouse.

Participant 1 also said that he found the game more challenging with the Critter Controller, and thought that “You can get better accuracy once you get a feeling for the controller." Using the Critter Controller required the development of a new perceptual-motor skill. A perceptual-motor skill is "Any ability or capacity involving the interaction of perception and voluntary movement, typical examples being the ability to type and the ability to play a ball game" (Colman, 2009). Participants in the study had a much easier time scoring points with the computer mouse because they were already very proficient at using it, but because none of the participants had ever used the Critter Controller before, this interface presented them with a new skill to master. This made it more challenging to score points and avoid obstacles, and increased the fun of the game.

Malone (1981) states that computer games require clear goals in order to be enjoyable. As the game's introductory screen stated, the goal of Relaxing Rabbit was to "Collect as many flowers as you can while avoiding the fences by jumping over them." This proved to be a sufficient goal, but not an optimal one. The game would have benefited from having a clearer goal for the player to work towards, with a clear indication of success or failure. All participants in the study understood that the immediate goal of the game was to collect flowers and avoid fences, but most wanted to know what larger goal they were supposed to try to work towards by performing this task. Participant 3 asked, "What do I get for collecting flowers? The joy of collecting flowers?" In other words, this participant, like several others, wanted to know what constituted a successful outcome when playing the game. As it was, the goal of the game was to beat the highest score you had attained in previous rounds of play. Participant 5, for example, managed to get 97 points on her fifth round of play, then stated "Now I want to get over 100." However, the way this goal was implemented had a couple of issues: it required the participant to remember their previous high score, which is problematic when they are playing multiple rounds and being shown a number of different scores, and also gave them no indication of what a *good* score is. For instance, getting 100 points doesn't indicate whether or not you are highly proficient at playing the game. To improve this goal, future iterations of the game could display the player's existing high-score on the screen, which would remove the burden of having to remember what your high score is. To provide the player with an indication of how successful they have been, they could also be given a ranking based on their high score (e.g., beginner, advanced, expert). A variation on this would be the implementation of a *leaderboard*, which would show the player the highest scores attained by anyone who has ever played the game. This approach would also introduce a competitive aspect to the game since the player would have to try and beat other players' high-scores in order to maintain their own place on the leaderboard.

Some participants in the study said that they thought the game would have benefited from having game levels. Participant 3 asked “If you get a certain score do you get a new level or anything?” Participant 4 echoed this desire for more levels, suggesting that “You could have different levels and difficulty go up with each level.” The use of game levels is another approach that would have helped give the game clear goals for the player to work towards. The use of game levels would mean that there would have to be some criteria for successfully completing each level; for example, the player might have to attain a certain number of points on the first level in order to reach the second level. As Participant 4 pointed out, another advantage of using game levels is that they could provide the player with a gradual increase in the challenge of the game. This would help maintain an appropriate level of challenge as the player becomes more proficient at playing the game.

Malone (1981) says that “users need some kind of *performance feedback* to know how well they are achieving their goals” (p. 65). My prototype offered several types of performance feedback: a score (i.e., number of points attained), visual feedback, audio feedback, and haptic feedback (i.e., vibrating sensations). It was discovered that one oversight in the game's design was the fact that it offered audio and visual feedback for successes (i.e., collecting flowers), but offered no audio feedback and limited visual feedback for failures (i.e., hitting a fence). As some of the previous quotes indicate, the Critter Controller helped solve this issue by providing haptic feedback, but several participants said they also wanted audio and/or visual feedback to let them know when their character hit a fence. Most participants were not able to quickly ascertain the fact that the carrots in the bottom right-hand corner of the screen represented the number of lives that their character had left, and some players wondered why they were being presented with the game-over screen when they thought they were playing successfully. “I don't really know how I'm dying,” Participant 3 said while playing with the Critter Controller. Later she asked “What are the carrots for?” A moment later, she realized that the carrots represented her character's lives. Participant 5 also asked “How do you know when you've hit the gate too many times?” Two rounds of play later, she too realized that the carrots represented the character's remaining lives. Two participants expressed a desire for greater visual feedback (beyond the subtle disappearance of the carrots) to let them know when their character hit a fence. While playing with the mouse version of the game, Participant 3 said “you don't really know when you're dying because it doesn't have a visual.” Similarly, Participant 4 said “I think once you hit a fence the fence should be knocked down or something” while playing the mouse version. Some participants in the study expressed a desire for audio feedback to let them know when their character hit a fence. “It might help to have sound feedback to let you know when you've hit a fence,” said Participant 1. This was echoed by Participant 4, who said “I would add some kind of audio feedback to let you know when you've hit a fence.” These responses indicate that, as Malone states, players need unambiguous performance feedback to let them know how successful they are in attaining their goals. The Critter Controller's haptic feedback largely eliminated the ambiguity of whether or not the player had hit an obstacle, but audio and visual feedback upon hitting an obstacle would have also enhanced the game. The display showing how many lives the player has left could be improved by making the carrots larger, putting a label that says *lives* above it, and by adding an animation that shows a carrot disappearing when the player loses a life. This would help make the display's purpose more clear, and would make the fact that the player has lost a life more apparent.

1.2. Flow theory as a model for challenge

The findings pertaining to challenge in the prototype are consistent with the ideas put forward by Mihaly Csikszentmihalyi in his theory of *flow state*. Csikszentmihalyi (1990) gives the following description of flow state:

> I developed a theory of optimal experience based on the concept of *flow* – the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it.
> (p. 4)

Csikszentmihalyi coined the term *flow state* to describe the state of absorption one can experience when engaged in an activity that they find enjoyable. Flow state can also be thought of as being *in the zone* (Chen, 2007), and flow experiences evoke feelings of accomplishment and achievement as the individual overcomes challenges and develops new skills (Csikszentmihalyi, 1990). From his studies, Csikszentmihalyi found eight elements (see Table 1) that are usually present when an individual is experiencing flow state[1].

1	A task we have a chance of completing.
2	The ability to concentrate on what we are doing.
3	Concentration is possible because the task has clear goals.
4	Concentration is possible because the task has immediate feedback.
5	One acts with a deep but effortless sense of involvement.
6	The ability to exercise a sense of control over one's actions
7	Concern for the self disappears, but emerges stronger after the flow

1 Source: Csikszentmihalyi, 1990, p. 49

	experience
8	The sense of the duration of time is altered

Table 1: The eight components of flow state

Csikszentmihalyi (1990) says that people who experience flow state will report at least one, and sometimes all, of the above-mentioned elements being present. Jenova Chen (2007) discusses the importance of Flow Theory for the design of video games and interactive products, and says that video game designers intentionally leverage these flow elements in order to help players attain flow state while playing.

> As a result of more than three decades of commercial competition, most video games deliberately leverage the eight components of flow. They deliver instantaneous, accessible sensory feedback and offer clear goals the player accomplishes through the mastery of specific game-play skills. (p. 32)

Chen says that games and other end-user technologies can be made more enjoyable by incorporating Csikszentmihalyi's flow components and by making the products adaptive so that they offer the correct level of challenge for individual users. Penelope Sweetser and Peta Wyeth (2005) also state that Flow Theory provides a model for player enjoyment in video games: “Flow, a widely accepted model of enjoyment, includes eight elements that, we found, encompasses the various heuristics from the literature” (p. 1). Lazzaro (2004) conducted a player study to determine the attributes that make video games fun, and says that “We were surprised how aptly 'Flow' describes challenge” (p. 7). Flow is a useful model for understanding challenge, since it describes the objective and subjective components we find in enjoyable challenges, and describes the relationship between task-difficulty and enjoyment.

According to Sweetser and Wyeth, the flow elements that represent subjective experiences—concentration on the task, a deep sense of involvement, concern for the self disappearing, and the individual's sense of time being altered—can be encouraged by specific design features found in video games. They state that games can encourage concentration by offering “detailed game worlds that draw the player into the game,” by avoiding situations in which the player is “burdened with tasks that don't feel important,” and by avoiding “distractions from major game tasks” (p. 6). Sweetser & Wyeth merge the remaining three subjective elements—“a deep but effortless sense of involvement,” “The sense of the duration of time is altered,” and “concern for the self disappears” (Csikszentmihalyi, p. 49)—into a single subjective experience they refer to as *immersion*. They state that feelings of immersion might be encouraged through sensory appeal and the use of narrative. The elements that represent the objective qualities found in a flow activity are: “a task we have a chance of completing,” “the task has clear goals,” “the task has immediate feedback,” and “the ability to exercise control over one's actions” (Csikszentmihalyi, p. 49). In terms of interaction design, a product can be designed with a particular usage in mind (i.e., a task with goals), and can offer the user performance feedback and control over the task they're performing. As I will discuss in the following sections, the nature of the goals featured in a particular product depend on the type of product it is. As Malone (1981) points out, interactive games and toys tend to feature goals invented for the player to achieve, while interactive tools tend to feature goals found in an existing task.

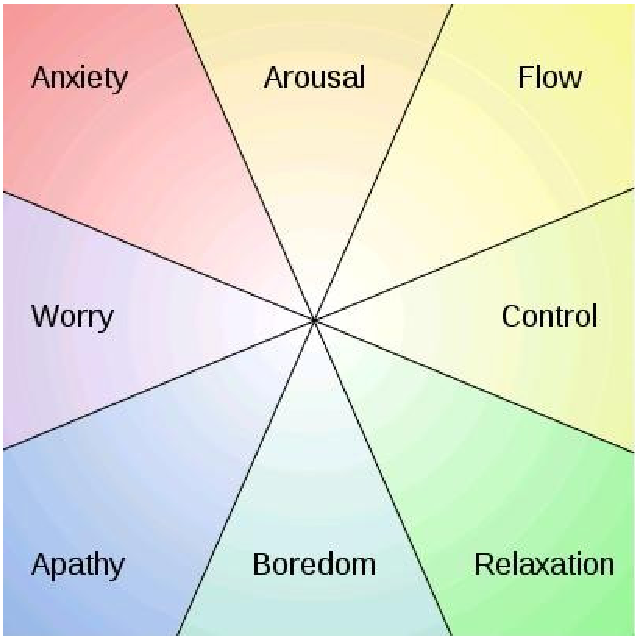

Figure 4: Csikszentmihalyi's flow channel diagram

According to Csikszentmihalyi (1990), flow occurs when there is a good match between the individual's skill-level and the difficulty of the task. Csikszentmihalyi (1990) says that “In all the activities people in our study reported engaging in, enjoyment comes at a very specific point: whenever the opportunities for action perceived by the individual are equal to his or her capabilities” (p. 52). Csikszentmhilahyi's (2008) flow diagram (Figure 4) illustrates his concept of the flow channel (or *flow zone* as Chen calls it), the point at which an individual is matched with a task that is of the correct difficulty for their skill level. This flow diagram also illustrates how flow relates to other emotional states. Csikszentmihalyi (2008) says that flow is the optimal performance state to be in, but also says that the areas on the diagram he has labelled as *control* and *arousal* are desirable states from which the individual can easily return to flow. To return to flow from the area Csikszentmihalyi has labeled *arousal*, the individual just has to increase their skill-level at the task a bit. To return to flow from the *control* area, the task must become slightly more challenging for the individual.

One of the goals of my prototype was to provide the player with an experience that was both relaxing and fun. However, participants in my study said that playing the game with Critter Controller made the game more challenging (and therefore more fun), but also said that this increase in challenge made the game less relaxing. Participant 2 said “I feel like the controller might not be more relaxing, even though it is more fun.” Similarly, Participant 5 said “This isn't relaxing, it's just really fun.” Participant 5 offered the following sentiments relating to challenge, fun, and relaxation in the game:

> Maybe increasing the speed as it goes on, therefore increasing the difficulty, which would make it more fun. That might take away from the relaxing though. That's a good question, how do you increase the difficulty without taking away from the relaxing-ness?

One of the key variables affecting the emotional states shown in Csikszentmihalyi's flow diagram is *arousal*, which refers to how awake or alert an individual feels. As the task became more difficult, the participants felt more aroused and less relaxed. The Oxford Dictionary of Psychology (Colman, 2009) gives the following definition for *arousal*: “Short for physiological arousal: excitation of the ascending reticular activating system, leading to a condition of alertness and readiness to respond, as evidenced by such physiological signs as increased heart rate and blood pressure, galvanic skin response (GSR), and desynchronized EEG activity.” Arousal is therefore both a mental and physiological phenomenon: an increase in arousal will make an individual feel more alert, and will elicit a physiological response that includes an increase in heart rate. Csikszentmihalyi's flow model shows that an individual's arousal level increases with task-difficulty: a task that is not very difficult will be relaxing and not very arousing, an adequately challenging task will be arousing and enjoyable, and a very difficult task will evoke feelings of anxiety (i.e., high arousal and displeasure). An increase in challenge makes the game more fun, but also increases arousal, which prevents the experience from being relaxing.

Ian R. Gellatly and John P. Meyer (1992) conducted a study to evaluate the effects of a task's difficulty on the arousal response, and the effects of task-difficulty on the individual's performance on the task. Gellatly & Meyer state that "Two experiments were conducted to examine whether arousal, as indicated by heart-rate acceleration, is affected by the difficulty of assigned goals and, if so, whether such arousal is related to changes in cognition and behavior typically observed in goal-setting studies" (p. 696). Subjects in the study performed a task in which they were asked to look at rows of letters on a sheet of paper and circle the vowels. Some participants were assigned an easy version of the task, while others were assigned a more difficult version of the task. Gellatly & Meyer found that "Subjects assigned more difficult goals on a perceptual-speed task perceived a higher performance norm, reported high self-efficacy strength, set a higher personal goal, exhibited increased heart rate, and produced more than subjects assigned easier goals" (p. 701). This indicates that challenging tasks can increase arousal levels, and that an increase in challenge can be conducive to better performance at the task, since subjects performing the difficult task in Gellatly & Meyer's study made fewer errors and on average completed more rows of letters in the six minute session than those participants who had been assigned the easy task.

Psychologist James A. Russell (1980) says that arousal is one of the two key dimensions of emotion (the other being *pleasure*—see Figure 5). Russell conducted a study in which participants were asked to place cards with words pertaining to emotional states in a circle, so that similar words were close together, and dissimilar words opposed each other. The result of this study is the image you see in Figure 6, which shows how participants perceived a variety of emotional states to differ in terms of arousal and pleasure. Russell says that excitement, for example, can be characterized by both high levels of arousal and high levels of pleasure, while relaxation can be characterized as being a low-arousal state with high levels of pleasure. Notice the overlap between Russell's model and Csikszentmihalyi's model: in both we see an increase in arousal as we move from the bottom of the diagram to the top, and an increase in pleasure as we move from left side of the diagram to the right. Because flow is characterized by both feelings of arousal and pleasure, emotional words like *excited*, *delighted*, and *happy* might be used to describe being in flow state.

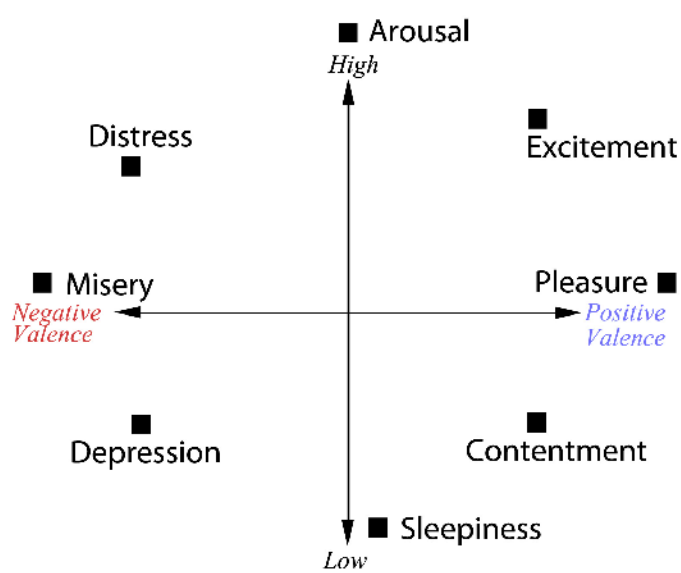

Figure 5: Russell's circumplex model of emotions

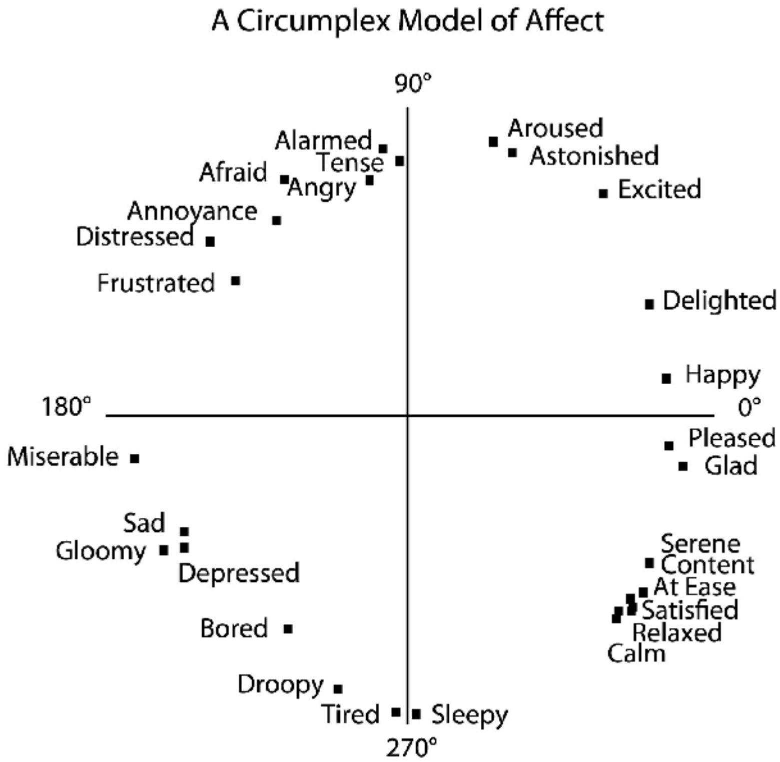

Figure 6: Russell's circumplex model showing many emotional states

1.3. Challenge in games and toys

Malone (1981) refers to computer games as *toy systems*, and says that "a challenging toy must either build in a goal or be such that users can easily create their own goals for its use" (p. 65). Toys and games require either the designer, or the user themselves, to invent a challenging goal for the user to accomplish when using the product. Csikszentmihalyi (in Geirland, 1996) says that flow activities "need clear goals that fit into a hierarchy, with little goals that build toward more meaningful, higher-level goals" (para. 4). As I discovered with my prototype, players like to have bigger goals to work towards through the accomplishment of smaller goals. Bejewelled 3 (Figure 7) is an example of a game that provides the player with hierarchical, nested goals in the form of game levels. The player's short-term goal is to "match sparkling gems three at a time to make them burst in showers of color and points" ("Bejeweled - The World's #1 Puzzle Game", n.d., para. 1), and by matching gems they can complete the current game level and progress to subsequent levels. These levels offer the player bigger accomplishments as they progress through the game, and give the player clear markers of success.

Figure 7: Popcap Inc.'s game Bejeweled 3

As one participant in my study mentioned, game levels can also help facilitate a steady increase in the challenge of the game as the player becomes more skilled at playing it. As Csikszentmihalyi (1990) states, "One cannot enjoy doing the same thing at the same level for long" (p. 75). Once the player has mastered one level of a game they will require a more difficult challenge to match their improved proficiency at the game. By offering the player a new, more challenging level, the game can provide the player with the correct level of difficulty as they progress through the game, keeping them in flow state. Another strategy for maintaining the correct level of difficulty in a game is by offering *variable difficulty*, which allows the player to select how difficult the game will be before the game begins via a selection mechanism like a switch, button, or menu. The game Guitar Hero, for example, allows the player to play a particular song on easy, medium, hard, or expert difficulty ("Guitar Hero Series", n.d., p. 163). Another example, The Atari video game system, offered the player "the option of setting a difficulty switch on the game console" (Jones, 1989, p. 185). Another way to provide players with the ability to select the difficulty level before a game starts is by providing them with a variety of tasks that vary in difficulty to choose from. Matthew Bouchard (2010) says that massively multiplayer online role playings games (e.g., World of Warcraft) do this by providing a "large world and a wide variety of things to do which can provide them with whatever level of challenge they are interested in" (p. 119). By offering the player a variety of tasks that vary in difficulty, the player can choose tasks that are well-suited to their interests and skill-level.

Another approach for maintaining the correct level of difficulty, discussed by Chen (2007), is called *dynamic difficulty adjustment*. With this strategy, the choices the player makes as they play determine how difficult the game is. This approach differs from variable difficulty because the choices pertaining to difficulty are made as the game is being played, not before it is played. Chen employed this concept in a game he created called Flow (Figure 8), in which the player plays a small organism that lives in the water and grows by eating other organisms. The player's goal is to grow their organism by eating smaller organisms while avoiding being eaten by predator organisms (which are orange). The player eats red or blue organisms to move up or down in the water (i.e., blue organisms make you move up, red organisms make you dive down further). This eating/diving mechanism allows the player to choose the difficulty of the game as they are playing, since the further the player dives down the more challenging the game becomes. Chen (2007) says that this DDA strategy involves embedding difficulty adjustment choices into the *core activities* of playing the game.

> The best way for game designers to avoid these counterproductive situations is to embed the player's

> choices into the core activities of the interactive experience. For example, once surfers of real ocean waves develop enough skill to be able to control their direction on the water, they have freed themselves to choose and engage particular waves. (Chen, 2007, p. 33)

Since the core activity of Chen's game is swimming and eating other organisms, Chen has embedded choices pertaining to the game's difficulty into this activity. Chen (2007) says that “In order to design an interactive experience for a broader audience, the experience cannot be the same for all players or users. Any such experience must offer many choices, adapting to different users’ personal Flow Zones” (p. 33). One of the advantages of this strategy is that the player can easily move back and forth between different levels of difficulty as they are playing, keeping them in their flow channel.

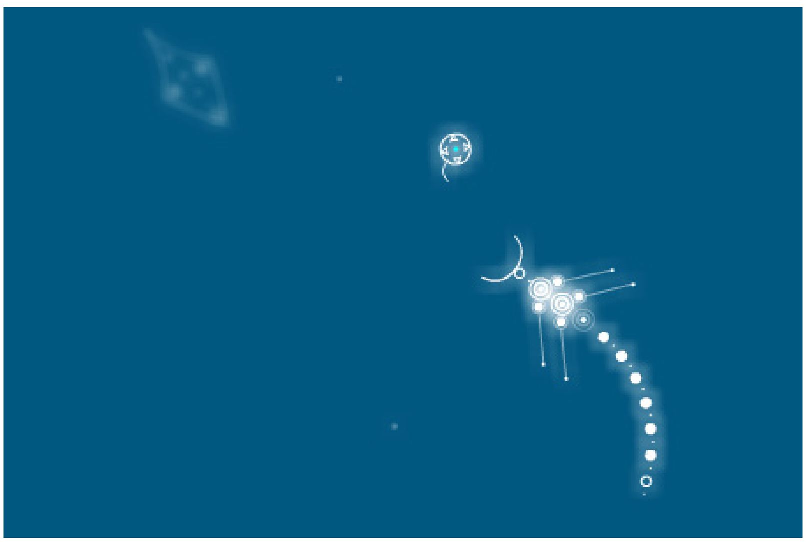

Figure 8: Jenova Chen's game Flow

Dynamic difficulty adjustment can also be achieved through the use of artificial intelligence systems that observe the player's performance and set the difficulty of the game accordingly. This method is used in Valve Inc.'s first-person shooter game Left 4 Dead. Left 4 Dead is a “replayable, cooperative, survival-horror game where four Survivors cooperate to escape environments swarming with murderously enraged 'Infected' (ie: zombies)” (Booth, 2009, p. 1). The game uses an artificial intelligence algorithm called the AI Director to dynamically adjust the difficulty of the game as it is being played.

> The Director, sometimes referred to as the AI Director, or simply as AID is the artificial intelligence of Left 4 Dead that features a dynamic system for game dramatics, pacing, and difficulty.
>
> Instead of set spawn points for enemies, the Director places enemies in varying positions and numbers based upon each player's current situation, status, skill, and location, creating a new experience for each play-through. The Director also creates mood and tension with emotional cues such as visual effects, dynamic music and character communication. Moreover, the Director is responsible for spawning additional health, ammo, weapons, and Special Infected, like the Witch or the Tank. ("The Director", n.d., para. 1-2)

In Left 4 Dead, difficulty is adjusted by the system based on how well the players are playing. According to the official Left 4 Dead company blog, "The better the Survivors are doing, the angrier the AI Director seems to get" (Malaika, 2009, para. 5). If players are performing well, the AI Director will make adjustments to the number of zombies, additional health, and weapons available in order to make the game harder for the players in order to keep the players in their flow channel.

Malone (1981) says that toy systems can also allow the user to create their own goals. This approach can be seen in the design of many children's toys; building blocks (such as those shown in Figure 9), for example, do not offer instructions telling the child what to create[2]. Instead, the child can decide on their own goals and challenges when playing with the toy. Second Life (Figure 10) is an example of a software application that allows the player to define their own goals and challenges when using the system. Harry E. Pence (2007) discusses the role of goals in Second Life:

2 Lego sets and similar building block systems are an exception to this, since they usually do feature instructions telling the child what to build and how to build it.

> Some people try to classify Second Life as a game. If Second Life is a game, it is a most unusual game, since it does not define goals for winning nor is there any method for keeping score. Each resident is responsible for defining his or her own personal goals. (p. 172)

There are a number of potential goals a player can pursue when playing Second Life. According to Second Life's website, players can use Second Life to do the following things: explore virtual worlds, chat with other players, use their avatar as a means of self-expression, attend virtual events, or engage in creative activities like taking snapshots, videos, or building structures in the game (“What is Second Life?”, n.d., para. 1-5). Notice that not all of these goals represent a challenge with strict criteria for success or failure: some of them pertain more to curiosity or social interaction than challenge (subjects covered in the following chapters of this thesis). Exploring a virtual world, for example, might be better described as *interesting* rather than challenging, putting it more in the Curiosity category. One example of a challenging task in Second Life is building a virtual structure, since it is a task with a clear goal that requires skills. The user will know if they have been successful in the task if they are able to complete the structure they intended to build.

Figure 9: Building blocks

Figure 10: Second Life

1.4. The role of challenge in tool systems

Word processors, search engines, and image-editing programs are all examples of interfaces Malone refers to as *tool systems*. Malone (1981) says that tool systems are “designed to achieve goals already present in the external task” (p. 66). The goals found in toys and games are invented for the player to accomplish, whereas the goals of a tool system are determined by needs that already exist. Malone (1981) and Csikszentmihalyi (1990) both state that in order for a task to be challenging the outcome of reaching the goals of the task must be uncertain. If the outcome is certain (i.e., the user is guaranteed to succeed or fail), then there will be no challenge. Malone (1981) says that tool systems already have uncertainty and challenge present in the external task, and therefore the tool itself should be “easy to learn and easy to master” (p. 66). This approach is echoed by Christina Wodtke (2012), who says that ease-of-use and ease-of-mastery is normally all that is required in order to encourage flow state in tool systems (para. 22). Wodtke says “Consider flow as you design, but only to make sure if the user manages to achieve it you don’t disturb it” (para. 22). Tool systems can therefore encourage flow state by being easy to use and easy to learn to use (i.e., having good usability).

Nielsen (2012b) says that “Usability is a quality attribute that assesses how easy user interfaces are to use” (para. 2). Nielsen goes on to state that usability is “defined by 5 quality components” (para. 3): learnability, efficiency, memorability, errors, and satisfaction. A product might be considered usable if it can easily be used to accomplish goals (i.e., efficiently and with few errors) and can be learned easily (i.e., can be understood quickly, easy to remember how to use). A similar definition of usability is offered by the International Standards Organization in their “ISO 9241-210” document. The ISO defines usability as the “extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (p. 3). This definition of usability emphasizes the importance of specific users using a product to accomplish specific goals. Nielsen (2012) refers to this as the *utility* attribute of a product, which he says “refers to the design's functionality: Does it do what users need?” (para. 3). Notice that both Nielsen and the ISO's definitions of usability include a *satisfaction* component: here we see some of the overlap between usability and pleasure. Marc Hassenzahl (2003) and Jordan (2000) have both argued that *satisfaction* can be thought of as an emotional response that is distinct from pleasure. Jordan says that “The human-factors profession has traditionally operationalised ‘satisfaction’ in a manner that is limited to the avoidance of physical or cognitive discomfort. This is clearly reflected in the International Standards Organization’s definition of satisfaction: ‘the level of comfort that the user feels when using a product and how acceptable the product is as a vehicle for achieving their goals’ (ISO DIS 9241–11)” (p. 7). Based on this definition of satisfaction, Jordan says that products must provide something more than usability and utility in order to be pleasurable. However, I disagree with Jordan that this definition of satisfaction cannot include feelings of pleasure or enjoyment, since according to Csikszentmihalyi's Flow Theory, accomplishing goals can be highly enjoyable. If a product is a suitable vehicle for accomplishing goals, that alone could potentially make it conducive to enjoyment. Additional features beyond its ability to help a user accomplish a task (e.g., aesthetic qualities, curious attributes) will further enhance the fun of using the product, but we should acknowledge that enjoyment can come from using a product with good usability to accomplish a task, so long as the user finds the task sufficiently stimulating.

Figure 11: Apple's iBooks application

Apple's mobile application iBooks (Figure 11) is an example of an interface that has strong usability. One strategy for evaluating the usability of an interface is the *heuristic evaluation* method. Several Human-computer Interaction theorists have proposed heuristic guidelines (i.e., rules of thumb) for evaluating the usability of interactive products, including Benjamin Shneiderman (2004b), Debbie Stone et al. (2005), and Jakob Nielsen (1995). As Jeff Johnson (2010) observes, there is significant overlap between these lists of heuristic guidelines: qualities like consistency, feedback, control, the ability to reverse actions, error prevention, and reducing the amount the user has to remember are consistently cited as qualities that improve usability. Notice that some of these qualities—feedback, a sense of control, reducing the amount the user has to remember (i.e., eliminating distractions)—also overlap with Csikszentmihalyi's list of flow components. For this example, I will be evaluating iBooks using Nielsen's ten usability heuristics. Nielsen (1995) says that this list represents “The 10 most general principles for user interface design. They are called 'heuristics' because they are more in the nature of rules of thumb than specific usability guidelines” (para. 1). Table 2 shows my evaluation of iBooks based on Nielsen's usability heuristics.

Usability Heuristics	**iBooks Features**
Visibility of system status	iBooks provides a *loading* animation when it is loading the books onto the bookshelf. Users can see what books are available to read by the titles that are present on the bookshelf. The status of other system attributes like battery power and wi-fi connectivity for the device are always visible above the app.
Match between system and the real world	The app uses a bookshelf metaphor to display the books the user has in their collection. Book *pages* mimic the appearance of real book pages and animations are used to mimic the way a page flips when reading.
User control and freedom	Users can move books on the bookshelf and delete books from their collection easily. Users can create multiple book collections. The user can easily navigate back to the bookstore or bookshelf by using the buttons in the top navigation bar should they accidentally end up on a screen they didn't mean to go to.
Consistency and standards	Follows platform conventions for Apple apps, has a persistent navigation bar at the top that has the *store* and *edit* buttons.
Error Prevention	It is difficult to make an error when using this app, and it is always possible to navigate back to the previous screen if you accidentally navigate to another screen. Purchasing a book involves a few steps and requires pressing a small button once you arrive at the book's product page, so it is unlikely the user would make an accidental purchase.
Recognition rather than recall	This app does not require much memorization since all the interface elements are pretty self-

	explanatory.
Flexibility and efficiency of use	This app does not offer much flexibility or the opportunity for skilled use, although users can organize their books into categories which could increase the efficiency of finding a desired book.
Aesthetic and minimalist design	The design is simple but effective, the bookshelf is well-rendered.
Help users organize, diagnose, and recover from errors	Error messages are not applicable to this application.
Help and documentation	Does not offer a *help* button, but documentation on usage can be found at "apple.com/support/ios/ibooks"

Table 2: Evaluating iBooks using Nielsen's ten usability heuristics

After evaluating iBooks using Nielsen's usability heuristics, the application appears to possess almost all the qualities Nielsen says are conducive to good usability. It is worth noting that I did not encounter any *error messages* when using the system because I did not experience any errors while using it, so I do not know for sure whether or not iBooks possesses that particular usability trait. I have not found a user study that evaluates iBooks's ease-of-use, but based on this heuristic evaluation it seems likely that users will be able to use the application to find, read, and organize books with ease. Because the interface is easy to use, the user can focus on the challenge of the external task: reading a book. Csikszentmihalyi (1990) says that reading is one of the most common flow activities.

> For instance, one of the most frequently mentioned enjoyable activities the world over is reading. Reading is an activity because it requires the concentration of attention and has a goal, and to do it one must know the rules of written language. The skills involved in reading include not only literacy but also the ability to translate words into images, to empathize with fictional characters, to recognize historical and cultural contexts, to anticipate turns of the plot, to criticize and evaluate the author's

style, and so on. (pp. 49-50)

Therefore, we might consider reading a book to be the challenging task the user is performing when using iBooks. In addition to the challenge of the task, aesthetic appeal is likely also an important factor contributing to user enjoyment with this application, since the interface has an appealing visual design.

1.5. Uncovering challenges and adding-in goals

Anderson says that a useful strategy for enhancing the fun of an interactive tool is to find the core challenges of the activity and offer the user goals pertaining to those challenges. In a way, this approach takes the tasks the product was made to accomplish and turns them into something of a game through the addition of goals created by a designer. To illustrate this approach, Anderson discusses a hypothetical application that would allow workers to estimate and track their work hours.

> Imagine a game that combines weekly (or daily) time estimation with time tracking. We all know the value of planning our days. Time tracking is the other half, a way to *reflect* on our planning. In this sense, time tracking moves from a chore to an estimation game—with the goal of seeing how accurately you estimated your time. Time tracking becomes analogous to checking your answers on a test—you naturally want to find out how you did. (pp. 170-171)

Anderson says that "You need an idea based on the person using the application; you need to find the thing that people naturally want to get better at. It's not about adding a fun layer but about finding the core challenge and presenting it in a fun way" (p. 170). In this example, challenge and uncertainty are already present in the task, but the design of the system turns it into something of a game through the addition of specific, achievable goals, such as getting 100% accuracy in your ability to estimate the time you spend on certain tasks. We also see this approach (i.e., adding a specific goal to a challenging task) in the fuel economy display in the dashboard of the 2013 Dodge Dart (Figure 12). The Dodge Dart features an LCD screen that can display a graphic of a sunflower that gains or loses petals depending on how economically the driver is driving[3] ("Inside the 2013 Dodge Dart Cars: Digital Gauges, Interior Design", n.d., para. 26). The sunflower display communicates to the driver that their goal is to drive economically, and maintain the flower's petals: it's obvious that a sunflower with all of its petals is *good*, and that a sunflower with few petals is *bad*. This feature also incorporates other enjoyment attributes discussed in this thesis: the novelty of the flower display peaks the user's curiosity, promoting exploration of the interface, and the flower itself is aesthetically pleasing to look at. The Dodge Dart's flower display, like Anderson's hypothetical time-tracking application, might be considered an example of *gamification.* Sebastian Deterding et al. (2011) define gamification as "*the use of game design elements in non-game contexts*" (p. 10). In the case of the Dodge Dart's flower display, the game design element at play is the introduction of an internal/invented goal: don't let the flower lose its petals. Deterding et al. distinguish game elements, which we find in *gamified* products, from playful elements in the broader sense. They state that "academic as well as industry critiques of 'gamified' applications have repeatedly emphasized that these focus almost exclusively on design elements for rule-bound, goal-oriented play (i.e., *ludus*) with little space for open, exploratory, free-form play (i.e., *paidia*)" (p. 11). This is precisely what we see in the Dodge Dart's flower display and in Anderson's time-tracking application idea: rule-bound systems with a specific goal and conditions for success. Therefore, we can consider both of these to be examples of gamification.

3. Economy driving can be achieved by such techniques as accelerating smoothly, stopping gently and infrequently, and making sure the car's tires are properly inflated (Cohen, n.d.).

Figure 12: The 2013 Dodge Dart's dashboard

1.6. Using tools like toys and toys like tools

Some tool systems offer the user advanced features that require skills to use. Malone (1981) says "Some users of complex systems may enjoy mastering tools that are extremely difficult to use. To the extent that these users are treating these systems as toys rather than tools, the difficulty increases the challenge and therefore the pleasure of using the systems" (Malone, p. 66). In this scenario, challenge can come from both the external task and from the challenge of learning to use the product itself. Adobe Photoshop (Figure 13) is an example of an interface that offers many opportunities for advanced mastery, and implements what Malone (1981) refers to as *successive layers of complexity*. Malone says "a multi-layered system could not only help resolve the trade-off between simplicity and power, it could also enhance the challenge of using the system. Users could derive self-esteem and pleasure from successively mastering more and more advanced layers of the system" (p. 66). The complexity and challenge in learning to use Photoshop is *multilayered* because the user can progressively work their way up to learning the more advanced features of the system. The user can start by learning to use the *toolbar*, which features icons for the most commonly used tools (e.g., the pointer tool, selection tools, paintbrush, etc.), then they can learn how to use the *layers panel* and other panels. More advanced functionality such as *curves* and *levels* can be found in drop-down menus such as the *image* menu, adding another layer of complexity to the interface. These layers, like levels in a game, offer the user goals to work towards when learning the system. One of the advantages of successive layers of complexity is that the user doesn't have to learn everything about the system before they can create something with it, since they can choose to perform easier tasks (e.g., using only features from the *toolbar* menu in Photoshop). This approach also reflects Chen's idea of *embedded choices*: by providing the user with different options that require different levels of skill, the user can select tasks that are of the correct difficulty level for them.

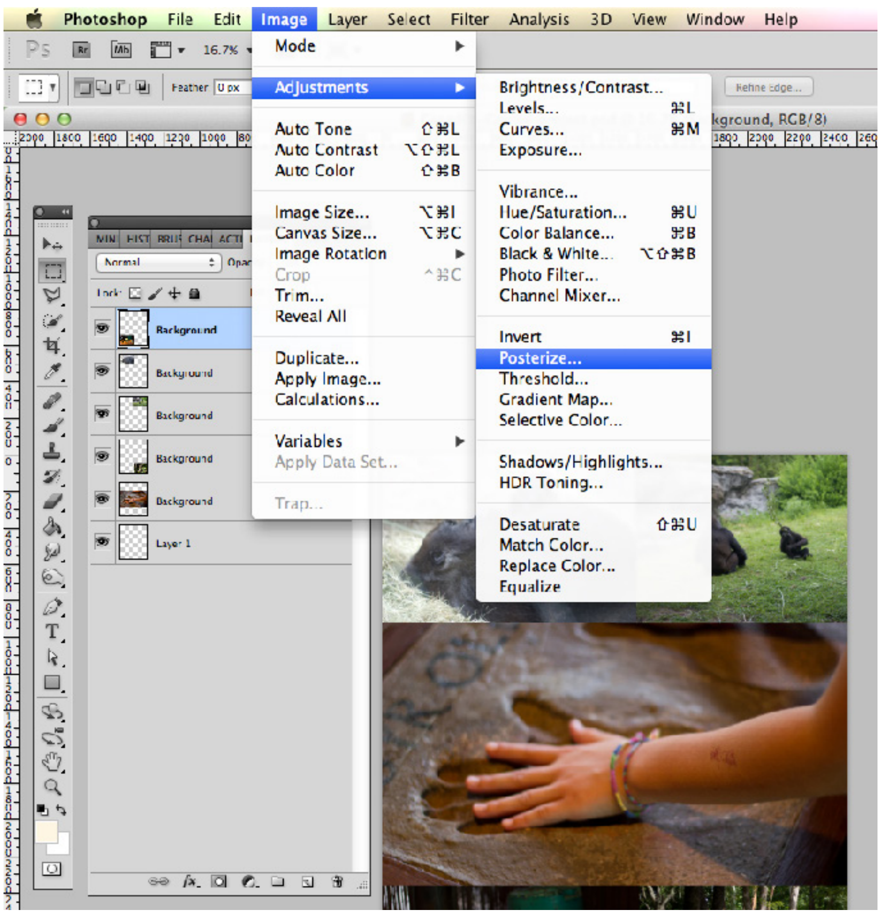

Figure 13: Adobe Photoshop CS5.1

Dennis Chao's application PSDoom (Figure 14) is an example of a game that Chao has modified for use as a tool. By editing the source code for ID Software's first-person shooter game Doom, Chao was able to create a game which can be used as a tool for closing applications running on the user's computer. In PSDoom, the monsters in the game represent applications that are running on the user's computer system, and the user can "affect the running programs by inflicting damage on the monsters" (Chao, 2004, p. 71). Chao (2004) says that "A light wound lowers the corresponding program's priority to give it fewer CPU cycles, causing the program to run more slowly on the computer. If the monster is killed, the associated program is terminated" (pp. 71-72). This application takes the normally mundane task of closing programs in a task manager and makes it a little bit more fun by adding a challenge to the task (i.e., shooting the monsters). This might also be considered an example of gamification since it takes a non-game task and adds in game elements (i.e., a challenging goal and the use of characters in a fantasy environment).

Figure 14: Dennis Chao's PSDoom

1.7. Challenge: conclusions of study

Challenges provide product users with opportunities to improve their skills at a particular task, and this skill-development process can be fun for users. Csikszentmihlayi's theory of flow state provides a model for offering users enjoyable challenges: the challenge offered should be well-matched to the user's skill set, there should be clear goals in the task, the user should have control over what is happening, and the product should offer unambiguous feedback about the user's performance. To maintain flow state over extended use, the product should offer the user challenges that progressively increase in difficulty.

Several strategies for maintaining a good match between the difficulty of a task and the user's skill-level have been explored in this chapter. Game levels were discussed as one strategy for maintaining a progressive increase in difficulty in video games. Once the player masters one level, they can move on to a new, more difficult level. Another strategy for maintaining the appropriate level of challenge is through the use of *variable difficulty*, which allows the player to select the level of difficulty before they begin playing the game via a button, switch, or menu. A third method for providing the correct level of difficulty is through a *dynamic difficulty adjustment* system, in which the level of difficulty of a particular task can be changed as the player is playing the game. Dynamic difficulty adjustment can be implmented through the use of artificial intelligence algorithms that monitor the player's performance and set the difficulty of the game accordingly, or by allowing the player to choose the difficulty of the task themselves as they are playing. With the latter approach, choices pertaining to the difficulty of the task are embedded into the task itself. Toy systems might also allow the user to define their own goals and tasks (that are of the appropriate difficulty-level for them), as we see in Second Life and MMPORGs.

As Malone states, toy systems tend to feature internal goals (i.e., goals invented for the product), while tool systems tend to feature external goals (i.e., the product is created to satisfy an existing need). Due to this difference, toy systems must build-in a challenge, while tool systems do not necessarily need to add a new challenge, since the task for which the product is being used is likely already challenging. A tool system might enhance the challenge of the task by pointing out specific goals, and offering the user feedback on their progress towards those goals. The Dodge Dart, for example, draws attention to the goal of attaining good fuel economy through its sunflower display. The toy/tool dichotomy is not necessarily a black-and-white model for defining products though, since it is possible for tools to offer internal challenges (i.e., advanced mastery of a challenging system) and toys can sometimes be used as tools to satisfy an existing need (e.g., Chao's PSDoom).

Challenge was found to be an important source of enjoyment in my user study with the prototype. One of the advantages of the Critter Controller was that it made the game more challenging to play because it required users to develop a new perceptual-motor skill. Participants in my study stated that the Critter Controller made the game more challenging, and therefore more fun to play. The challenge aspect of the game could be improved by offering a clearer goal and audio-visual feedback when the player's character hits an obstacle.

Chapter 2: Curiosity

2.1. Curiosity and the Collative Properties

Three of the participants in my study said that the most enjoyable part of playing with the prototype was discovering how the interface worked. Participant 1 said that his favourite part was "When you first pick it up [the Critter] and you try to understand the input to output relationship." Participant 5 gave a similar answer: "Learning to use the Critter Controller at the beginning, it was really fun." Participant 6 said that her favourite part of the experience was "The rabbit [i.e., the Critter Controller] and figuring out how it works and where the sensitive spots are." During his think-aloud session, Participant 4 also said that he enjoyed finding out how the Critter Controller worked, and said that finding out how the device worked was "half the fun." Two of the participants in the study also explicitly stated that they felt curious about the Critter Controller when they first encountered it: Participant 3 said "I'm just curious as to how to use it," and Participant 4 said "It peaks my curiosity." These responses indicate that curiosity and exploration were important factors that made the prototype fun to use. As I will discuss in this section, the Critter Controller evoked feelings of curiosity because of its novelty, and because it did not make its functionality immediately apparent to the user. This made users feel as though their knowledge of the device was incomplete, and motivated them to explore the interface in order to better understand it.

Daniel Berlyne (1966) defines curiosity as "the condition of discomfort, due to inadequacy of information, that motivates specific exploration" (p. 26). Berlyne says that curiosity is evoked by a stimulus's *collative properties*, which Berlyne (1966) says are "the properties that we designate by words like *novelty*, *surprisingness*, *incongruity*, *complexity*, and *puzzlingness*" (p. 30). Berlyne says "These are the properties for which I have suggested the term *collative*, since they depend on comparison or collation of stimulus elements appearing simultaneously in different sectors of a stimulus field or elements that have been perceived at different times" (p. 30). In other words, when we encounter an object or situation that possesses these collative properties, we sense that there is some conflict between what we are familiar with (from past experience) and what we are currently experiencing, and we begin to feel curious. George Loewenstein (1994) refers to this disparity between existing knowledge and current experience as an *information gap*. According to Loewenstein, "The proposed theory views curiosity as occurring when an individual's informational reference point becomes elevated in a certain domain, drawing attention to an information gap. Curiosity is the feeling of deprivation that results from an awareness of this gap" (p. 93). According to Berlyne (1966), feelings of curiosity motivate the individual to explore the curious stimulus in order to better understand it, and Berlyne (1966) refers to this behaviour as *specific exploration*.

To evaluate the effects of different collative properties on curiosity, Tieben, Bekker, and Schouten (2011) conducted a study with prototypes in a public space. Their study used "six prototypes, which we call *speakers*, which contained a webcam and a louspeaker" (p. 3). Each speaker was capable of producing sounds when someone was directly in front of it. Tieben et al. propose that "we can define five main principles for evoking curiosity: novelty, partial exposure, complexity, uncertainty, and conflict" (p. 2). Tieben et al. used different interaction arrangements to test the five collative properties (see Table 3). Their system was set up in a corridor of a student centre for five days, and on each day a different principle for evoking curiosity was tested.

#	**Principle being tested**	**System setup**
1	Novelty	Out-of-context animal sounds played when passerby walked in front of the speakers
2	Partial exposure	Fragmented sounds from films played when passerby walked in front of the speakers

3	Complexity	When passerby walked in front of the speakers random sounds were played
4	Uncertainty	Each speaker said a number when walked in front of, but occasionally one did not
5	Conflict (i.e., incongruity)	Each speaker had a coloured mat in front of it. Each speaker would say the colour that corresponded to the mat that was stepped on. The last speaker would always say the wrong colour.

Table 3: Tieben et al.'s five collative properties for stimulating curiosity.

As Tieben et al. state, some of the arrangements had overlapping principles at play; for example, every arrangement was inherently novel because the installation appeared out-of-place in the student centre, so the condition testing for *complexity* (see item #3 in Table 3) was both novel and complex. Insomuch as was possible, they attempted to isolate each of the collative properties so each experiment primarily tested one principle.

In the *novelty* arrangement, passerby heard scared farm animal noises when they came close to the speakers. “By creating a situation that is clearly out of context, we evoke curiosity through novelty. This means that something is new, or out of place, in a context where someone wants to know or feel 'what it is'” (Tieben et al., p. 5). After observing people interacting with the system, they concluded that “As expected, novelty works as a strong, but short evoker of curiosity” (p. 5). Similarly, novelty was an important collative property for evoking curiosity in my own prototype, since the Critter Controller was a novel interface. The novelty of the Critter Controller made participants feel curious about the device, and elicited a desire to explore the interface.

Partial information can be thought of as a strategy for evoking curiosity in which some piece of information is obviously hidden from the user. Anderson (2011) states that some user interfaces will explicitly tease the user with hidden information in order to entice the user to engage in specific behaviours. This approach can be seen on the dating website OkCupid, which tells the user that other members have rated them highly, but that in order to see who those members are they have to sign-up for a paid membership (Figure 15). To test this collative variable, Tieben et al. had their prototypes play fragments of movie dialogue when passerby walked in front of them. They wanted to see if the passerby would become curious about the missing portion of the dialogue and would interact with the system in order to try and hear the missing piece of information. They learned an important lesson: the user must be interested in the information that is missing. “We learned that the information, and the hidden part, must really 'trigger': the passerby should be interested in the information” (p. 6). The reason this principle works in the case of OkCupid is because the user probably has a strong interest in finding out who has rated them highly. The Critter Controller also elicited curiosity through by only revealing partial information about itself. Participants in the study could see that the device was connected to a computer, and was therefore some type of interface, but upon first encountering it they did not know how it worked. The signal conveying the partial information was the device's USB cord: the cord signified that it was a human-computer interface, but provided no information about how the device was used. The device didn't have any buttons or other interface elements that suggested how it could be used, and therefore the information about how it was used was effectively hidden from the participants in the study. Before playing the game, participants were shown an instructional video explaining how the device worked, but this did not appear to extinguish their desire to explore the interface. Even after they had been told how the interface worked, they still seemed keen on trying it out for themselves.

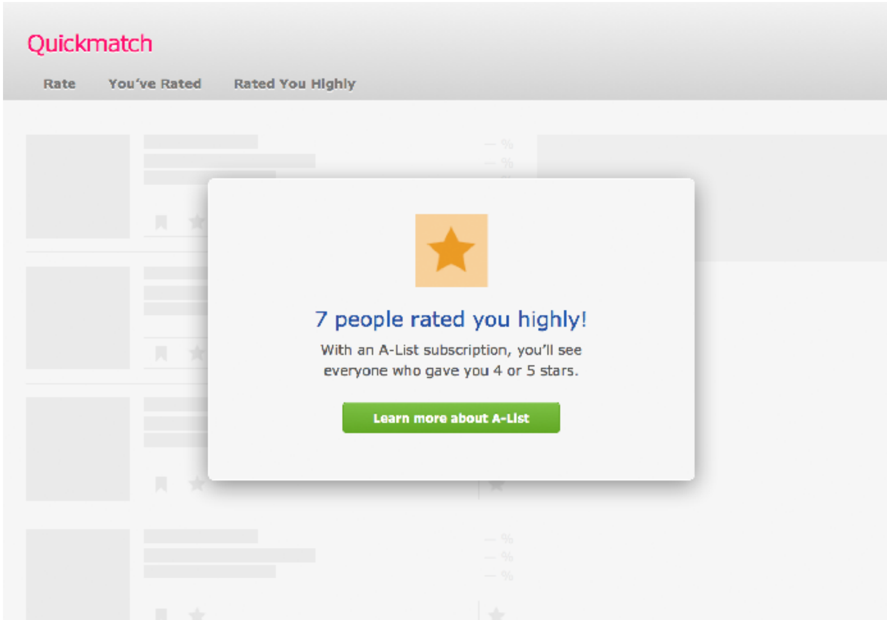

Figure 15: OkCupid's "see who rated you highly" feature

Norman (2011) says that *complexity* is the result of something having many "intricate or interrelated parts" (p. 2). Tieben et al. examined complexity's power to evoke curiosity by having their prototypes output random musical sounds in response to the gestures of passerby. According to Tieben et al., "The variable and ambiguous output elicited a lot of curiosity: passerby tried to find out 'how the system worked', and while doing this they discovered additional ways of interacting" (Tieben et al., p. 6). The interactive relationship in this arrangement was less simple to understand than the arrangement testing for novelty, where an action evoked a scared farm animal sound. However, it seems to me that this particular arrangement was actually more of an illusion of complexity than actual complexity, since there wasn't actually a relationship to be discovered between specific movements and responses. It seems to me that, as Norman's definition suggests, randomness is different from complexity because complexity implies that there are relationships and order amongst the many parts of the stimulus in question. Perhaps users in this experiment developed beliefs that certain types of movements evoked particular responses from the system, leading them to perceive it as being complex. Norman (2011) says that people tend to prefer a moderate level of complexity: stimuli which are neither too simple nor too complex. Berlyne (1966) also says that a moderate level of complexity will be the most conducive to pleasure. In terms of interaction design, if a system has too few features it may be considered too simple evoke curiosity, but if it has too many features it will be perceived as too complex. As Norman (2011) notes, the ideal amount of complexity is relative to the individual: “Moreover, the ideal level of complexity is a moving target, because the more expert we become at any subject, the more complexity we prefer” (p. 13). Malone's concept of *multiple layers of complexity* could be employed as a solution to help maintain curiosity over extended use, since, as was shown to be the case with Photoshop in Chapter 1, an interactive system could potentially feature a multi-layered design with multiple levels that increase in complexity. Once curiosity for one level has been satisfied, other levels will still remain to be explored.

Tieben et al. tested the collative property *uncertainty* using the following arrangement: “Walking through the corridor results in a sequence of numbers – 'One!' from the first speaker, 'Two!' from the second, and so on. One of the last speakers is quiet, not responding to passerby at all” (p. 6). Tieben et al. found that people did indeed become curious about why one of the speakers in the sequence did not respond to their presence by saying a number. However, users didn't find any resolution to their curiosity, and remained uncertain about why the number was omitted. Tieben et al. state that “From their comments, it seemed that they did not know if their expectations were wrong, or if the system was wrong” (p. 7). As Tieben et al. point out, uncertainty in this experiment was more like doubt about the system's status, and this doubt prompted people to explore the system to see if it was working correctly. “In general, many users (~20%) walked back and started to wave in front of the speaker. Some users even started to talk to the speaker and peers, usually ending with an ‘it must be broken’” (Tieben et al., p. 367). A different type of uncertainty results from chance outcomes. Anderson (2011) talks about the smart-phone application Urbanspoon as an example of an interactive product that employs chance-outcomes to make the experience of choosing a restaurant more fun. “Urbanspoon created an interesting twist on choosing a restaurant. Taking a cue from slot machines, it turns deciding where to eat into a playful experience” (Anderson, p. 75). To use the Urbanspoon application, the user shakes their smart-phone and the application outputs a random nearby restaurant. The user can shake the phone again to find a different restaurant, and the user can constrain the output results by locking-in a particular type of cuisine, price range, or location. With this type of uncertainty, the user is aware that some aspect of the outcome cannot be predicted, and they become curious to find out what the outcome will be. Urbanspoon, games of chance (e.g., slot machines, roulette), and systems that output random responses (e.g., Tieben et al.'s other experiment testing for complexity) are examples of activities and products that utilize this form of uncertainty to elicit feelings of curiosity.

To test incongruity[4] as a means of evoking curiosity in an interactive system, Tieben et al. placed coloured footsteps in the hallway of the student centre, and the system would say the colour of each footstep as it was stepped on. The last speaker, however, would always say the wrong colour, creating incongruity between the colour the user saw and the colour the system said.

> We created a conflicting situation by placing coloured footsteps on the floor in the corridor. Students passing a speaker would hear the colour they walked on, e.g. 'Red!' while walking on red footsteps. The last speaker always responded with the wrong colour, creating a mismatch between the real situation and the output from the system. (p. 4)

4 This is the property Tieben et al. have labeled *conflict* in Table 3, but it is the same principle Berylne refers to as *incongruity*. Berlyne (1966) actually uses the term *conflict* to describe the common quality that all the collative variables share: “What all the collative variables have in common to give them the motivational effects that they apparently share is an interesting but still debatable question. One hypothesis for which supporting arguments can be found is that these effects all depend on conflict between incompatible neural, and ultimately motor, reactions that are simultaneously mobilized” (p. 30).

Tieben et al. discovered that their arrangement testing for conflict (i.e., incongruity) evoked some puzzlement from passerby, and didn't evoke the level of exploration that the other experiments did. Passerby appeared to be confused about what the system was actually responding to: “Students assumed that the speakers responded to the colour of their clothes, and commented that the system was either smart (when correct), or stupid (when wrong)” (Tieben et al., p. 7). As was the case with their uncertainty experiment, passerby thought the system was malfunctioning when it didn't produce the expected response.

Figure 16: Life Lights at the River Market in New Westminster, British Columbia

2.2. Case Study: Curiosity and exploration in Rauscher & Thorogood's Life Lights installation

Life Lights (Figures 16 and 17) is an interactive public art installation created by artists Morgan Rauscher and Miles Thorogood that is on display in the

River Market in New West Minster, British Columbia (Rauscher, n.d., para 1). According to Rauscher, “The work has hundreds of color changing lights and a specialized sound environment that allow participants to play with the work like a musically illuminated sculpture” (n.d., para. 1). Visitors to the installation can evoke a response from the piece by touching sensors which are mounted on the guardrail surrounding the installation, causing the installation to display a pattern of lights and sounds. Thorogood says that the light display featured in Life Lights is based on a *cellular automation* algorithm (personal communication, February 28, 2013), which means that the activation of the lights begins at a single point in the array of lightbulbs and then spreads outward according to a specific formula. Using a four-channel sound system, the piece also creates the effect that the sounds are emanating outward in three-dimensional space from the point of activation (Thorogood, personal communication, February 28, 2013). By touching a particular point on the guardrail, the visitor can cause the chain reaction to begin at a particular point in the array of light bulbs, adding complexity to the interaction's design.

Figure 17: A hand touching the guardrail that activates Life Lights

Since the piece is installed in a public space, it likely evokes strong reactions of curiosity as a result of its novelty. As Tieben et al. state, any stimuli that seems sufficiently new or out-of-place in a particular context is likely to evoke strong reactions of curiosity. Complexity also plays a role in the installation's ability to evoke curiosity, and the artists had to try and provide the right level of interactive complexity for their audience. As Thorogood states, the installation had to be simple enough to be understood by both young children and adults, while still maintaining interest and encouraging exploration.

> We found this algorithm, and its audio and visual manifestation, worked well for the theme of the piece and audience interaction. That is, the spreading activation of the CA [cellular automation] when a person touches a sensor was obvious enough that the audience would feel as if they were 'making something happen'. Moreover, the fact that the algorithm took control of the activation after the touch added further cerebral investigation of the audience, if they chose to think about it. In the context of

> the mall audience, this type of interaction was flexible enough to be exciting and involving for children and adults. (Thorogood, personal communication, February 28, 2013)

The key feature adding complexity to the system is its ability to respond to being touched at different points along the guardrail, which causes the chain reaction of lights and sounds to begin at different points in the array. Myron W. Krueger (1977) says that responsive environments should be able to collect rich information about what the visitor is doing, and as we see in Life Lights, the system should use this information to respond in an intelligent or composed way.

> The distinguishing fact of the medium is, of course, the fact that it responds to the viewer in an interesting way. In order to do this, it must know as much as possible about what the participant is doing. It cannot respond intelligently if it is unable to distinguish various kinds of behavior as they occur. (p. 430)

Krueger says that “It is necessary that the output media be capable of displaying intelligent, or at least composed reactions, so that the participant knows which of his actions provoked it and what the relationship of the response is to his action” (p. 430). In the case of Life Lights, the relationship between the user's location around the guardrail and the point of activation with the array of lightbulbs provides visitors with an experience that is slightly more complex, and therefore more interesting, than if the system's response did not reflect the user's position along the guardrail.

2.3. Humour

As Malone (1981) states, a phenomenon closely related to curiosity is *humour*. Two of the participants in my study laughed when they first began playing the game with the Critter Controller. Participant 6 said “I find it very funny having to pet the Critter.” Following up on this comment, I asked “What do you find funny about it?" Participant 6 laughed and responded "I feel like I'm petting my cat!" Similarly, Participant 3 said "This is funny" when she first began playing the game with the Critter Controller. Rod A. Martin (2010) says "Berlyne suggested that humor is distinguished from these other types of experience by the brief time scale on which the arousal changes occur, the clues precluding seriousness that accompany it, and the extreme bizarreness of the collative variables involved" (p. 59). In other words, Berlyne believed that experiences which are strange, yet playful, will evoke laughter. This seemed to be why participants in my study found the Critter Controller funny: it is a deviation from the standard interface one would expect to play a game with, and using a petting gesture to control a character's movement is an unusual way to play a game.

Peter McGraw and Caleb Warren (2010) conducted a study to try and identify the qualities that make something funny, and found that "anything that is threatening to one's sense of how the world 'ought to be' will be humorous, as long as the threatening situation also seems benign" (p. 1142). The collative property *incongruity* is closely related to McGraw & Warren's theory of humour, and Berlyne (1957) says that incongruity occurs when an individual is confronted with a situation that features elements that shouldn't be compatible, and something seems out of place. Berlyne (1957) says "An important case of such conflict is *incongruity-conflict,* aroused by a stimulus pattern with characteristics which S [the subject] has been trained to regard as incompatible" (p. 400). To illustrate Berlyne's concept of incongruity, let's consider an experiment Berlyne (1957) conducted. Berlyne measured the amount of time subjects spent looking at illustrations of animals. Half of the images shown to participants featured illustrations of actual animals, while the other half featured illustrations of fictional hybrid animals (e.g., a lion with an elephant's head). Berlyne found that participants in his study spent more time looking at the incongruous images than the non-incongruous images, indicating that they were more curious about the incongruous stimuli. While this doesn't speak directly to how humorous the subjects found the incongruous animals, we do see this type of incongruity used to create humour, since strange juxtapositions are often very funny. The smart-phone application Face Swap is an example of a product that uses incongruity to create humour. Face Swap detects the faces of people in a photo, and then (like in Berlyne's experiment) swaps the faces of the people in the picture so they appear on the wrong bodies ("Face Swap", n.d., para. 1). By creating strange juxtapositions of apparently incompatible elements, this application creates funny pictures.

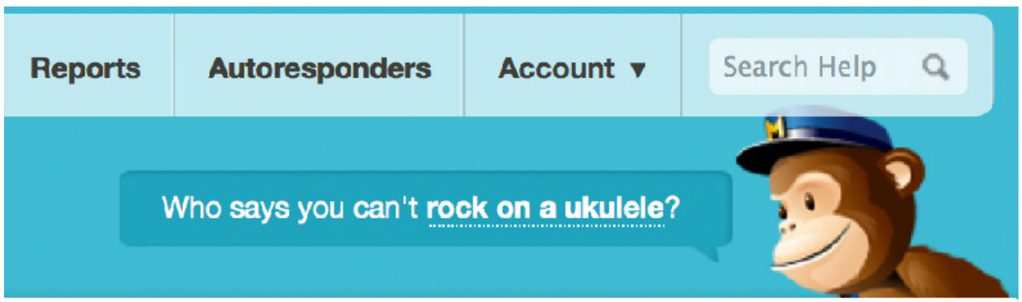

Figure 18: MailChimp

MailChimp (Figure 18) is an online service that allows users to maintain mailing lists and send emails to subscribers, and MailChimp's user interface designers have chosen to incorporate humour into the site's design. Anderson (2011) interviewed Aaron Walter, MailChimp's user experience architect, who says that "in general, people love our sense of humor, but as is true in the real world, when you let your personality come through you're bound to discover some people who just don't like you" (p. 70). The main humorous component of the website is the company's mascot, Freddie the Mail Chimp, who is "always present in the header" and "always exclaiming rather interesting phrases" (Anderson, p. 69). As can be seen in Figure 18, Freddie says funny things to the user via his speech bubble, and Walter says that they've "learned to scrutinize each greeting more closely to consider the various ways people might interpret it" (Walter in Anderson, p. 72) as a result of past jokes backfiring and being interpreted the wrong way. Anderson says that “humor is appropriate (or not appropriate) based on the situation” (p. 68). Anderson says that it can be worth injecting humour into an interactive experience to make it more fun, but cautions that in very serious contexts it might not be welcomed.

2.4. Curiosity: conclusions of study.

Berlyne and Loewenstein define curiosity as a feeling of discomfort resulting from an individual's awareness that their knowledge of a subject, object, or situation is incomplete. This awareness of missing information occurs when an individual encounters stimuli that possess collative properties such as novelty, complexity, partial information, uncertainty, or incongruity. When an individual feels curious they will engage in specific exploration in order to better understand the stimulus that has provoked their curiosity. Curiosity has the power to motivate specific behaviours and feelings of enjoyment in product users. Interfaces can evoke feelings of curiosity by presenting the user with a mystery, as we see with the dating website OkCupid. In this scenario, the product must draw attention to the fact that the user doesn't know a specific piece of missing information that would be of interest to them. Interactive products can also evoke curiosity by presenting the user with interactive environments for them to explore (which might be physical or virtual).

One of the reasons participants in my study found the Critter Controller fun to use was because it peaked their curiosity and gave them the opportunity to explore the interface and learn how it worked. The main collative variables that were at play in the Critter Controller appear to be novelty (i.e., a new and unusual interface) and partial information (i.e., they could tell it was an interface but didn't know what it did). The *petting* action required to use the interface was humorous to some participants in the study, and this humour was likely the result of incongruity, since the petting gesture seemed out-of-place in the context of using a human-computer interface.

Chapter 3: People & Characters

3.1. Playing with other people increases enjoyment

One participant in my study said that his favourite part of playing with the prototype was that it gave him the opportunity to have a conversation with another person (i.e., myself) while he played. When asked what part of the experience he found most enjoyable, he responded “You can have a conversation with someone while you play, it makes it fun. You could hang out with a friend and play because you're relaxed, you're doing something.” At another point in the session he also expressed a desire for a competitive element to the game, asking “What score did the other guy get?[5]” Multiple studies suggest that social interaction is indeed a strong source of enjoyment for video game players (Lazzaro, 2004; Weibel et al., 2008; Gajadhar et al., 2008), and that opportunities to cooperate or compete with other players can enhance the fun of playing a video game. Lazzaro (2004) refers to the social aspect of games as the *people factor*, a term she uses to denote the “enjoyment from playing with others inside or outside the game” (p. 5). According to Lazzaro, social interaction is such an influential factor in player enjoyment that players will even “play games they don't like so they can spend time with their friends” (p. 5). Sweetser & Wyeth (2005) also state that social interaction contributes to the fun of video games.

> The final element of player enjoyment, social interaction, does not map to the elements of flow, but is highly featured in the literature on user-experience in games. People play games to interact with other people, regardless of the task, and will even play games they do not like or even when they don't like games at all. (p. 4)

My prototype, being a single-player game, did not offer players the opportunity to interact with other people inside the game. However, as Participant 2 suggested, it might have been conducive to social interaction if multiple people were in the

5 By the *other guy* he meant the previous participant in the study.

same room as it was being played. Participant 2 thought that the game “might be more fun if it was on a projection screen in a museum where your friends are there and other people could be talking and having conversations as you're playing.” As an installation in a public space the game would become more conducive to social interaction, since players could take turns playing and the installation could potentially become a centrepiece for conversation.

David Weibel et al. (2008) conducted a study that examined how playing against another person in an online game influenced players' feelings of presence[6], flow state, and enjoyment. Participants in the study were asked to play a fantasy combat game[7] in one of two conditions: participants in the experiment group were told that they were playing against another human who was located at a computer in another room, while participants in the control group were told that they were playing against the computer (in actuality, both groups were playing against the computer). Everything else about the game was the same for both groups—the game was even programmed in such a way that players were guaranteed to lose the virtual battle. Weibel et al. found that “participants who played against a human-controlled opponent reported more experiences of presence, flow, and enjoyment” (p. 2274) than those who knew that they had played against a computer-controlled opponent. This study suggests that just knowing (or in this case, believing) that you are competing against another person can make the experience of playing an online game more enjoyable.

Gajadhar, de Kort, and Ijsselsteijn (2008) conducted a study that was similar to Weibel et al.'s, but Gajadhar et al. also sought to understand the influence of a co-located player on enjoyment (i.e., two competitors playing next to one another in the same room). Gajadhar et al. used a game called WoodPong

6 According to Lombard & Ditton (1997), *presence* refers to “an illusion that a mediated experience is not mediated” (p. 1). In other words, it's the sense that one is actually present in a virtual environment or other media experience.

7 The game in this study was a custom module built using the Aurora toolset found in Bioware Inc.'s game Neverwinter Nights.

(a remake of the classic paddle-and-ball game Pong) in their study, and tested the game in three different conditions: playing against a virtual player (i.e., the computer)[8], playing against another person who was located at a computer in another room (i.e., a mediated co-player), and playing against another person who was co-located next to the participant in the same room. Like Weibel et al., Gajadhar et al. found that players' feelings of enjoyment increased when they believed they were competing against another person who was located at a computer in another room, but in addition to this, Gajadhar et al. also found that player enjoyment increased even more when both players were playing against one another in the same room. According to Gajadhar et al., "Results indicate that, compared to playing against a virtual or mediated co-player, a co-located co-player significantly adds to the fun, challenge, and perceived competence in the game" (p. 116). Gajadhar et al.'s study also found that players experienced greater enjoyment when playing against a friend than they did when playing against a stranger, indicating that the participants' existing relationships affected how enjoyable they found the gaming experience. These two studies suggest that Lazzaro is correct in her assertion that the social aspect of games is an influential factor in player enjoyment.

One of the recurring themes of this thesis is that fun experiences often involve the intersection of multiple categories of enjoyment attributes. As was demonstrated in the studies just discussed, social interaction can intersect with *challenge* to create an even more enjoyable experience for players if they are able to compete or cooperate with one another on a challenging task. Social interaction can also intersect with curiosity if multiple users are able to explore curious elements together. Funky Forest (see Figure 19), an interactive installation created by artists Emily Gobeille and Theo Watson, is an example of an interactive system that combines opportunities to explore curious features with opportunities for

8 Participants in this group were told they were playing against the computer, but in actuality they were playing against another person who was located in another room (Gajadhar et al., 2008, p. 109).

social interaction. Watson (2007) says that "'Funky Forest' is an interactive ecosystem where children create trees with their body and then divert the water flowing from the waterfall to the trees to keep them alive" (para. 1). Upon encountering Funky Forest, children probably have questions, like "What does this do?" This curiosity compels them to play with the installation—seeing what responses different gestures provoke, moving the plush 'rocks' around, etc.—in order to better understand the interactive environment. Since multiple children can play together at once, they can explore the interactive environment together and share their discoveries. Funky Forest also features an element of challenge, since children have to try and divert the flow of (virtual) water to the trees in order for them to grow.

Figure 19: Funky Forest

Jordan (2000) discusses the *socio-pleasures* a product can offer, and defines socio-pleasure as "the enjoyment derived from relationships with others" (p. 13), a definition that is almost identical to Lazzaro's definition of the people factor in games. Jordan says that internet chat rooms and forums are examples of interactive products that are conducive to socio-pleasure because, like multiplayer games, they provide users with a virtual space in which they can socialize with other people. Jennifer Hart et al. (2008) conducted a user study to determine what qualities make Facebook such an appealing and popular application, and not surprisingly, found that users enjoy Facebook because it allows them to interact with other people. However, Hart et al. also found that curiosity plays an important part in the fun of using Facebook, and state that “Facebook takes advantage of curiosity by enticing users in to find out more about their friends though the numerous options on a profile page” (p. 473). From Hart et al.'s user study, it appears as though Facebook evokes curiosity in two ways: curiosity about content, and curiosity about other people. Hart et al. state that “An example of curiosity is when one user navigates to a friend’s profile due to an activity update shown on her newsfeed” (Hart et al., p. 473). In this scenario, the user becomes curious about a piece of content they have seen in their newsfeed, and they might navigate to a friend's profile in order to see what other interesting content that person has posted. Hart et al. also state that “Another interesting social aspect of curiosity that was commented on frequently in the interviews was that of keeping an eye on what friends are up to. This was often referred to as 'stalking' or 'page-stalking' or just being 'nosey'” (p. 473). In this second scenario, the user wants to find out details about another person, and will view another user's profile in order to learn more about them.

3.2. Identification with characters

Video games often require the player to play the role of a character. *Identification* is a term used to refer to the temporary experience of feeling as though you *are* the game character you are playing, and Dorothée Hefner, Christoph Klimmt, and Peter Vorderer (2007) state that “identification is proposed to contribute to the fun of playing a computer game” (p. 41). Hefner et al. conducted a study to explore the relationships between identification, interactivity, and enjoyment in video games. Hefner et al. tested two games in their study, a racing game and a first-person shooter game. Participants were asked to do one of two things: play a level of one of the games for six minutes, or watch a video of a game level being played for six minutes. At the end of six minutes, the participant was asked to fill out a questionnaire which assessed “their enjoyment experience, state of presence during the game, current self-concept and identification with the game character” (Hefner et al., p. 43). Participants who played the game were also asked to report how competent they felt they were at playing the game. Hefner et al. found that participants who played the game (versus those who just watched) reported higher levels of identification with the game's character, and found that identification was strongly correlated with their reported experiences of enjoyment. They found that the participants' self-concept (i.e., the degree to which they perceived themselves as having the same qualities as the game character they played) affected their ability to identify with the game's character, as did their sense of how competent they were at playing the game.

Anther study on identification in video games, conducted by Christoph Klimmt et al. (2010), also found a relationship between reported experiences of identification and reported experiences of enjoyment. Klimmt et al. used two methods to evaluate the degree to which participants experienced identification: implicit word associations (i.e., detecting identification without explicitly asking the participant how much they felt a sense of identification), and having the participant explicitly report how much they felt a sense of identification with the character they had played. Participants were also asked to explicitly state how much they enjoyed playing the game, but implicit associations testing for enjoyment were not used in this study. Peter Graf and Daniel L. Schacter (1985) give the following description of implicit versus explicit recollection: “Implicit memory is revealed when performance on a task is facilitated in the absence of conscious recollection; explicit memory is revealed when performance on a task requires conscious recollection of previous experiences” (p. 501). In other words, explicit recall involves directly asking participants about their experiences, while implicit evaluation methods attempt to assess the participant's experience without directly asking them about it. In this study, participants' experiences were implicitly evaluated by presenting the participant with a series of word-pairs and asking them to choose the word that they felt was most closely associated with the word *me*. “An implicit measure of associations between character-related concepts and 'me,' therefore, was applied in order to search for empirical evidence for video game identification as an automatic shift in self-perception” (Klimmt et al., p. 327). These implicit methods of measurement, however, did not seem to provide much insight in the players' experiences, though the explicit evaluation methods did reveal a relationship between identification and enjoyment. Klimmt et al. found that “explicit identification ratings displayed a considerable correlation with the enjoyment measure in both game conditions” (p. 330). However, they did not find “a direct link between (implicitly measured) identification and video game enjoyment,” and furthermore, “correlations between the implicit and explicit measures of identification were also low” (p. 333). Based on the correlation between participants' reports of identification and enjoyment in both Hefner et al. and Klimmt et al.'s studies, there appears to be support for idea that the experience of identification with a video game character contributes to the fun of playing a video game. In my own study, participants playing Relaxing Rabbit played the rabbit character, but I am uncertain if they experienced identification while playing this character. One participant in my study stated that he liked the way the rabbit “closes his eyes when he jumps,” and said that “it conveys that he's experiencing what you're experiencing.” This could be interpreted as a feeling of identification with the character, but I did not follow up on this with questions about his experience, so it is difficult to say for certain.

3.3. Para-social interaction with characters

Lazzaro (2005a) says that part of the enjoyment players derive from video games comes from their interactions with non-player characters in the game. We might refers to these interactions as *para-social interactions*, since they occur between an individual and a character, as opposed to the reciprocal human-to-human relationships we find in actual social interactions. The concept of para-social interaction was first introduced by Donald Horton and R. Richard Wohl

(1956), who argued that television and radio audiences respond to media characters and personalities “with something more than mere running observation” (p. 215). Horton & Wohl proposed that media audiences actually become participants in a type of simulated social exchange with the characters and personalities presented by the media. Horton & Wohl state that “This simulacrum of conversational give and take may be called *para-social interaction*” (p. 215). Christoph Klimmt, Tilo Hartmann, and Holger Schramm (2006) state that “in many cases, PSI [para-social interaction] with a media persona triggers specific experiential processes that viewers regard as enjoyment” (p. 305).

Some participants in my study expressed a desire for a para-social relationship with the rabbit character and/or the Critter Controller. Participant 3 said “I want it [the Critter Controller] to talk to me,” and Participant 5 said “You know what would be the coolest? If you pulled its fur and it made a yelping noise, or you could pet it and it would like it.” Participant 1 said that the game Nintendogs came to mind when he was playing Relaxing Rabbit with the Critter Controller. Nintendogs (Figure 20) is a game for the Nintendo DS system that allows the player to play with (and care for) a virtual dog or cat (“About the Game: Nintentdogs + Cats”, n.d.). Participant 1 thought that the Critter Controller could add to the fun of playing a game like Nintendogs because the furry interface would give the user “something you can pet” when interacting with a virtual animal. Nintendogs allows the player to interact with the dog (or cat) using a stylus (i.e., a plastic pen), but an interface like the Critter Controller could provide the haptic sensations associated with petting an animal, and this haptic experience would likely make the experience of petting a virtual pet more enjoyable (albeit less portable). Nintendogs can be considered an example of a game which is based on a para-social relationship between the player and the game's virtual pet characters.

Figure 20: Nintendogs

Interactive technology can add a new dimension of believability to para-social interactions because the characters featured in an interactive product can give dynamic responses to the user's actions, and as we see with Nintendogs, this can enhance the sense that the character is responding to specific things that the user has done. Para-social interaction can also vary in the degree of interactivity between the user and the character. Freddie the Mail Chimp (discussed in Chapter 2), for example, occasionally addresses the user by their first name in his speech bubble comments, which helps create the effect that Freddie is talking directly to the user. Although Freddie the Mail Chimp doesn't engage in complex interactive exchanges with the user, referring to the user by name probably does help create some sense of character-to-user conversation. This helps to shift the user's perspective from that of a third-person observer (i.e., someone observing the character) to that of a first-person participant in an interactive exchange with the character, even though the user is unable to talk back to the character. The Fijit Friend (Figure 21), an interactive character toy from Mattell Inc., is an example of a toy that uses interactive technology to create the effect of a conversational exchange with the child playing with it. A Fijit Friend can respond to questions and verbal commands from the child, and can say more than 150 different phrases ("Fijit Friends", n.d., para. 1). The toy can ask the child questions such as "What do you want to do now?" The child can respond by saying things like "dance" or "tell me a joke," to which the Fijit Friend will respond appropriately. Because it allows the child to have a conversational exchange with the character, the effect of para-social interaction is very strong.

Figure 21: Fijit Friend

Even if a product can't provide the experience of having a conversational exchange with a character, the addition of a character can potentially still enhance the fun of the product. Klimmt et al. (2006) state that "The vast majority of media entertainment is about people" (p. 291), so the addition of a character or personality to a product is likely to enhance the product's entertainment value, even if the level of interactivity isn't as sophisticated as that of the Fijit Friend or Nintendogs. Consider Robie the Banker, a mechanical piggy bank sold by Radio Shack (Figure 22). To use Robie, the user places a coin in his hand and Robie deposits the coin in his mouth, then chomps his mouth up and down a couple of times. A red mechanical tongue then comes out from his mouth, apparently licking his lips, as if to say “that was tasty.” The addition of a face, a body, and a name gives this simple mechanical device a personality, and turns it into something that is much more fun to use.

Figure 22: Robie the Banker

3.4. What was wrong with Clippy?

Clippit the Paperclip, also referred to as *Clippy* (Figure 23), was a feature that used to be included in the Microsoft Office suite. “Clippy was first included in the 1997 release of the Office suite and continued to be part of the product line until 2007 when it was permanently removed” (“Clippy”, n.d., para. 1). Clippy was intended to help users learn to use the Microsoft Office Suite, and Clippy would appear while the user was working to provide suggestions and links to lessons that were supposed to be relevant to the task the user was working on, which (in theory) would allow the user to reach their goals with greater ease (“Clippy”, n.d., para. 9). Hassenzahl and Blythe (2004) state that “the infamous winking paperclip in Word is clearly intended to be fun but most people find it annoying. It distracts rather than aiding in concentration” (p. 96). Luke Swartz (2003) says that the primary problem with the feature was that many users found that Clippy simply interfered with their work-flow, and rarely provided useful assistance. Swartz says that another part of the problem was probably that the default character Clippy, an anthropomorphized paperclip, wasn't very likable (although it did tie into the office theme of the software), but says that this was probably a smaller factor than its shortcomings as an assistant. “While it seems clear that Microsoft chose a relatively unpopular look for its character, it seems that the strongest user responses are unrelated to the paperclip character itself” (Swartz, p. 31). However, Chris Pratley (2004) says that Clippy was actually more popular with users than one might suspect, with as much as 50% of users actually liking the feature. “Many users told us that they really liked it and found it useful, something which technical people have a hard time believing, since they were the ones who pretty much uniformly didn't like the assistant. In terms of population, the numbers were split about 50/50 for/against its value” (Pratley, para. 16). It seems as though Clippy's major flaw was that it wasn't that useful to people who already knew how to achieve their goals with the software, and often didn't provide information that was relevant or useful to the task the user was working on. Swartz says that “If the anthropomorphic agent almost always presented useful information in an easy-to-understand way, perhaps it would not be annoying or distracting” (p. 14). Information which is not useful in helping the user achieve their goals is going to be experienced as a distraction, and distractions interfere with flow state, which detracts from user enjoyment. According to Pratley, one of the reasons that Clippy wasn't very helpful was because the Office Assistant software that was included in the Microsoft Office Suite was actually a limited version of what the developers had originally created and tested (para. 9).

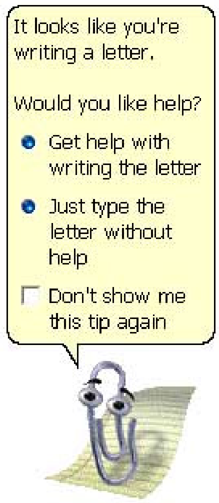

Figure 23: Clippit the Office Assistant

So what can be learned from Clippy? Freddie the Mail Chimp is another example of a character featured in a tool system, and according to Walter (in Anderson, 2011), Freddie has been well-received by most MailChimp users. Both characters are featured in a tool application, and both use speech bubbles to talk to the user, so why is there a difference in their popularity with users? The key difference seems to be the way they relate to the tasks the user is working on: since it rarely offered useful advice, Clippy was perceived as an annoyance who disrupted experienced the user's flow state, whereas Freddie is an additional feature which does not interfere or get involved with the user's work. Users have much more discretion in their interactions with Freddie: they can choose to ignore him and focus on their work, or they can choose to engage with him by reading his comments and clicking on the links to funny content in his speech bubble. Clippy may have been more well-received if it was either more useful in helping the user achieve their goals, or if it stayed out of the user's work-flow. The latter approach would have defeated its original purpose as an Office Assistant, but maybe Clippy would have been more successful as a fun-feature that wasn't related to work.

3.5. People & Characters: conclusions of study.

This chapter has explored the social aspect of fun in product use. The studies conducted by Weibel et al. and Gajadhar et al. indicate that players find it more fun to play competitive games against another person than they do against a virtual (i.e., computer-controlled) opponent. The *people factor*, or *socio-pleasure* as Jordan calls it, also contributes to enjoyment in other interactive products, including social media applications like Facebook. Social interaction can intersect with challenge if the product allows multiple users to compete in a task or cooperate on a task, and social interaction can intersect with curiosity if the product allows the user to explore things with other users, see content other people have posted, or if it allows them to learn more about other people. Facebook, for example, entices the user to find out more about the people on their friends list by exploring their profiles.

Hefner et al. and Klimmt et al.'s studies on identification with video game characters suggest that players enjoy the experience of temporarily feeling as though they are the video game character they are playing. Horton & Wohl's concept of para-social interaction was explored as a way of thinking about the interactions a user can have with a character. Para-social interactions put the user in a first-person relationship with the character; instead of observing the character from a third-person perspective, the user feels as though the character is speaking directly to them. The level of interactivity in these exchanges can vary: with Freddie the Mail Chimp, for example, the character talks to the user, but the user cannot talk back to the character. Mattell's Fijit Friend, on the other hand, does allow the user to talk back to the character and provoke a response. Characters employed in tool systems should not interfere with the challenge of accomplishing the task.

Opportunities for social interaction could make future iterations of the prototype more fun. Opportunities for social interaction could potentially take two different forms in the prototype: the first approach would be to present the game as an installation in a public space, allowing multiple people to take turns playing the game. The second strategy would be to create a version of the game that features two Critter Controllers, each controlling a separate character in the game. Using this approach, players could compete against one another in an attempt to get the highest score. This same controller arrangement could also be used for cooperative play, allowing players to work together to get a single high score which could then be displayed on a leaderboard. As was suggested by one of the participants in my study, the prototype could also be turned into a toy which emphasizes the para-social relationship the user has with the rabbit character. The Critter Controller would be an effective interface for such an application since it would provide the user with the haptic sensations of petting and holding an animal.

Chapter 4: Sensory Appeal

4.1. What makes a product visually appealing?

During the think-aloud sessions, three of the participants in my study stated that they liked the game's graphics. Participant 2 said “That's a cool tree at the beginning, I like it. The opening screen looks good, very clean and polished.” Participant 3 said “I like the graphics of it, they're cool,” and also said that she thought the game was “pretty cute.” Participant 4 simply proclaimed “I quite like your graphics!” None of the participants in the study made comments that suggested that they didn't like the game's graphics. The Critter Controller's appearance generated a lot of interest from participants, but none of the participants explicitly stated that they *liked* its appearance or found it attractive-looking. Participant 5 actually said that she found the Critter Controller unattractive, stating “It's ugly. It looks kind of like a skunk.” Participants 2 and 3 both said that the Critter Controller reminded them of Davy Crocket's hat, and Participant 6 said it reminded her of her pet cat. These responses to the Critter Controller's appearance might be interpreted as responses of interest, but not necessarily aesthetic pleasure. None of the participants in the study said that they found the Critter Controller *cute*, a reaction one might expect an object resembling a plush toy to evoke. Participant 1 suggested that “A face might add some personality” to the Critter Controller. Although my original goal was not to create a cute interface, a face could potentially enhance the interface's cuteness, which might make it more attractive to users.

So, what makes a product visually appealing? Norman (2004) discusses the concept of the *visceral level of response*, and proposes that there are specific qualities a product can possess which will make it appeal to the user's visceral (i.e., innate) sensory preferences. Norman uses the term *visceral level of response* to refer to an individual's innate predispositions to feel pleasure or displeasure in response to specific stimuli. Norman says that these preferences are genetically predetermined, sentiments which are echoed by Mihalyi Csikszenmihalyi & Rick Emery Robinson (1990): “In current terms, the claim would be that the central nervous system is genetically hardwired to experience pleasure when processing certain patterns of stimuli” (p. 12). Norman says that humans have evolved visceral preferences in order to feel attracted to objects and situations which are conducive to survival, and to feel repelled by objects and situations which represent a threat to survival. “We humans evolved to coexist in the environment of other humans, animals, plants, landscapes, weather, and other natural phenomena. As a result, we are exquisitely tuned to receive powerful emotional signals from the environment that get interpreted automatically at the visceral level” (Norman, 2004, p. 66). Norman says that symmetrical objects, rounded objects, smooth surfaces, and bright, saturated colours are examples of visual stimuli that people will tend to find viscerally appealing. The Little Tikes Discover Hammer (Figure 24) is an example of a children's toy that possesses many of the qualities Norman cites as viscerally appealing: it features smooth, rounded shapes, and bright, saturated colours. The smooth bumps on the handle may also be appealing to the child's sense of touch, giving it haptic (i.e., tactile) appeal. The toy also appeals to the child's sense of curiosity: the toy lights up and produces a variety of sounds when the child taps it on a surface, creating an interactive relationship for the child to explore.

Figure 24: Little Tikes' Discover Sounds Hammer

One of the viscerally appealing qualities Norman lists is *symmetry.* Rolf Reber et al. (2004) also state that humans have "an innate preference for symmetry" (p. 369), and suggest that people may find symmetrical objects attractive because they are easy for the viewer to mentally process, sentiments which are echoed by Paul Hekkert and Helmut Leder (2008).

> The reasons for a preference of symmetry are not fully understood. 'Reading' a symmetrical object is much easier than asymmetrical ones. Once you have seen half, you know what the other half is like. Thus, an important part of symmetry preference might be due to ease of processing. (p. 263).

If an object is symmetrical it takes less mental effort to process, and this ease-of-processing may contribute to the feelings of aesthetic pleasure we experience when looking at symmetrical objects. Another reason we might find symmetrical objects appealing is because symmetry can give an image or object a sense of visual *balance*. *Balance* is achieved when elements on the and left and right side of an image or object have equal visual weight. Bonnie Skaalid (1999) gives the following description of visual balance:

> To understand balance, think of a balance beam. When objects are of equal weight, they are in balance. If you have several small items on one side, they can be balanced by a large object on the other side. Visual balance works in much the same way. It can be affected not only by the size of objects, but also their value (i.e., lightness or darkness, termed visual weight). (para. 1)

Figure 25: 2012 Apple iMac Computer

The Apple iMac (Figure 25), for example, has a symmetrical design: the left and right sides mirror each other, and this symmetry gives its appearance visual balance. As Skaalid says, visual balance can also be achieved without symmetry. An object or image can be *asymmetrically balanced* if the elements on the left side and the right side have the same visual weight. Figure 26 demonstrates the concept of asymmetrical balance: the left side of the image features one large object that is balanced by four smaller objects on the right side.

Figure 26: A demonstration of asymmetrical balance

Norman (2004) also says that humans have an innate attraction to “bright, highly saturated hues” (p. 11). Patricia Valdez and Alberta Mehrabian (1994) conducted a study that examined the effects of colour on emotional responses, and found that a colour's brightness and saturation do indeed contribute to its ability to evoke feelings of pleasure. From their study, Valdez & Mehrabian concluded that “Pleasure was simply a joint positive function of color brightness and saturation, being influenced more by brightness than by saturation” (p. 406). An earlier study, conducted by Gerda Smets (1982), also found that brightness and saturation are the primary determinants of a colour's ability to evoke pleasure, however, Smets found that saturation had a stronger influence on pleasure than brightness. Both studies found that brightness and saturation have more of an effect on feelings of pleasure than a colour's hue.

> There is a positive relationship between saturation and pleasantness which determines 88.36% of the total variance of the pleasantness judgements. A similar relationship exists for brightness, although it is less important (11.53%). The influence of hue is negligible (0.68%). It is striking that the least known color attribute has the greatest impact on color pleasantness. Needless to say, this finding does not necessarily imply generalizations to color preferences for specific objects or even another set of color stimuli. (Smets, p. 1163)

Smets found hue to be a negligible factor on pleasure in her study, but notes that "nevertheless, there is some degree of consistency running through color preferences. The most preferred hue has repeatedly turned out to be blue, with red placing a close second" (p. 1159). Like Smets, Valdez & Mehrabian found that blue was the most preferred hue among adults, but Valdez & Mehrabian did not find that red rated highly in terms of pleasure. According to Valdez & Mehrabian, "Blue, blue-green, green, red-purple, purple, and purple-blue were the most pleasant hues, whereas yellow and yellow-green were the least pleasant" (p. 394). Another study on colour preferences, conducted by Russell Adams (1987), looked at the colour preferences of adults and infants and found that "on the average, the order of adults' preference among the four elemental chroma is blue, red, green, and yellow" (pp. 143-144). Adams also discusses the findings of a large-scale colour preference study conducted by Helson and Landsford (1970) and summarizes their findings:

> In perhaps the most systematic of color preference experiments, Helson and Lansford (1970) evaluated the subjective pleasantness of 125 Munsell colors. Adults' ratings (N=156,250) were obtained under a wide variety of viewing conditions, including variations in brightness, saturation, chroma, background contrast, field size, and source of illumination. Overall, adults rated blues and greens highest, yellows lowest, and reds intermediate. The ratings reported by Helson and Lansford, and previously by Guilford, are typical of those found in the literature: Among the elemental chroma, the order of adults' preference is blue, green or red, and yellow. (p. 114)

Once again, blue was shown to be the most popular colour among adults and yellow was the least popular. An international study conducted by Thomas Madden, Kelley Hewett, and Martin Roth (2000) looked at the colour preferences of "undergraduate students in East Asia, Europe, North America, and South

America,” (p. 94) and “found that the colors blue, green, and white are all well liked across countries and share similar meanings” (p. 100). These studies suggest that while brightness and saturation are the primary determinants of pleasure, hue also has an effect, and adults tend to prefer shorter wave-length colours (with blue being the most popular). Adams (1987) also found that infants hold different colour preferences than adults, stating that “3-month-olds preferred the long-wavelength (red and yellow) to the short wavelength (blue and green) stimuli” (p. 143). Adams found that newborns did not hold preferences for particular hues, but did prefer coloured stimuli to achromatic stimuli. Saturation, brightness, and hue are therefore all variables that influence feelings of pleasure when viewing specific colours, and these variables might influence our preferences for products that feature colour in their designs.

Figure 27: Blueberry-coloured iMac G3

Norman cites the Apple iMac G3 computer (Figure 27) as an example of a product that became more popular because of its use of colour. “Apple Computer found that when it introduced the colorful iMac computer, sales boomed, even though those fancy cabinets contained the very same hardware as Apple's other models, ones that were not selling particularly well” (Norman, 2004, p. 68). In accordance with the colour studies just discussed, the blueberry-coloured iMac G3 was the most popular of all the available colours Apple had on the market. Jim Davis (1999) of CNET.com talks about the popularity of the blueberry-coloured iMac G3:

> And a pecking order has already been established among the new models, an imbalance in availability that could cause tension for dealers and customers. Blueberry is tough to find, but there are plenty of strawberries around. Tangerine, meanwhile, is big in Denver, home of the NFL champion Broncos and their legion of orange-clad fans. (para. 2)

In this example, the popularity of the blueberry-coloured iMac might be attributable to an innate preference in adults for the colour blue.

4.2. The elements and principles of art and design

Allan Pipes (2003) says that "Line, shape, texture, space, motion, value, and colour are the principal elements of art and design" (p. 13). To make an object or image aesthetically appealing, these elements are skillfully arranged by an artist or designer using the principles of art and design. Pipes lists *unity*, *harmony*, *balance*, *scale*, *emphasis*, and *rhythm* as six principles of art and design.

> The principles of arranging and organizing the elements from Part 1 into an aesthetically pleasing composition have been developed over centuries, either intuitively or according to mathematical or quasi-scientific methods. Here we present a guide to the principles of unity and harmony, balance, scale, emphasis, and rhythm. (p. 173)

To explore the principles of design, let's examine how they are employed in the Google Play Music Tour webpage[9] to make the page visually appealing. One of the reasons I have selected this page as an example is because it won the 2012

9 URL: http:// music.google.com/about/tour

Webby Awards's *People's Voice Winner* award in the category of *Best Visual Design – Aesthetic* (“The Webby Awards Gallery + Archive”, 2012). The Google Play Music Tour page, shown in Figure 28, gives users a tour of the Google Play Music application for Android smart phones.

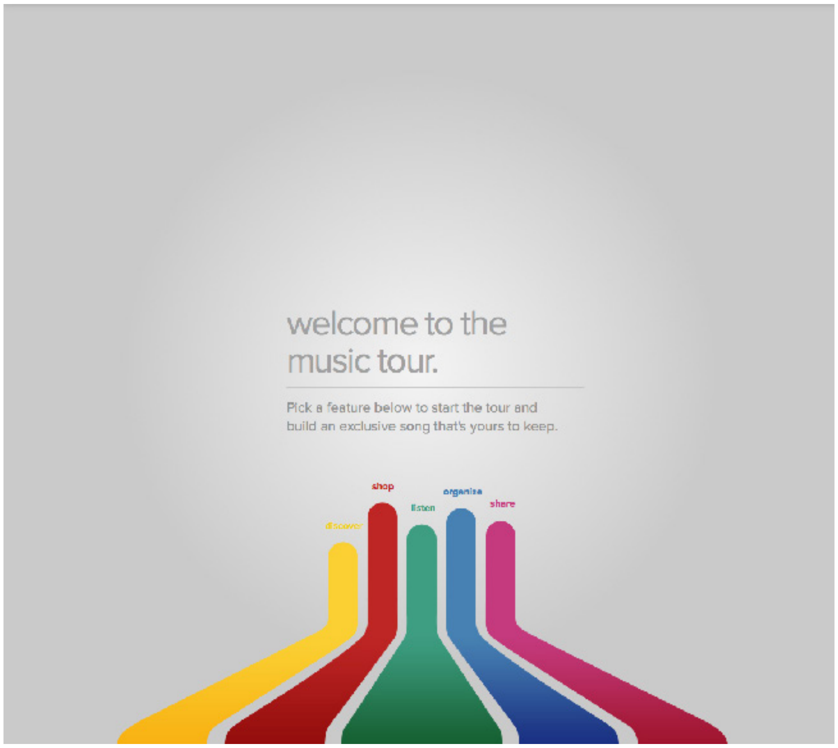

Figure 28: Google Play Music Tour

One of the features that makes this page attractive is its use of colour. The colour palette is saturated and bright, and all the colours work together in harmony. The previously discussed studies looked at the variables that affect a single colour's ability to evoke feelings of aesthetic pleasure, however, products often utilize multiple colours in their designs, so it is necessary to consider the ways that colours can work together in harmony to create aesthetic appeal. According to Rolf Kuehni (2004), colour harmony is “the combination of color elements in a work of art or craft so that the total effect is perceived as being in concord” (p. 185). Of course, the question then becomes “Which colours work well together to create a sense of harmony?" Kuehni says that many colour models have been developed with the intention of identifying harmonic relationships among colours: "Of the dozens of color systems proposed in the last 300 years, the majority have been developed with the idea that its particular form would be suitable to derive harmonic laws" (p. 163). Keuhni says that the modern colour wheel (Figure 29) is based on opposing, or *complimentary*, colours that are thought to work well together to create a sense of harmony and aesthetic appeal.

> A principle of harmonious colors based on complimentaries was described in 1793 by Benjamin Thompson, the Count of Rumford. He proposed that colored lights are harmonious if together they combine to white. Although Rumford only applid this rule to lights, it was soon also taken to apply in principle to colorants. (p. 163)

One can find the compliment of a given colour by finding the colour that opposes it on the colour wheel. For example, red is opposed by green, making red and green a complimentary pair. These two colours provide strong contrast with each other, and should create a sense of harmony when used together. Laurie Schneider Adams (2002) says that "hues directly opposite each other on the wheel (red and green, for example) are the most contrasting and are known as complimentary colours. They are often juxtaposed when a strong, eye-catching contrast is required" (p. 20). Using the colour wheel, one can also identify many other colour-relationships which are thought to be conducive to aesthetic appeal. For example, a less contrasting strategy for achieving colour harmony is the *analogous colour scheme*. According to www.tigercolor.com, "Analogous color schemes use colours that are next to each other on the color wheel. They usually match well and create serene and comfortable designs" ("Color Harmonies: Complimentary, Analogous, Triadic Color Schemes", n.d., para. 5). While complimentary colour schemes emphasize the contrast between two colours, analogous colour schemes emphasize the similarity of the colours in the palette.

Figure 29: Colour wheel

More complex colour harmonies can be achieved by using schemes such as the *triadic*, *split-complimentary*, or *tetradic* colour schemes, which are named for the shapes their relationships form on the colour wheel ("Basic Color Schemes", n.d.). Figure 30 shows how these colour schemes are derived from the colour wheel. From my analysis, the Google Play Music Tour page is based on a triadic colour scheme. Triadic colour schemes are based around three main colours which form an equilateral triangle on the colour wheel (see Figure 30). Figure 31 is a colour wheel that shows the relationships of the five colours used for the Google Play Music Tour page[10]. Green, violet, and yellow form an equilateral triangle, creating the triadic relationship that forms the foundation of the page's colour palette. Red and blue, which are analogous with violet and green respectively, complete the five-colour palette and create contrast with yellow. Because of this contrast, yellow becomes the most dominant colour on the page.

10 To create this colour wheel map I simply put selected the colours from the vertical portion of the coloured bars and input the colour values into a colour wheel software application.

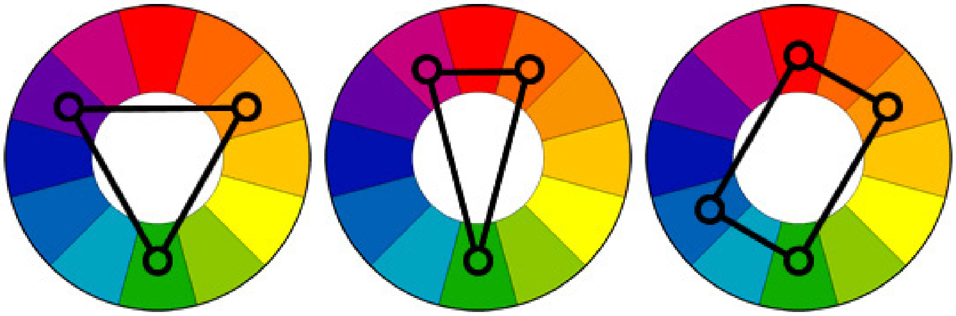

Figure 30: Triadic, split-complimentary, and tetradic colour schemes

The Google Play Music Tour page also employs some of the other principles of design discussed by Pipes. The page is symmetrically balanced: the left side of the page very closely mirrors the right side of the page. The design principle *rhythm* is also employed, since the rounded tops of the coloured lines form a rhythmic visual pattern. Pipes says that “rhythm depends on contrast, which may be between horizontal and vertical lines, between geometric and biomorphic shapes, or between slow, smooth, and fast, hectic transitions as the eye is directed around the picture” (p. 246). Finally, a sense of visual depth is achieved through the use of *perspective*, which creates the effect of three-dimensional space in a two-dimensional image. Pipes says that “perspective is a way of introducing systematic distortions into drawings to symbolize reality. Objects appear to diminish and converge as their distance from the viewer increases” (p. 90). The coloured lines appear to recede and converge as they move backwards into the picture plane, creating the appearance of visual depth. By thoughtfully employing the principles of design in order to arrange the page's visual elements, the page's designer(s) have succeeded in creating an aesthetically appealing web page.

Figure 31: Colours used on Google Play Music Tour page

4.3. The influence of novelty and familiarity on visual appeal

Preferences for symmetry, rounded shapes, and bright, saturated colours may be the result of innate predispositions, but as Norman (2004) states, people also develop new preferences beyond their visceral preferences with experience. The idea that people can develop preferences for stimuli with repeated exposure is evidenced by studies on the *mere-exposure effect*, which was first described by psychologist Robert Zajonc (1968). Hekkert & Leder (2008) give the following summary of Zajonc's mere-exposure effect:

> While William James and Gustav Fechner, both pioneers of psychology in the nineteenth century already assumed that 'familiarity breeds liking', it was in 1968 that Robert Zajonc provided a systematic empirical study of this phenomenon. In a seminal paper he reported evidence, from a number of sources, that mere exposure to a stimulus increases its aesthetic appreciation. (p. 267)

In one experiment, Kunst-Wilson and Zajonc (1980) examined the effects of repeated exposure on subjects' preferences for irregular octagonal shapes. The experiment had two goals: to evaluate the effects of repeated exposure on the subjects' preferences for the shapes, and to see if this effect would still happen even when participants could not remember which shapes they had already seen. In the first portion of the experiment, participants viewed a series of irregular octagonal shapes. In the second portion of the experiment, participants were shown a series of pairs of octagons, which consisted of an octagon they had been shown in the first portion of the experiment and one they had not yet been shown. The participant was asked to select which of the two octagons they had already seen, and which of the two octagons they liked the best. Kunst-Wilson & Zajonc found that participants tended to like the octagons they had already seen in the first portion better than the new octagons, even though they were unable to remember which of the octagons they had already been shown (their attempts to identify which ones they had already seen were shown to be no better than chance guesses). According to Kunst-Wilson & Zajonc, “Individuals can apparently develop preferences for objects in the absence of conscious recognition and with access to information so scanty that they cannot ascertain whether anything at all was shown” (p. 558). This indicates that an individual's preferences for particular visual stimuli can be affected by repeated exposure, and that this effect can occur even if the individual is unable to explicitly recall which stimuli they have already been exposed to. In relation to product design, Hekkert & Leder state that our preferences for a product's aesthetic qualities can be influenced by our past experiences with products like it. “Thus, in order to create objects that people like, a straightforward recommendation could be to refer to existing, familiar solutions” (Hekkert & Leder, p. 267). However, Hekkert & Leder also state that this approach to achieving aesthetic appeal has several limitations.

> However, repeated exposure has its limitations and will at a certain point (often after 20 repetitions) lead to over-exposure and saturation, and, consequently boredom. Furthermore, Bornstein's review (1989) showed that the

> effect of repeated exposure depended on the type of stimulus, being strongest for simple patterns, weak for real objects/persons, and was often not found with artworks and complex drawings. (p. 268)

Based on Hekkert and Leder's discussion, the effect of repeated exposure on aesthetic preferences can range from weak to strong depending on the stimulus. This effect also wears off with enough repetitions, since people can grow tired of objects they have been overexposed to. Therefore, while familiarity can be conducive to aesthetic appeal, on its own it is probably not an effective strategy for making a product look good.

Interestingly, Berlyne (1970) found that people tend to prefer objects which are novel, and found that novelty was tied to feelings of both curiosity aesthetic pleasure. On the surface, these findings appear to contradict Zajonc's findings indicating that familiarity breeds liking. Zanjoc himself observed that the "most pronounced source of ostensibly contradictory results is in the area of exploration and curiosity" (1968, p. 21), and goes on to say that "there is impressive evidence today that in a free situation the subject (human or animal) will turn toward a novel stimulus in preference to a familiar one" (p. 21). Hekkert & Leder also state that "Biederman and Vessel (2006) claim that as our brain has evolved in order to understand the world, it derives pleasure from processing new and unfamiliar objects," and that "at various occasions people look for novel or original instances and especially children have a bias towards novelty in their early ages" (p. 269). So, is it better if a product is perceived as novel by a user, or will familiarity be more conducive to aesthetic appeal? To reconcile these contradictory findings, Hekkert & Leder suggest that "designers need to find a balance between innovation and novelty (advanced) and a certain amount of typicality (acceptable)" (p. 270). Hekkert and Leder discuss the *Most Advanced Yet Acceptable* (MAYA) principle (first proposed by industrial designer Raymand Loewy) as a way of achieving a balance between novelty and familiarity, and argue that this balance will be most conducive to aesthetic appeal. Glenn Porter (in Loewy, 2002) gives the following description of Loewy's approach to product aesthetics:

> There were other criteria in Loewy's aesthetics. Designs must avoid what he called parasitic aspects such as noise, bad odors, glaring lights, hard or rough surfaces, and harsh colors. Ease of maintaining and cleaning, and built-in safety for use by careless consumers, also counted. The latest materials and current styles helped make a product modern and up-to-date, but consumers also had a legitimate psychological need for the familiar and the comfortable: the new must not be jarring or disorienting. The ultimate responsibility of an industrial designer was to create a product that would succeed in the marketplace, and therefore consumers must never be forced beyond the point where the novel and known elements balanced. The point was characterized by his famous acronym, MAYA – the Most Advanced Yet Acceptable principle. (pp. xxii-xxiii)

To test Loewy's principle, Hekkert, Snelders, and Wieringen (2003) conducted an experiment involving "various products, such as telephones and teakettles" (Hekkert & Leder, p. 270), which ranged from very typical to very novel in appearance. Participants were asked to rate the products in terms of "typicality, novelty, and aesthetic preference" (Hekkert & Leder, p. 270). Hekkert et al. found that participants did indeed tend to rate products which they perceived as neither too typical nor too novel as being the most aesthetically pleasing.

> In full accordance with the MAYA principle, Hekkert et al. found independent effects on aesthetic preference of both novelty and prototypicality, and these effects were nearly equally strong. Thus indeed, attractive designs comprise a thoughtful balance between novelty and typicality. (Hekkert & Leder, p. 270)

Hekkert et al.'s study demonstrates that novelty and familiarity are both factors in the aesthetic appeal of products. A product's attractiveness is therefore at least partly a function of the user's perception of how novel or familiar the product is. With regards to this dimension of a product's appearance, Loewy's MAYA principle serves as a good rule-of-thumb.

Loewy's MAYA principle is also supported by the findings of Berlyne (1970), since Berlyne says that a moderate level of novelty or complexity is most conducive to both the *pleasantness* and *interestingness* of a stimuli. Berlyne found that stimuli which were too novel or complex tended to be rated as unpleasant, while stimuli that were too familiar or not very complex tended not to evoke feelings of pleasure. Berlyne illustrates this theory of the relationship between novelty, complexity, and pleasure using a graph he refers to as the *Wundt curve* (Figure 32). According to Berlyne, an object's ability to evoke pleasure is directly tied to its ability to increase or decrease an individual's level of arousal. According to the Wundt curve, the greatest level of pleasure results from a moderate level of arousal. Berlyne says that if an object is highly novel it will evoke feelings of displeasure at first, since it will boost arousal to a very high level, but as it becomes less novel it will also become more pleasant. “A high degree of novelty means a high degree of arousal potential, so that, as a stimulus becomes becomes familiar and loses its novelty, we must imagine ourselves moving along the horizontal axis of the Wundt curve from right to left” (Berlyne, 1970, p. 284). Berlyne also says that the same holds true for complex stimuli: “Our findings support our hypothesis that the hedonic value of complex stimuli tends to rise as they become less novel while the opposite holds true for simple stimuli” (p. 284). Nico H. Frijda (1986) questions whether or not it is the change in arousal level that affects feelings of pleasure, and says “there is no reason why the pleasures and displeasures of collative stimuli should be linked to arousal rather than directly to that arousal's cause” (p. 346). In other words, Frijda thinks that it may be the collative properties themselves that evoke feelings of pleasure, whereas Berlyne says that it is the increase in arousal (as a result of the collative properties) that evokes feelings of pleasure. From my literature review I have not found a definitive answer that explains this pleasure mechanism, however, I do believe that Berlyne is correct in his assertion that a moderate level of novelty or complexity will be most conducive to pleasure, since this was demonstrated in his studies and in Hekkert & Leder's study.

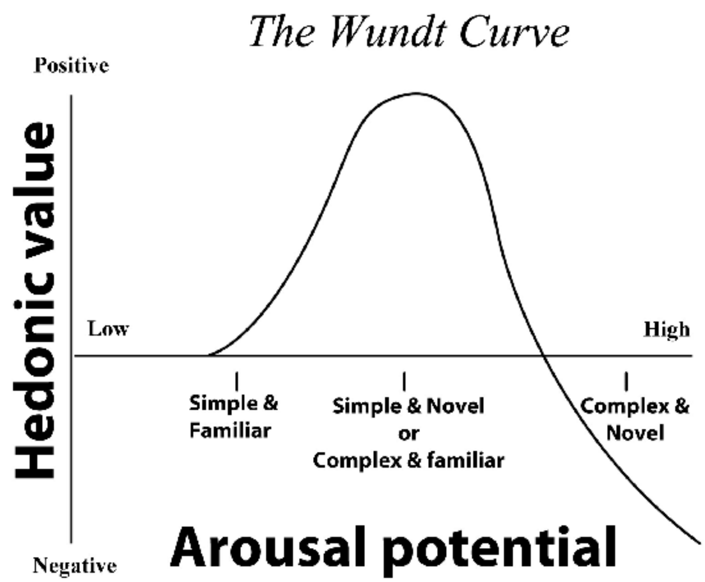

Figure 32: The Wundt curve

4.4. Does aesthetic appeal enhance usability?

Norman (2004) says that users perceive products they find aesthetically pleasing as being easier to use, and cites studies conducted by Masaaki Kurosu & Kaori Kashimura (1995) and Noam Tractinsky (1997) as evidence of this effect. Kurosu & Kashimura produced 26 different designs for an automated teller machine and had subjects evaluate the apparent usability and aesthetic appeal of the designs. Kurosu & Kashimura state that a "total of 252 subjects were asked to rate these two aspects on ten point rating scales, i.e. how much they look to be easy to use (apparently usable) and how much they look beautiful" (p. 292).

According to Kurosu & Kashimura, “A relatively high correlation (0.589) was obtained between these two scales which suggests that the apparent usability is somewhat related to aesthetic aspect of the layout pattern” (p. 292). Kurosu & Kashimura's study was re-created by Tractinsky (1997) to see if the effect was culturally dependent (Kurosu & Kashimura conducted their study in Japan, Tractinsky conducted his study in Israel). Tractinsky found that the effect was actually stronger in his study with Israeli participants, and came to the following conclusions:

> This study was designed with the prospect of demonstrating that high correlations between aesthetics and perceived usability are culture specific. It was expected that the correlations in Israel would be lower than those obtained in Japan. Surprisingly, the results indicated the opposite. This leads to three major conclusions: First, aesthetic perception and its relations to HCI relevant constructs *are* culturally dependent. Second, our current knowledge limits our ability to accurately predict how culture influences HCI related issues. Third, the results provide further support for the contention that perceptions of interface aesthetic are closely related to apparent usability and thus increase the likelihood that aesthetics may considerably affect system acceptability. (p. 121)

Another study, conducted by Manfred Thuring and Sascha Mahlke (2007), used cell phone designs that varied in appearance and also found the same influence of aesthetic appeal on perceived usability. “The data revealed a trend for an influence of the factor aesthetics on the perceived usability rating, but showed no influence of the factor usability on attractiveness ratings. This result points in the same direction as the study by Tractinsky et al. (2000), but more data are required to clarify the connection between perceived usability and aesthetics definitively” (Thuring & Mahlke, p. 259). These studies indicate that attractive products (at least initially) tend to be perceived as having better usability.

Similar to Norman's argument that users perceive aesthetically pleasing products as being easier to user, John M. Carroll and John C. Thomas (1988) argue that users tend to perceive systems which are fun to use as being easier to use. John M. Carroll and Sandra A. Mazur (1986) conducted a usability study in which six participants (staff members working in a research laboratory) learned how to use Apple's personal computer the Lisa. Participants in Carroll & Mazur's study used LisaProject (project planning software) to plan a schedule for the construction of a three-bedroom house. Carroll & Mazur found that their subjects actually had a rather difficult time learning to use the Lisa. According to Carroll & Mazur, “The only reasonable view seems that in spite of pertinent and timely research and development work, the Lisa interface was formidably difficult, even for professionals with some computer experience” (p. 47). Carroll & Thomas point out that the Lisa was hailed by many as a breakthrough in ease-of-use and ease-of-learning, but the results from Carroll & Mazur's study indicated that the system probably wasn't any easier to learn how to use than existing computer interfaces on the market at the time (e.g., the Apple II). Carroll & Thomas concluded that there must be some tendency for users to confuse the qualities *fun* and *ease* when describing an interactive system. Alistair Sutcliffe (2009) calls this influence of fun or aesthetic appeal on perceptions of usability the *halo effect*, in which a “judgement of one quality can spill over into another” (p. 4). As Daniel Kahneman (2011) describes it, this halo effect can happen when our initial impression of a person (or in this case, a product) influences our judgements of other attributes of the person or object. “The halo effect discussed earlier contributes to coherence, because it inclines us to match our view of all qualities of a person to our judgement of one attribute that is particularly significant. If we think a baseball pitcher is handsome and athletic, for example, we are likely to rate him better at throwing the ball too” (Kahneman, p. 201). From the studies discussed in this section, it seems evident that the halo effect is at play in our perceptions of product usability: products that are attractive or fun will tend to be perceived as easier to use.

Norman (2004) also argues that when a user finds a product aesthetically pleasing they will be better able to overcome difficulties in reaching their goals using the product. This part of Norman's argument has its roots in the research of psychologist Alice Isen, who found that people tend to be better at finding effective solutions to problems when they feel happy. In one experiment, Isen, Daubman, and Nowicki (1987) had participants attempt a creative problem-solving test called the *Duncker candle problem*. In this test, invented by Karl Duncker (1945), the subject is presented with three boxes: one containing three candles, one containing thumb tacks, and one containing matches. The subject is told they have to fasten the candles to the wall in such a way that the wax from the candles will not drip onto the ground when the candles are lit. Subjects might try and fix the candles to the wall using the tacks, or they might try to adhere the candles to the wall by melting them with the matches, however, neither of these methods will solve the problem of the candle wax dripping onto the floor when the candles are lit. The solution to the problem, which is not immediately apparent, is that the subject must use the tacks to fasten the boxes to the wall and place the candles inside the boxes, thus preventing the wax from the candles from dripping onto the floor when the candles are lit. Because the solution involves using the less-prominent objects (i.e., the boxes used to contain the other objects), arriving at the solution involves some creative problem-solving. Isen et al. wanted to see if people would be better at finding the solution to the candle problem when they were in a state of positive affect (i.e., when they felt happy). To manipulate subjects' emotional states, Isen et al. gave participants in the experiment group a small gift (candy wrapped in gift wrap) before having them attempt to solve the candle problem, while participants in the control group received no gift. Isen et al. found that participants were more likely to find the solution to the candle problem when feelings of positive affect had been evoked by giving the participant the small gift, and found that other means of manipulating positive affect before the creative problem-solving task (e.g., having the subject watch a short comedic film) produced the same results. Isen et al. (1987) state that "Results of these four studies taken together show that positive affect, induced by a comedy film or small gift of candy, can facilitate creative responding on tasks usually thought to reflect creativity" (p. 1128). Norman argues that the same effect observed by Isen et al. could influence a product user's ability to find solutions to problems they encounter when using a product.

> These and related finding suggest the role of aesthetics in product design: attractive things make people feel good, which in turn makes them think more creatively. How does that make something easier to use? Simple, by making it easier for people to find solutions to the problems they encounter. With most products, if the first thing you try fails to produce the desired result, the most natural response is to try again, only with more effort. In today's world of computer-controlled products, doing the same operation over again is very unlikely to yield better results. The correct response is to look for alternative solutions. (Norman, 2004, p. 19)

The studies conducted by Kurosu & Kashimura (1995), Tractinsky (1997), and Thuring & Mahlke (2007) all indicate that users' initial perceptions of usability are influenced by aesthetics, but none of them looked at the influence of aesthetics on the user's ability to accomplish tasks with the product. A recent study conducted by Andreas Sonderegger et al. (2012) also found a relationship between aesthetic appeal and initial perceived usability in cell phones, but after analyzing the users' behaviours over a two week period, did not find a relationship between aesthetic appeal and task-completion time or task-completion rate. Sonderegger et al. state that "these findings do not support our second hypothesis in which it was assumed that aesthetics would have an influence on measures of user behaviour" (p. 725). These findings do not support Norman's hypothesis that aesthetic appeal should result in improved task completion.

Norman's hypothesis does make sense in theory, but more user studies are required to say conclusively whether or not aesthetics affect the user's ability to find to solutions to problems they encounter when using a product. I propose a novel experiment to determine the validity of Norman's hypothesis: create prototype interfaces which are intentionally challenging to accomplish tasks with and vary the aesthetics of each of the prototypes, then test these prototypes in a usability experiment. Using these prototypes would be akin to solving the Duncker Candle Problem: the user should not be able to immediately understand how to accomplish the task they are being asked to perform, and finding the solution would require creative problem-solving. The prototype, for example, could be a cell phone that does not make it immediately obvious how the user could add a new contact to their contact list. Users in the study would first be asked to rate the interface in terms of aesthetic appeal, then they would be asked to perform the task (e.g., entering a contact into the phone's contact list) in a given amount of time. If Norman's hypothesis is true, we should see that the interfaces which are rated as most attractive also have the highest success rate in completing the task.

4.5. Haptic Appeal

One of the goals of the Critter Controller was to create an interface which appealed to the user's sense of touch, or *haptic sense*. Some participants' comments from the think-aloud sessions indicate that they enjoyed touching the Critter Controller as they played the game. Participant 1 said that using the mouse to play the game was "less tactile, everyone is used to using a mouse." Participant 2 said "Because I had stuffed animals as a kid, maybe that's what gives me the compulsion to want to touch it." At one point during the think-aloud session, Participant 5 declared "I like this part" and squeezed the Critter Controller's tail. Participant 3 thought that the "whole name, Relaxing Rabbit, makes more sense with the tactile element." Participant 1 said he wanted to know if the controller could produce different vibrations to indicate different events in the game (it did not). Participant 3 said “I like how this vibrates,” indicating that she found the vibrating sensation pleasant. From these responses, it appears as though the tactile qualities of the Critter Controller did indeed evoke feelings of pleasure in some participants.

According to Dzmitry Tsetserukou and Alena Neviarouskaya (2010), “Affective Haptics is the emerging area of research which focuses on the design of devices and systems that can elicit, enhance, or influence the emotional state of a human by means of sense of touch” (p. 72). An example of such a device is the HaptiHug interface, which was produced by Tsetserukuo (2010) to augment and enhance the experience of communicating with another person in an online environment (see Figure 33). “Driven by the motivation to enhance social interactivity and emotionally immersive experience of real-time messaging, we developed a novel haptic hug display producing realistic force feedback through an online communication system” (Tsetserukuo, 2010, p. 341). The HaptiHug prototype consists of a vest that the user wears that is capable of exerting a squeezing pressure on the wearer's body which is similar to that of being hugged by another person. The HaptiHug vest works in conjunction with Second Life, allowing the wearer to experience the sensation of being hugged when another person's avatar hugs theirs. By simulating affectionate social touching, the HaptiHug prototype is capable of eliciting feelings of pleasure in the user, and restores some of the haptic sensations of social interaction to online communications.

Figure 33: The HaptiHug prototype

Some touchscreen interfaces, such as the Samsung Galaxy S III smart phone, can provide the user with vibrational feedback in response to onscreen button presses (“Keyboard Options On Your Galaxy S III”, n.d., para. 28). A study conducted by Rock Leung et al. (2007) examined the usability benefits of a mobile touchscreen device that offered vibrational feedback when the user touched onscreen elements with their finger or a stylus. According to Leung et al., “Our haptically augmented progress bars and scroll bars led to significantly faster task completion, and favourable subjective reactions” (p. 374). This suggests that the use of haptic feedback in touchscreen devices can enhance usability, since users in this study were able to complete tasks more efficiently. Leung et al.'s prototype was capable of outputting a variety of vibrations that varied in amplitude and frequency, but touchscreens that offer more sophisticated haptic feedback are currently being developed. One example is a prototype from Immersion Inc., called the Touchsense Haptic Screen. The Touchsense Haptic Screen is intended to provide sensations of texture when the user touches objects on the screen, and achieves this effect through the use of tiny motors positioned under the surface of the screen that can be individually actuated. A video demonstration shows the prototype's ability to simulate the tactile sensations of rough and smooth surfaces[11], and its ability to simulate the sensation of shaking dice in a cup. The ability to simulate texture could enhance usability since the tactile sensations of textured buttons and interface elements would likely allow the user to accomplish tasks faster and with fewer mistakes. Simulated textures could also enhance the fun of games and toy applications used on touchscreen systems, since as we see in the Touchsense Haptic Screen's dice-shaking example, simulated tactile textures could be used to add realism to virtual elements.

4.6. Sounds

My prototype's soundtrack seemed to be successful in adding a relaxing ambience to the game, and was generally well-received by participants in the study. Participant 1 commented that the game had "Nice relaxing sounds in the background." Participant 2 said "I like the music," and Participant 3 said "the music is very appropriate with the [name] 'Relaxing Rabbit'." However, after several rounds of play participant 3 said that she found the music a bit repetitive. She also said "I like how there are Critter Noises—they're like magic noises." Participant 4 said that he liked the sounds that the game made when the rabbit collected flowers. When asked what part of the experience he found most enjoyable, Participant 4 replied "Definitely the sound." According to Participant 4, "The game wouldn't be half of what it is without the sound. It wouldn't be the same without that ambience." Participant 5 commented that "the music is too intense," and went on to say "I guess I feel like this music is trying too hard to be relaxing." She also thought that it might be more relaxing if the game just featured nature sounds without the musical component (i.e., the cello and piano track). This participant also said that she liked the noises the game made when the rabbit collected flowers. Participant 6 said "I like the piano music, I feel like I could just fall asleep to it or just put it on and read a book." These responses indicate that the

11 Video URL: http://www.youtube.com/watch?v=bZq3bCGlrjA

game's use of sound made the experience more enjoyable for participants in the study, and that the soundtrack made the game more relaxing.

Sound and music are often employed in video games to enhance the atmosphere of the game and to provide the player with information and feedback about what is happening onscreen. Inger Ekman (2005) distinguishes between two classifications of sounds found in video games: *diegetic sounds* and *nondiegetic sounds*. These classifications come from theatre and film studies, and describe the perceived origins of a sound that the audience hears. David Neumeyer (2009) says "At their most basic level, the initial terms in these binaries refer, respectively, to spatial and temporal relations between image and sound: the anchoring of sound in the physical world depicted in the film, its diegesis, on the one hand, and the appropriate or apparently natural coordination of sound with a moving image, on the other" (p. 26). Ekman says that diegetic sounds "are real within the game world and signify events or information that is real in the game" (p. 2). In my prototype, the nature sounds (i.e., flowing water, crickets chirping, etc.) could be considered diegetic because they appeared to emanate from sources within the game world. The musical sounds in my prototype, on the other hand, did not appear to originate from some identifiable source within the game world, and can be considered examples of nondiegetic sounds. Ekman says that "in most games, background music is non-diegetic. Like in movies, the player accepts the symphonic sounds as something from outside the story and does not anticipate finding an orchestra perched on a nearby hilltop or balcony" (p. 3). Ekman says that there are cases where the sounds used in games will fall outside of this binary, including the sounds he refers to as *symbolic sounds*.

> Symbolic sounds have diegetic referents, but the actual sound signals are non-diegetic. These kinds of sounds are very common in computer games. One example is the use of music to accompany the player's actions in the game. These sounds relate to events in the game, while the

signals remain non-diegetic. (p. 3)

For example, in my prototype a sound was played each time the player collected a flower. These sounds were musical (i.e., a random synthesizer note played when the player got a point), but were also representative of an action that was occurring in the game world. Ekman also says that there is often room to interpret whether or not a sound is emanating from inside or outside the game world. Ekman says that the sounds in the game Pac-Man are an example of this, and says that they may be "considered diegetic or non-diegetic, depending on how we choose to interpret the maze world in which Pac-Man exists" (p. 4).

Jordan (2000) says that "product sounds can give useful information about the state a product is in" (p. 107). These feedback sounds can enhance the usability of a product and can also be a source of pleasure for users. A cell phone's ringtone, for example, lets the user know that they are receiving a call or message, but might also be a pleasant sound or song that the user likes hearing. Debbie Stone et al. (2005) say that user interfaces can use sounds to reinforce the visual components of the interface, confirm successful completions of operations, and to draw attention to events such as errors. I believe that the affective (i.e., emotional) character of a particular sound is an important consideration when deciding what sounds should accompany particular events. An error message might be accompanied by an arousing (but not necessarily highly pleasant) sound to indicate a problem and draw attention to itself, while the successful completion of an operation might be accompanied by a pleasant and slightly arousing sound, which would reflect the excitement and positivity of successfully completing an operation. Operations which aren't that exciting, like clicking on links or buttons, might be accompanied by feedback sounds that are pleasant but not necessarily highly arousing.

Johnathan Effrat et al. (2004) conducted a study that examined which sounds people like and dislike. Effrat et al. found that people tended to dislike sounds which are associated with “disruptions (e.g., alarms, beeps, car crashes) or sadness (e.g., a woman sobbing)” (p. 65), and found that sounds relating to “escapism (e.g., fantasy chimes, birds singing) and pleasure (e.g., children laughing)” (p. 65) tended to be rated as the most pleasant by participants in their study. Another study, conducted by Margaret M. Bradley and Peter J. Lang (2000), produced similar results: subjects rated sounds pertaining to escapism as the most pleasant (e.g., baseball stadium sounds, a beer can being opened, roller coasters, etc.), and subjects tended to rate sounds relating to disruptions or threats as being the least pleasant (e.g., weapon sounds, a baby crying, a dog growling, etc.). Bradley & Lang also found that different sounds evoked different levels of arousal. For example, the sound of a cardinal chirping was found to be less arousing than the sound of a roller coaster, though both were similar in terms of average ratings of subjective pleasantness. A sound's potential for evoking feelings of pleasure and arousal might make it conducive to provoking particular behaviours from the user. Alarms, for example, are intended to move people to action, and aren't intended to sound pleasant. In this context, an unpleasant but highly arousing sound might be the best choice because it will be the most conducive to getting people to take the desired action (e.g., fleeing the scene, getting a heavy sleeper to wake up). Toys intended to help infants relax or go to sleep, on the other hand, will benefit from the use of relaxing sounds that will soothe the child and help them fall asleep. Fisher Price's Precious Planet Projection Mobile (Figure 34) is an example of this. This product features nature sounds, gentle music, and a sound intended to replicate that of being in the mother's womb (“Fisher-Price 2-in-1 Precious Planet Projection Mobile”, n.d., para. 1). These sounds are pleasant but not very arousing, which will help the child fall asleep.

Figure 34: Fisher-Price's Precious Planet Mobile

4.7. Smells & Tastes

Finally, interactive products might evoke feelings of sensory pleasure if they can appeal to the user's sense of smell or taste. Yasyuki Yanagida (2008) says that “among the so-called 'five senses,' only olfaction and gustation (sense of taste) have been left unexamined. These unexploited sensations are chemical senses, whereas the relatively well-developed interfaces (visual, auditory, and haptic) are related to physical stimuli” (p. 65). According to Yanagida, it is difficult to implement interfaces that produce smells and tastes because these senses are dependent on chemical stimuli being delivered to the user's nose or mouth. Another challenge lies in creating a system that can produce a variety of scents or tastes, and can deliver these scents in a controlled way so that they can be synced with the presentation of audio, visual, and haptic stimuli. In spite of how rare they are, some olfactory and gustatory displays do exist.

As Yanagida points out, one example of an entertainment simulator ride that makes use of olfactory stimuli has existed for over fifty years: Morton Heilig's Sensorama machine. The Sensorama is “a simulator for one to four people that provides the illusion of reality using a 3-D motion picture with smell, stereo sound, vibrations of the seat, and wind in the hair to create the illusion” (“InventorVR”, n.d., para. 1). An article from www.3dfocus.co.uk gives the following description of the types of fantasy experiences the machine offers the user:

> The two minute films cost 25 cents to view and were played in a loop. They consisted of a series of journies, including a motorcycle ride through Brooklyn (complete with seat vibrations mimicking the motor of the bike, the smell of baking pizza and voices of people walking down the sidewalks—you can see the Pan-Am building, symbolic of the era) and a view of a belly-dancer (with whiffs of perfume). The other titles were DUNE BUGGY, HELICOPTER and A DATE WITH SABINA, all of which he produced, directed and edited. (“World's First Virtual Reality Machine Yours for $1.5 Million”, 2013, para. 4).

One of the things that makes this machine remarkable is its ability to release specific smells at specific points in the film in order to compliment what the user sees, hears, and feels (i.e., haptic sensations), which helps to add believability to the fantasy experience. Currently there are no commercially available olfactory displays on the consumer market, but several prototypes are being developed by researchers (Yanagida, 2008). One such prototype, created and tested by Yanagida et al. (2004), is capable of shooting a burst of scented air at the user. One of the highlights of this system is that it can place a scent at a particular point in space relative to the user, creating the effect that the smell is coming from a particular direction. Having the ability to place smells in space allows for such effects as seeing a peach on the left side of a computer screen and smelling the scent of a peach coming from that direction. Olfactory displays like this could potentially add another dimension of sensory experience to entertainment media, thereby making these experiences more immersive for the audience.

One example of a consumer product that uses scents to create a multi-sensory fantasy experience is the Peaceful Progression Wake Up Clock (Figure 35) from Hammacher Schlemmer Inc. The company's website gives the following description of the alarm clock:

> More gentle than traditional jarring alarms, this clock uses gradually increasing light, stimulating aromas, and peaceful nature sounds to awaken sleepers. At 30 minutes before wake-up, the clock's light begins to glow softly, brightening over the next half-hour. The device can simultaneously release aromatherapy scents into the air to stimulate the olfactory senses. Fifteen minutes before wake-up, the clock generates your choice of six nature sounds (inlcuding ocean surf, thunderstorm, white noise, spring rain, mountain stream, and forest stream). The cycle concludes with a chime (that gradually increases in volume) to wake the most stubborn sleepers.
> ("The Peaceful Progression Wake Up Clock", n.d., para. 1)

The alarm releases scents by heating up aromatherapy beads or oils. Like the Sensorama machine, scents are used to enhance the fantasy experience the product offers. Hassenzahl (2013) discusses a very similar product, the Philips Wake-up Light, and says that this fantasy element is part of what makes the product enjoyable for the user. The Philips Wake-up Light, like the Peaceful Progression Wake Up Clock, features a light that gradually increases in brightness and nature sounds (e.g., birds chirping) that gradually become louder as wake-up times approaches ("Wake-up Light", n.d., para. 1). These two alarm clocks simulate the experience of waking up to the sun rising and the birds chirping (or in the case of the Peaceful Progression Wake Up Clock, possibly some other natural scene). Hassenzahl refers to this as a *surrogate experience*, since it is a simulation of an experience one could actually have. By incorporating scents related to the particular fantasy being offered (e.g., ocean water), the Peaceful Progression Wake Up Clock adds another dimension of simulation to the fantasy experience.

Figure 35: The Peaceful Progression Wake Up Clock

Gustatory (i.e., taste) interfaces, like olfactory interfaces, depend on chemicals being delivered to the user in order to create the desired sensory experience. Gustatory interfaces pose a unique challenge because they are necessarily invasive: some portion of the device will have to go into the user's mouth in order to deliver the chemicals to their taste buds. Hiroo Iwata (2008) says that “Although humans can taste a vast array of chemical entities, they evoke few distinct taste sensations: sweet, bitter, sour, salty, and 'umami'” (p. 291)[12]. Iwata also says that “another important element of food taste is texture” (p. 292), so an interface simulating taste should also be able to simulate the texture of a food. Iwata discusses a novel prototype that delivers flavoured liquid into the user's mouth and provides resistance as they bite down on the flavour-delivery mechanism in an attempt to simulate texture when chewing. To test the

12 Iwata says that “umami” is a Japanese word meaning “savory” (p. 91).

prototype's ability to simulate various foods, Iwata et al. (2004) conducted a user study in which users tried the prototype and were asked which food they thought was being simulated. Iwata et al. found that the majority of participants were able to identify which food was being simulated (87% in one experiment, and 96% in another). Another taste interface prototype created by Takuji Narumi et al. (2011) used visual and olfactory sensations to alter the taste of a cookie, giving the prototype the ability to simulate the taste of a variety of cookies. “Based on this concept, we built a 'meta cookie' system to change the perceived taste of a cookie by overlaying visual and olfactory information onto a real cookie” (p. 127). The prototype they tested consisted of a head-mounted display that the user wore (see Figure 36), and cookies with QR codes on them that the camera on the head-mounted display could read. Each QR code corresponded to a specific flavour of cookie. Through the head-mounted display the user was shown a video feed from a camera mounted on the headset. The appearance of the cookie was changed by overlaying an image of a different cookie onto the meta cookie, and the scent of the virtual cookie was delivered to the user's nostrils via a small fan. By augmenting the cookie-eating experience with additional visual and olfactory stimuli, Narumi et al. were able to change the user's perception of the cookie's taste. Narumi et al. state that “the results suggest that our system can change a perceived flavor, and lets users experience various flavors without changing the chemical composition by only changing the visual and olfactory information” (p. 130). Both of these prototypes attempt to create a simulated taste experience for users. Taste interfaces like these might have a place in the design of future virtual reality systems, complimenting to the systems' visual, audio, and haptic stimuli.

Figure 36: Narumi et al.'s taste simulation system

4.8. Sensory appeal: conclusions of study

Products can evoke feelings of pleasure by engaging the user's senses. Factors that influence a product's visual attractiveness include its viscerally appealing qualities (symmetrical shapes, smooth surfaces, bright colours), the way the designer has employed the principles of art and design to arrange the visual elements, and the perceived novelty and/or complexity of the product's appearance. The Most-Advanced-Yet-Acceptable principle was discussed as an approach for balancing novelty and familiarity in order to make the product more appealing. Products can appeal to the user's haptic sense by offering pleasant tactile sensations, which might include soft/furry surfaces (e.g., the Critter Controller), vibrating sensations, and sensations that simulate affectionate social touching (e.g., the HaptiHug interface). Sounds used in video games and other virtual environments can be classified as diegetic (i.e., coming from sources within the game world), nondiegetic (e.g., music and sounds not appearing to emanate from sources within the game world), or symbolic (i.e., sounds associated with events in the game, but not appearing to emanate from sources within the game world). People tend to enjoy sounds relating to escapism, and tend to dislike sounds relating to disruptions and threats. However, context is also a factor that will determine which sounds are appropriate for a particular interactive experience; for example, players might enjoy disruptive or threatening sounds in the context of a first-person shooter game or a horror game (e.g., Left 4 Dead), and unpleasant or highly arousing sounds can serve a purpose in certain systems (e.g., alarms) if they motivate desired behaviours (e.g., fleeing the scene). Interfaces can potentially appeal to the user's olfactory and gustatory senses if they can deliver scents and tastes to the user, but sophisticated olfactory and gustatory displays currently only exist as prototypes. Simpler implementations of interfaces that appeal to the user's sense of smell are possible (as is demonstrated by the Peaceful Progression Wake Up Clock), and the use of olfactory sensations can help immerse the user in a fantasy scenario.

Sensory feedback can enhance the usability of a product: Leung et al. found that vibrational feedback improves task-completion time, and sounds can be used to provide the user with feedback and information about the product's current state (e.g., that a button has been pressed, that they have received a message, etc.). Because of the halo effect, a product's appearance can influence the user's perception of how easy it is to use. After reviewing the literature, I did not find any studies confirming Norman's hypothesis that users will be more effective at overcoming usage difficulties when using an aesthetically appealing product (versus an unattractive product), but further user studies are required to confirm or disprove this idea. I have proposed that such a study might involve creating prototype interfaces which would require creative problem-solving to accomplish a specific task with, and that by producing prototypes with varying aesthetics we can evaluate aesthetic appeal's influence on the user's ability to overcome difficulties when using the product.

Participants in my study found the prototype to be enjoyable in part because of its sensory appeal. Participants commented that they liked the game's graphics, enjoyed its sounds, and enjoyed the haptic sensations of touching the Critter Controller and feeling its vibrational feedback. Future iterations of the prototype would likely benefit from a less-repetitive musical score.

Conclusion

Summary of findings

This thesis has explored factors that contribute to enjoyable user experiences through a discussion of the literature and a user study with a prototype. Four categories of enjoyment factors have been discussed: challenges, curious attributes, the social aspect of the product (i.e., people and characters), and way that the product engages the user's senses. This thesis has also explored the relationship between usability and enjoyment. A usable product may be conducive to feelings of enjoyment if the user can use it to perform a task they find stimulating. As Shneiderman (2003) and Jordan (2000) have argued, there is a hierarchy of user needs: products must be functional, then reliable, then usable, then offer additional pleasure features. Even if the task itself is already fun to do, the product will likely become even more enjoyable through the inclusion of additional pleasure features, so long as they don't distract from the task itself. Clippy the Office Assistant, for instance, was discussed as an example of a feature that distracted from the task, and therefore detracted from enjoyment for many users. This thesis has also discussed a phenomenon known as the *halo effect*, in which a user's judgement of one dimension of a product influences judgements of other aspects of the product. Because of this effect, products which are aesthetically attractive or fun to use are often perceived as also being easier to use. Further user studies are required to determine if users are better at overcoming product-usage difficulties when using products they find the product aesthetically appealing.

Fun vs. Relaxation

When I created my prototype, I intended to provide the player with an experience which would be both relaxing and fun. However, after reviewing the responses of participants in my study and the literature, it seems paradoxical that a game could be both relaxing and fun at the same time. Participants in my study said that playing Relaxing Rabbit with Critter Controller made the game more challenging, and therefore more fun, but also said that this increase in challenge made the game less relaxing. The difference between fun and relaxation might be thought of as a difference in the arousal level associated with each of these emotions. While both are pleasurable (and might both be considered forms of enjoyment), fun activities are characterized by an increase in arousal, while relaxing activities are characterized by a decrease in arousal. So, was Relaxing Rabbit actually relaxing, or was it fun? Ultimately, when played with the Critter Controller, I believe the game was more fun than relaxing. The design of the game was simultaneously pulling in two different directions: the audio and graphics were intended to be relaxing, while the challenge of the task (i.e., the difficulty of mastering a new perceptual-motor skill) and the novelty of the interface were fun. The difficulty of the task likely increased the player's arousal level, detracting from relaxation but increasing the fun of the game. Likewise (as Berlyne's theory of curiosity suggests), the novelty of the Critter Controller probably also contributed to an increase in arousal, once again pushing the experience more towards fun than relaxation.

Understanding fun and relaxation as a dichotomy is consistent with the models of emotional responses I have discussed in this thesis. Three models for understanding emotional responses have been discussed in this thesis: Csikszentmihalyi's flow model, Russell's circumplex model of emotions, and Berlyne's theory of hedonic value based on the Wundt curve. In all three of these models, emotional reactions vary in terms of pleasure and arousal. In flow activities, we see an increase in feelings of pleasure and arousal in the individual. Likewise, Berlyne says that stimuli which possess collative properties (which evoke feelings of curiosity) can also elicit an increase in feelings of pleasure and arousal. We might think of both of these experiences (flow state and curiosity) as relating to the emotion *excitement*, since Russell's circumplex model of emotions describes excitement as a state in which the individual experiences feelings of both arousal and pleasure. Therefore, we might associate fun activities with feelings of excitement, while relaxing activities, as Russell's model describes, represent a form of enjoyment characterized by feelings of pleasure and low arousal.

The Critter Controller was more fun because...

All six participants in my study stated that they found it more fun to play Relaxing Rabbit with the Critter Controller than with the computer mouse. The Critter Controller was demonstrated to be a better controller for this game than a standard computer mouse because it added challenge to the game, provoked curiosity and exploration of the interface, related to the character featured in the game, and appealed to the user's haptic sense with its furry texture and vibrating feedback. Because the Critter Controller added so much fun to the experience of playing the game, future iterations of the game might take the form of a public installation where players can use the Critter Controller to play the game (as opposed to, say, an online version where they would have to play the game using their computer mouse). As an installation, the game would also be more conducive to socio-pleasure, since multiple people could be present as it is being played and could take turns playing the game.

Opportunities for improving Relaxing Rabbit

Participants in my study enjoyed playing Relaxing Rabbit, especially using the Critter Controller, but opportunities to improve the game were discovered. The game would have benefited from having a clearer goal for the player to work towards, and a few possible improvements to the game's goal have been identified in this thesis. For instance, the implementation of a feature that remembers the player's past high scores and ranks their skill-level would provide a clearer goal for the player to work towards. The implementation of a leaderboard (that shows the highest scores attained by anyone who has ever played the game) would also provide a clear goal for the player since it would tell the player what score they have to beat, and would also add a competitive aspect to the game. The implementation of game levels is another strategy that could enhance the game, since levels would provide hierarchical goals, a progressive increase in the difficulty of the game, and opportunities to explore new game environments. The game would have also benefited from audio and visual performance feedback to let the the player know when their character hit an obstacle. These features would likely enhance the game's ability to keep the player in flow state, therefore making the game more fun to play.

Next steps in product enjoyment research

While the four categories discussed in this thesis are certainly the ones that appeared the most frequently in the literature on user enjoyment that I have reviewed, they by no means represent an exhaustive list of enjoyment factors. There are likely other factors which contribute to user enjoyment beyond the four discussed here. Malone (1981) cites fantasy as a factor contributing to enjoyment in video games, and suggests that the implementation of fantasy and metaphor in tool systems could potentially help make routine or mundane operations more fun to perform. For example, he suggests that “certain kinds of factory control operations (e.g., monitoring a steam engine) could be presented to the user as more captivating 'virtual tasks' such as flying an airplane full of passengers onto a dangerous landing field” (p. 67). This approach could be worth exploring through a user study; for instance, it could be possible to produce two user interfaces, one with a fantasy element and one without, and conduct a user study to see which one participants enjoy more.

Another area of enjoyment that merits further exploration is the *horror* or *thriller* genre of games and entertainment experiences. In such entertainment experiences, the emotion *fear* – which we typically regard as unpleasant – can actually be enjoyable. The arousal increase that comes with feeling afraid is probably one of the key reasons that scary experiences can be fun, but what conditions must be in place so that the experience evokes feelings of pleasure instead of displeasure? Also, in what different ways can feelings of fear be evoked in the context of an interactive product?

A third area worthy of exploration is enjoyment resulting from product customization. Many products allow the user to alter or customize the product in some way (e.g., allowing the user to give a profile page a custom colour scheme), and this might potentially enhance their liking for the product. It could be worth examining the relationship between customization, enjoyment, and frequency of product use.

Finally, it is worth exploring the effects of aesthetic appeal on user behaviour in greater depth. In this thesis I have proposed that an experiment with a prototype (that would require creative problem-solving to accomplish tasks with) could be one way of evaluating the effects of aesthetics on user task-completion behaviours.

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Appendix

Notification of Approval

Date:	June 13, 2012
Study ID:	Pro00030576
Principal Investigator:	Brandon Boyd
Study Supervisor:	Scott Smallwood
Study Title:	*Examining usability and user experience of a relaxing musical (digital) game that makes use of an affective haptic controller interface*
Approval Expiry Date:	12 June 2013

Approved Consent Form:	Approval Date	Approved Document
	13/06/2012	Information Letter

RSO-Managed Funding:	Project ID	Project Title	Speed Code	Other Information
	There are no items to display			

Thank you for submitting the above study to the Research Ethics Board 2 . Your application has been reviewed and approved on behalf of the committee.

A renewal report must be submitted next year prior to the expiry of this approval if your study still requires ethics approval. If you do not renew on or before the renewal expiry date, you will have to re-submit an ethics application.

Approval by the Research Ethics Board does not encompass authorization to access the staff, students, facilities or resources of local institutions for the purposes of the research.

Sincerely,

Dr. Stanley Varnhagen
Chair, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Notification of Approval - Amendment

Date:	July 26, 2012
Amendment ID:	Pro00030576_AME2
Principal Investigator:	Brandon Boyd
Study ID:	MS1_Pro00030576
Study Title:	*Affective Game Interfaces*
Supervisor:	Scott Smallwood

Approved Consent Form:	Approval Date	Approved Document
	26/07/2012	Information Letter

Approval Expiry Date:	12 June 2013

Thank you for submitting an amendment request to the Research Ethics Board 2. This amendment has been reviewed and approved on behalf of the committee. The following has been approved: Revision of the study title (from *Examining usability and user experience of a relaxing musical (digital) game that makes use of an affective haptic controller interface to Affective Game Interfaces).*

Sincerely,

Suzanne Marney
Administrator, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

Notification of Approval - Amendment

Date:	January 9, 2013
Amendment ID:	Pro00030576_AME3
Principal Investigator:	Brandon Boyd
Study ID:	MS2_Pro00030576
Study Title:	Making Interactions Enjoyable: Finding Fun and Pleasure in Interactive Technology
Supervisor:	Scott Smallwood

Approved Consent Form:	Approval Date 09/01/2013	Approved Document Information Letter

Approval Expiry Date:	June 12, 2013

Thank you for submitting an amendment request to the Research Ethics Board 2. This amendment has been reviewed and approved on behalf of the committee. The following has been approved: Change in study title, and revised information letter, as noted above.

Sincerely,

Suzanne Marney
Administrator, Research Ethics Board 2

Note: This correspondence includes an electronic signature (validation and approval via an online system).

INFORMATION LETTER

Study Title: *Making Interactions Enjoyable: Finding Fun and Pleasure in Interactive Technology*

Research Investigator:
NAME: Brandon Riley Boyd
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Supervisor:
NAME: Scott Smallwood
ADDRESS:
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Background: You are being asked to be in this study because we are testing a computer game with a custom soft/furry game controller and we would like to see how the game succeeds (or what needs to be improved) by having people play the game. There are no direct benefits to the participants volunteering for this study. We are looking for participants over the age of 18 who can read and speak English and have a basic understanding of how to use a computer. This study is in support of my Master's thesis in Humanities Computing. I have acquired participants' contact information from their responses to my advertisements for volunteers. These advertisements were posted on my online social media accounts and on flyers I posted on bulletin boards at the University of Alberta.

Purpose: This study has produced a 'relaxing musical game' which participants will be playing on a computer screen using a soft/furry custom game controller interface. The purpose of this study is to see if the game controller that has been produced for this is game is a good interface for allowing the participant to play the game and if participants enjoy the experience of using the furry controller while playing this game. I am trying to see if a game controller which is pleasing to the participant's sense of touch can create an enjoyable gaming experience. This study will help us understand the ways in which a game controller which appeals to the participant's sense of touch can add to a digital gaming experience.

Study Procedures: This study will take place in room on the campus of the University of Alberta. Your participation in the study will take approximately one hour. As a participant you will be asked to sit down at a computer and play my computer game using the custom furry game controller. The researcher will explain the project to you, and then you will be asked to 'think out loud' as you are playing the game. With this 'think-aloud' approach you (the participant) will be saying out loud the things you are thinking as you are playing the game. This will help me identify what problems you might be having as you are using the furry controller and playing the game and so that I can get an understanding of your experience using the game. I will be writing down notes on the things you say out loud as you play through the game. Once you have played the game from start to finish (which should take about 5 to 7 minutes) I will conduct an interview with you where I will ask you questions about your experience of playing the game, and I will take notes as I interview you.

Interview Questions

What was the most enjoyable part of the experience for you?

Was any part of the experience difficult or frustrating?

Was the experience what you were hoping for?

What's a successful outcome when playing this game?

Can you explain to me how you acquire points in this game?

How would you use the controller to move the rabbit to the left?

How would you use the controller to make the rabbit jump?

Tell me what you thought about playing a game with this type of controller.

Did you find it enjoyable playing a game with this type of controller?