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Exploring Interpersonal Touch As a Human-Computer Interface for Video Games

by

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Abstract

As the medium of video games rapidly evolves, the ways in which we play these games are also changing. Whereas these games were once played almost exclusively using peripherals like keyboards, joysticks and gamepads, modern games are increasingly making use of embodied interfaces which afford natural, physically-expressive forms of control. By departing from established norms, these embodied interfaces have exposed new areas of game design and enabled new forms of gameplay.

In this thesis, I investigate the use of interpersonal touch (physical contact between two people) as an embodied interface for player-to-player interaction in video games. Interpersonal touch is a sociable form of interaction which is commonly shared among friends, family and couples in real life. Touch evokes feelings of love, connectedness, and familiarity. I believe that the inherent social aspects of interpersonal touch make it well-suited as a way to promote socialization between teammates in cooperative multiplayer video games.

My investigation of interpersonal touch interaction is rooted in two video games of my own design. *Matchmaker* is a two-player cooperative tabletop video game which examines the effects of touch in a romantically-themed game. *Prism Squad: GO!* is three-player cooperative science-fiction game which uses touch as a way to promote teamwork and camaraderie. Based on my analysis of *Prism Squad: GO!* and *Matchmaker* I come to conclude that interpersonal touch is a powerful tool for enhancing player socialization, a focus for cooperative gameplay mechanics and an enabler for interesting new forms of gameplay.

Publications

Materials, ideas, tables and figures in this thesis have previously appeared in the following publications:

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Chapter 1. Introduction

1.1 Background

The days when video gaming was a niche hobby of the technologically-savvy have long since passed. Today, video games are an ubiquitous part of our daily lives, appearing on our television screens, in our web browsers and even on our cellular phones. These games are now so popular that they decorate soda cans[1], inspire feature-length movies[2] and even serve as the impetus for nationally-televised competitions[3]. Video games have become a pillar of our modern popular culture alongside movies, television and popular music. In fact, video games have become so popular that they are starting to rival the popularity of these old media: "*Halo 3*, the best-selling title of 2007, took in more revenue in its first day of sales than the biggest opening weekend ever for a movie ('*Spider-Man 3*') and the final '*Harry Potter*' book's first day sales." (Entertainment Software Association, 2009)

One of the biggest underlying causes of video games' booming popularity is their expanding audience. Although video-gaming has traditionally been the domain of young males, this is quickly changing (Griffiths et al., 2003). More and more young females, mothers, fathers, and even grandparents are becoming gamers too (Voida et al., 2009). Video gaming is increasingly gaining acceptance as common social activity – one which is often shared between friends, families, and couples.

[1] During *Halo 3*'s release, Mountain Dew promoted the game with a variety of *Halo*-themed cans and bottles. Mountain Dew is now running a similar promotion with *World of Warcraft*-themed drinks.
[2] Literally dozens of video games have received movie adaptations, most notably the *Resident Evil* and *Tomb Raider* franchises, both of which have gone on to become successful movie franchises in their own right.
[3] *Starcraft* is so popular in South Korea that it has been called "[a] national sport for South Koreans under age 40" (Schiesel, 2007). Teams of professional *Starcraft* players are paid exorbitant salaries by sponsors such as Samsung and the South Korean Air Force to compete live on Korean TV.

One of the causes of video games' increasing popularity is the ongoing evolution of their *interfaces* – the peripherals and devices which allow players to interact with the games themselves. Historically, most video games have been played using *generic interfaces* such as joysticks, keyboards and gamepads (Figure 1.1). A generic interface is comprised of a variety of widgets (buttons, analog control-sticks, etc.) whose functionality is not specific to any particular game or task, but which can be applied to any number of arbitrary game designs. The mappings between a generic interface's widgets and their in-game effects are abstract and vary from game to game. In a hypothetical game, pressing the 'X' button on a gamepad may cause the player's onscreen character to jump upwards, while in another hypothetical game, the 'X' button may cause the player's character to throw a punch. For each new game, players must learn and memorize these mappings before they can play. This provides a frustrating barrier to entry for many new players.

Figure 1.1 – A generic interface – Sony's PlayStation 3 gamepad (released in 2006)

Generic interfaces like the gamepad are very effective at supporting certain types of games, but they are weak in other areas. Because of their limited physical affordances, generic interfaces make very poor choices for representing expressive physical activities such as singing, fishing, bowling, dancing, or playing the guitar. As a result, game developers are increasingly turning towards custom-built *embodied interfaces* in their drive to deliver engaging, physically-expressive forms of gameplay.

Embodiment is a philosophy of design which seeks to establish meaning in interaction. It has been described as the underlying principle which unites both Weiser's work on Ubiquitous Computing (Weiser, 1991) and Ishii's "Tangible Bits" (Ishii et al., 1998):

> "The world has meaning in how it is physically organized in relationship to our physical abilities, and in how it reflects a history of social practice. […Embodied interfaces] attempt to exploit our natural familiarity with the everyday environment and our highly-developed spatial and physical skills to specialize and control how computation can be used in concert with naturalistic activities." (Dourish, 2001)

Embodied interfaces work to create meaning through physical interaction which leverages our innate physical skills and knowledge of how to apply them. One of the oft-stated goals of embodied interaction is to eliminate the schism of abstraction between a user and their task, so the interface seems to disappear and the user can interact with their task directly.

Drawing from Dourish's definition, I define an embodied video game interface as an interface which draws on players' spatial and physical skills, and leads players to express themselves through physical actions which have an intuitive and meaningful relation to the game they are playing.

The Nintendo Wii's handheld remote controller (the "Wiimote") is one of the most famous examples of an embodied interface in video gaming. Each Wiimote contains an embedded accelerometer which allows it to sense its own acceleration and orientation in three-dimensional space. When a Wiimote is held in a player's hand, the embedded accelerometer effectively allows the Wiimote to be used as a primitive form of hand-motion-tracking. Game developers have used this capability to great effect, using it to turn the Wiimote into a surrogate for anything from a fishing pole, to a sword, to a tennis racquet (Figure 1.2).

Figure 1.2 – Four players pantomime playing tennis using their Wiimotes

Ishii defined computer-supported cooperative play as: "[the use] of computer technology [to] enhance physical exertion, social interaction, and entertainment in sport and play." In accordance with Ishii's vision of computer-supported cooperative play, this thesis introduces interpersonal touch as a new embodied interface for playing video games.

1.2 Interpersonal Touch

Interpersonal touch is defined as any act of bodily contact which occurs between two people. This broad label includes such diverse forms of interpersonal interaction as high-fiving, hugging, kissing, tickling, handshaking, huddling, punching, kicking, slapping, tackling and head-butting. In human beings, interpersonal touch is often used as a form of non-verbal communication. When used in a positive fashion, touch can convey love, compassion, support, togetherness and unity. However, when used with negative intent, touch can convey hostility, intimidation and the threat of bodily harm.

In this thesis, I explore the notion of using interpersonal touch as an interface for playing video games. When I talk about exploring interpersonal touch as an interface for gaming, I am suggesting to explore the design space of video games which are capable of recognizing when two or more of its players are touching each other, and which use this

information to affect or modify the state of the game itself, thus allowing the players to interact with the game through the act of interpersonal touch.

Interpersonal touch covers many different behaviors, but within this thesis I use the term to refer to the subset of non-violent gestures in which one person puts their hands on another (including handholding). By limiting the scope of my investigation in this way, I am not seeking to suggest that other forms of interpersonal touch are of no value to video gaming. Real-life sports such as boxing and football make extensive use of aggressive interpersonal touch, and there is no reason to believe that such forms of touch couldn't contribute to the realization of enjoyable video games as well. But I have chosen to focus on more benign forms of touch because such gestures are easy to detect and are relatively inoffensive to the general public, which, in my mind, makes them a prudent choice for exploring the notion of playing games through touch.

Although playing games through interpersonal touch may seem unusual, I believe that interacting through touch offers several benefits:

Firstly, as an interaction technique, interpersonal touch has the benefit of being simple, direct and flexible. Touch is never something which needs to be taught or explained. It is simple and natural to reach out and touch someone as a method of demonstrating a connection with that person and it is just as simple to withdraw your hand to break such a connection. Touch can also playfully scale to larger groups – while our two hands allow us to touch two people simultaneously, arbitrarily large groups can connect through touch if they join their hands together in a chain.

Secondly, interpersonal touch is a form of physical interaction – something which is common in real-world games, but largely absent from digital gaming. Even in cooperative multiplayer video games, the players themselves rarely interact directly. Instead, the majority of the players' collaboration is carried out onscreen, between the players' digital avatars. It is entirely common in video games to witness a group of virtual characters performing as a tightly-honed team, while their human counterparts sit slack-jawed in the real world. While this is not necessarily bad, it is at least incongruous. Introducing interpersonal touch into such cooperative games gives designers the opportunity to create

interesting gameplay scenarios where players must cooperate not just in the digital realm, but in the physical one too.

Finally, interpersonal touch is a form of social interaction between players in a media where social interaction is needed. “Many other forms of entertainment (e.g. sports or board games) heavily rely on human factors to create a joyful interaction experience [...] however, contemporary entertainment technology does not commonly incorporate social interaction as an integral part of the entertainment experience.” (Magerkurth et al., 2004) Human beings instinctively recognize interpersonal touch as a gesture which underscores meaningful social connections. If game designers could tactfully exploit this aspect of touch to reinforce the interpersonal connections between players, I believe that it would be possible to create cooperative games with substantive social value – games in which players truly feel connected to their partners.

In light of these benefits, I believe that interpersonal touch has the potential to facilitate enjoyable new forms physical, cooperative gameplay which may not otherwise be possible.

1.3 Research Questions

In recognizing interpersonal touch as a unique and largely unexplored way of playing cooperative multiplayer video games, this thesis explores the following research questions:

1. **Why apply interpersonal touch interfaces to video games?** The benefits of using interpersonal touch in video games may not be immediately obvious. By exploring the purpose of video games, the needs of game developers, the history of interfaces in video gaming and the innate aspects of touch, I intend to present a case which makes clear the value of exploring interpersonal touch in video games.
2. **How does interpersonal touch interfaces contribute to players’ enjoyment of video games?** Theoretical knowledge is well and good – but I also seek to explore the effects of interpersonal touch in practice. By examining players’ experiences

playing interpersonal touch-based games, I seek to discover the mechanisms by which interpersonal touch shapes players' perceptions of the games themselves.

1.4 Research Approach

To truly understand the full potential of interpersonal touch as an interface for video games, I believe it is important to study games which have been designed from the ground up to take advantage of interpersonal touch. While it would certainly be possible to explore interpersonal touch by adding touch interfaces to existing multiplayer video games, I believe that this would be a misguided approach simply because such games have already been designed with a specific and different (that is, non-interpersonal touch-based) interface in mind, and consequently their gameplay may not afford an effective use of interpersonal touch.

Thus, I propose to address the two research questions posed above by examining two original games of my own design. These games have been specifically created to take advantage of what I believe are the strengths of interpersonal touch as an interaction technique. These names of these two games are "*Matchmaker*" and "*Prism Squad: GO!*"

Matchmaker is a two-player, cooperative game for the MERL DiamondTouch tabletop, which is based around the themes of love and romance. In *Matchmaker* players hold hands to invoke the "Power of Love" – a technique which aids the players in their quest to spread love throughout the game world. Through *Matchmaker*, I examine how the romantic connotations of interpersonal touch can complement a romantically-themed game for couples.

Prism Squad: GO! is a three-player cooperative multiplayer game set in outer space. In *Prism Squad: GO!*, players use Nintendo Wiimotes to pilot spaceships on a large-screen video display as they fly around the planets of our solar-system. Each *Prism Squad* player is assigned their own unique color, but by touching with their partners players can "blend" their colors together, creating powerful new combinations which are vital in their war against an invading alien menace. Through *Prism Squad*, I examine how the inclusion of

touch affects teamwork, communication and group coherence among friends in a casual group setting.

Each of these games has been evaluated through a formal user study. By combining the data gathered through these studies with an examination of the games themselves, I aim to present a rich analysis of how the inclusion of interpersonal touch shapes a player's gaming experience.

1.5 Thesis Contributions

Following the research approach detailed above, this thesis documents the following contributions:

1. **The very first academic exploration of interpersonal touch as an embodied interface for video games and its place in the current state of the art**: To the best of my knowledge, this thesis represents the first attempt to rigorously justify and classify the use of interpersonal touch in video games, one of the very first attempts to implement this type of game interaction in practice and the first attempt to evaluate the resulting experience.
2. **A thorough discussion on the role of interpersonal touch from the perspective of human-computer interaction**: In this thesis, I examine interpersonal touch from the perspective of human-computer interaction and the specific sub-domain of video game interaction. By illustrating how interpersonal touch relates to established research in these domains, I seek to provide a broader context for understanding the role and the value of touch in video game interaction.
3. **An exploration of the first original video game designed specifically for interpersonal touch**: *Matchmaker* is one of the first complete interpersonal touch-based video games. To the best of my knowledge, it is also the first original video game designed specifically to be played using interpersonal touch.
4. **The first exploration of interpersonal touch in a three-player cooperative video game**: *Prism Squad: GO!* explores the use of interpersonal touch amongst

three partners simultaneously. The game has been completely implemented and evaluated, although the interpersonal touch component of the game has not yet been fully realized.

5. **A set of design heuristics for the effective application of interpersonal touch to video games**: By combining lessons learned from designing *Prism Squad: GO!* and *Matchmaker* with feedback from their players, I have produced a set of heuristics for the effective application of interpersonal touch to video games. These heuristics can be used as both a framework to evaluate a video game's use of interpersonal touch, or as suggested guidelines for the design of future games based on touch.

1.6 Thesis Overview

The remainder of this thesis proceeds as follows: In chapter two, I present the background which has motivated my research into interpersonal interaction in video games; I attempt to explain video games in terms of their functions and purpose and I illustrate how game interfaces have served this purpose over time. In chapter three, I present a variety of work related to my thesis. This chapter examines the social aspects of touch and gaming, and highlights some existing uses of touch in human-computer interaction. Chapter four features *Matchmaker*, a touch-based game for couples. In this chapter, I provide a thorough description of *Matchmaker* itself, followed by an analysis of the game drawn from the results of various formal and informal user studies. In chapter five, I *Prism Squad: GO!*, a three-player game inspired by interpersonal touch. In this chapter, I describe the game's inspiration, along with its design, themes, and gameplay. I also present the results of my study on *Prism Squad: GO!* and describe their implications to interpersonal touch in video games. In chapter six, I present my findings from *Matchmaker* and *Prism Squad* as a set of consolidated design heuristics for the effective application of interpersonal touch to video games. I then apply these heuristics to four examples of touch in human-computer interaction to show what insight they can provide. Finally, in chapter seven, I summarize the contributions of this thesis and present my ideas for possible future work in this domain.

Chapter 2. Background & Motivation

This thesis is concerned with the application of an embodied interface (i.e. interpersonal touch) to video games. And while the study of embodiment has a rich history in the field of human-computer interaction (e.g. Dourish, 2001) the study of video games has been less illustrious. While gamers have long been subjects of interest in sociological studies (e.g. Dill et al., 1998) it is only recently that video games themselves have come under academic scrutiny: "The relatively short history of video games is complemented by an even shorter history of research. It is only around the turn of the millennium that video games studies began to come together as a field with its own conferences, journals and organizations." (Juul, 2005)

The purpose of this chapter is to provide some insight into my approach to studying video games. In this section, I shall address such questions as:

- What is a video game?
- What is the purpose of a video game? (Or: What makes a "good" video game?)
- How have video game interfaces evolved over time?
- What advantages do embodied interfaces have to offer video games?

I hope that the perspectives I present here will serve as a foundation of common understanding from which further discussion can emerge.

2.1 What is a Video Game?

Before we seek to understand video games, we must first define our terms. When we talk about "video games", what do we mean? Here are three definitions, taken from various online sources:

1. Any interactive game operated by computer circuitry. (*Encyclopædia Britannica*, 2009)
2. Any of various games played using a microcomputer with a keyboard and often joysticks to manipulate changes or respond to the action or questions on the screen. (Dictionary.com, 2009)
3. An electronic or computerized game played by manipulating images on a video display or television screen. (*The American Heritage Dictionary of the English Language*, 2009)

None of these definitions are perfect – they all contain subtle flaws and oversights. But, taken together, they clearly share certain commonalities. All three definitions imply some form of interactivity, using words like "play", "respond" and "manipulate". All of them allude to computers or computer-processing. And – with the exception of *Britannica* – they all make reference to a "screen". Together, these three facts combine to form a more robust definition of a video game:

1. A video game is interactive. All video games have at least one player and every player exerts some control over the game that they play.
2. A video game utilizes some form of computer processing. By modern standards, this effectively means that a video game is a set of executable instructions running on a CPU. However, this was not always true – some of the earliest video games were "written" in hardwired circuit boards.
3. A video game provides visual feedback to the player through a video device[4].

However, these three criteria alone are not enough to define a video game. Having met all of the above criteria, there is one further criterion which every video game must meet:

4. A video game must have the characteristics of a game.

[4] Interactive electronic games which provide player feedback through sound rather than video are known as "audio games". Audio games are not nearly as popular as video games, but they have the distinction of being equally accessible to both the blind and the sighted.

Alas, this final point raises yet another question of definitions: What is a game? Jesper Juul – a preeminent theorist in the field of video game studies – offers this definition:

> A game is a rule-based formal system with variable and quantifiable outcomes, where different outcomes are assigned different values, where the player exerts effort in order to influence the outcome, the player feels emotionally attached to the outcome, and the consequences of the activity are optional and negotiable. (Juul, 2005)

Juul's definition identifies six defining characteristics inherent in all games:

1. Games have systems of formalized rules. These rules specify how the game proceeds and which actions the players are allowed to perform at any given time.
2. Games have variable and quantifiable outcomes. That is to say, a game must provide the possibility of multiple outcomes and the game-states which lead to these outcomes must be identifiable, unambiguous, and mutually agreed-upon.
3. In games, different outcomes are assigned different values. In any game some outcomes (the "winning" outcomes) will be more desirable, and some outcomes (the "losing" outcomes) will be less desirable. Typically, the most desirable outcomes will be more difficult to achieve: this creates the element of challenge in games.
4. Games are interactive. In any game, the player must have some capability to affect the state of the game and in so doing, to steer the game state towards their own most desirable outcome.
5. In games, players should feel emotionally attached to the outcome. Admittedly, this is not something that can be formalized by the structure of a game itself, but in order for a game to function effectively, players must be incentivized to pursue their own most-desired outcomes.
6. Finally, the consequences of games are optional and negotiable. Any real-world consequences of the game (such as the exchange of money by the players, as in poker) are discussed and agreed upon by the players before the game begins, but

> more often than not these games have no real world consequences at all. (Juul, 2005)

Juul's definition is well-reasoned, and comprehensive. I find his fifth criterion – the one which introduces the concept of "attachment" between a game and its player – to be particularly interesting. Attachment is that mysterious "something" which cannot be formalized by the structure of a game itself, but which all good games have in common. I believe that the concept of attachment is central to this thesis because it – more than anything else – instructs us how to recognize (and how to create) good games.

At its core, a video game is nothing but a series of instructions executing on a CPU. In this sense, games are not so different from "ordinary" programs like Microsoft Word, Adobe Photoshop, or Mozilla Firefox. Applications like Word and Photoshop have become fixtures on the modern desktop because they are so useful; they simplify the tasks which we perform every day. If I want to write a letter, Word helps me to accomplish this task effectively, by giving me control over fonts, styling, margins, and so on. If I want to touch up a photo, Photoshop gives me a variety of powerful tools and filters. And if I want to find information online, Firefox makes it easy through useful features like favorites, tabs, and customizable plug-ins. Each of these applications is validated by the existence of some external goal – we use these applications because they help us to solve a problem.

Now, compare these applications to a game, such as *Pac-Man*. At first blush *Pac-Man* appears to be quite useless; it can't help us to write a letter, or touch up a photo, or find information online. But this is not especially surprising. Juul defined a game as something whose impact on the real-world is often negligible or even non-existent. Such is the case with *Pac-Man* – whether the player wins or loses, the effect on the real world is entirely negligible. It is in this regard that video games are most different from other pieces of software. In the absence of an external goal to motivate the user, a good game must provide an intrinsic reward – the game must be structured so that the very act of playing is a satisfying experience. This intrinsic reward goes by many names; Juul calls it emotional attachment, but it is variously known as immersion, engagement or simply "fun". Regardless of the term, the implication is clear: games are designed to be enjoyed.

Unfortunately for game designers, the process of creating an enjoyable game is anything but straightforward. There's no such thing as a "unified theory of fun." Each game pursues fun in its own way and different players may enjoy a single game for many different reasons. But that's not to say designing good video games is a shot in the dark, either. There are many factors which will have a clear impact on the players' enjoyment. One of these factors is the game's interface which – as the channel through which the player experiences the game – has a huge impact on way players' receive a game.

In the next section, I provide an abbreviated history of the role of interfaces in video gaming. I show how game interfaces have evolved to meet the needs of game designers over time, and I describe how embodied interfaces can complement a game's design, and help it to connect with its players.

2.2 Video Game Interfaces

In section 2.1, I presented a definition for the term "video game". That definition included the following two criteria:

1. All video games make use of a video device to display the game to the player.
2. All video games are interactive. That is, there exists some mechanism (the "controller") through which the player can manipulate the state of the game.

Taken together, a video game's display and its controller make up the game's interface. The purpose of these interfaces is to allow reciprocal communication between the player and the game – while the video display informs the player about the game's state, the player conveys their intentions to the game through the controller. This creates a sort of feedback loop where the player is constantly reacting to changes in the game and the game is constantly changing in response to the player's actions.

This reciprocal interaction model is a hallmark of video games, one which has persisted since 1958, the year when *Tennis for Two* – the world's first video game[5] – debuted (DeMaria, 2003).

2.2.1 The Earliest Video Game Interfaces

Tennis for Two was developed by William A. Higinbotham – a physicist and former member of the Manhattan Project – while he was working at the Brookhaven National Laboratory, a national nuclear research center based in the United States. During Higinbotham's tenure there, Brookhaven hosted annual public demonstrations in order to demonstrate the importance of their research. After attending several of these demonstrations, Higinbotham found himself bored by the lab's dull exhibitions. This inspired him to create a hands-on, interactive exhibit which would excite the visiting crowds. In his own words, Higinbotham wrote: "it might liven up the place to have a game that people could play, and which would convey the message that our scientific endeavors have relevance for society." (Gettler, 2006)

One of Brookhaven's analog computers – the Systron Donner SD-3300 – came with an instruction manual that detailed how to simulate a bouncing ball under the influence of gravity and wind. Using these instructions as a starting point, Higinbotham created *Tennis for Two* – a competitive, two-player tennis game (Figure 2.1).

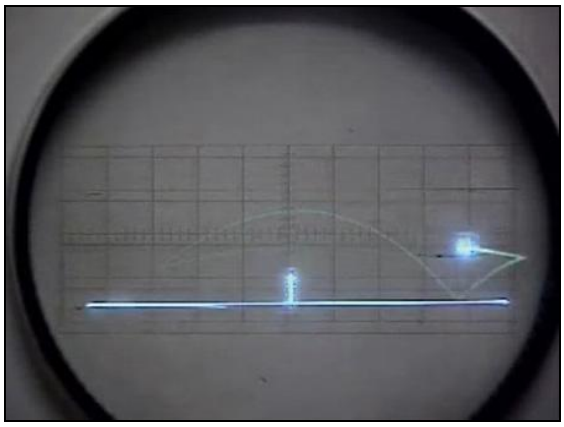

Figure 2.1 – *Tennis for Two*

[5] Because of its iconic status, many people erroneously believe that Atari's 1972 title *Pong* was the first true video game. However, *Tennis for Two* predated *Pong* by more than a decade.

By modern standards, *Tennis for Two* is quite rudimentary. The game's graphical display was a 5-inch oscilloscope, which displayed the ball, the court, and the net in brilliant monochrome (the players' paddles were invisible.) To control the game, Higginbotham custom-built two control devices which would allow players to adjust their angle of return using a rotating dial and hit the ball with a pushdown switch (Figure 2.2).

Figure 2.2 – *Tennis for Two*'s input devices

Spacewar! (a two-player space-combat game reminiscent of *Asteroids*) was released in 1962 and often competes with *Tennis for Two* for the title of the first video game. Developed for the PDP-1 by three MIT students (Steve Russell, Martin Graetz and Wayne Wiitanen) *Spacewar!* initially used the PDP's front-panel test-switches to control the game. But over time, as the test-switches proved to be an unsatisfying and unreliable method of playing, enterprising hackers created their own *Spacewar!* peripherals by wiring customized control boxes directly into the PDP's switches (Figure 2.3).

Figure 2.3 – Two men playing *Spacewar!* using custom control boxes

Because of its compelling gameplay, *Spacewar!* proved to be enormously popular, and copies of the game eventually propagated to other universities. But although the source code could spread easily from university to university, peripherals could not, forcing players at each new institution to create their own control devices. Allegedly, some players even managed to hack jet-fighter joysticks found at army surplus stores to work with the game (Computer History Museum, 2009).

Tennis for Two and *Spacewar!*'s interfaces reflect on a time when computing-technology was not widely available to the general public. These games were never intended for commercial sale, and so the developers were free to create their own one-off control devices designed especially for their particular game. But this practice of customizing peripherals for each new game would ultimately prove to be short-lived. Over time, as the costs of computing decreased and video games consoles began to appear in consumers' homes, the one-controller-for-one-game paradigm became untenable and game developers moved towards a new device model.

2.2.2 The Emergence of Generic Interfaces

In 1972, the Magnavox corporation released the Odyssey – the world's first home video game console. The Odyssey was a cartridge-based system, which meant that the logic for each Odyssey game was stored outside the console, on an external cartridge. Players could switch between games on a whim simply by inserting different cartridges into the Odyssey's cartridge-slot. Although the Odyssey originally shipped with twelve games, Magnavox had plans to produce and sell additional games. And indeed, during the system's lifetime a total of twenty-eight different games were released. Obviously, it would have been prohibitively expensive (not to mention a logistical nightmare) to create customized control devices for every one of the Odyssey's twenty-eight games. Magnavox's solution to this problem was to bundle the Odyssey with a generic interface – a single input device providing generic functionality which could be used to play any number of various games. Hence, the Odyssey's "Player Control Unit" (Figure 2.4).

Figure 2.4 – The Odyssey's Player Control Unit

Each Player Control Unit housed two rotating dials, a reset button, and the enigmatically-named "English" knob[6]. By today's standards, these Player Control Units are very primitive, but the games they controlled were similarly primitive, and so these controllers provided all the functionality necessary for playing such diverse Odyssey titles as *Cat & Mouse*, *Roulette*, *Simon Says* and *Table Tennis*.

Over time, as more and more game systems entered the home console market, the Odyssey fell into obsolesce. But the practice of bundling a generic controller device with each new game system endured. Prior to the North American video game crash of 1983 (Taylor, 1982) the designs of these controllers varied wildly from console to console, but after Nintendo reinvigorated the market with their Nintendo Entertainment System ("NES") in 1985, gamepads became the de facto standard for generic interface devices. Since the debut of the NES, a gamepad has accompanied almost every console release in the last 25 years – the only exception is the Nintendo Wii (2006), which shipped with a one-handed remote controller. However, despite its primary functionality as a pointing device, even the Wiimote can be held sideways with two hands to mimic the functionality of a gamepad.

[6] The existence of the English knob is a testament to the popularity of *Pong*-style games at this time. This knob was used to control the amount of English or "spin" on the ball in the Odyssey's *Table Tennis* game.

2.2.3 The Rising Popularity of Embodied Interfaces

In the introduction to this thesis, I defined an embodied video game interface as an interface which draws on players' spatial and physical skills, and leads players to express themselves through physical actions which have an intuitive and meaningful relation to the game they are playing. Embodied interfaces stand in direct contrast to generic interfaces; whereas a generic interface is designed to provide functionality which is unspecific to any particular task, embodied interfaces are designed to draw upon our existing knowledge of specific forms of physical interaction.

Embodied interfaces for video games are not a new development – in fact, they've always floated at the periphery of mainstream gaming. Even the Magnavox Odyssey had a shotgun-shaped peripheral which allowed players to aim and shoot directly at their TV screen. But historically, embodied interfaces have always been overshadowed by the ubiquity of generic interfaces. Prior to the late 90s, commercial experimentations with embodied interfaces failed more often than not – history is littered with these crass designs which were poorly supported by game developers and poorly received by the gaming public (Jefferies, 2009). Even in the rare cases where a new interface succeeded, these successes were typically modest; the best-selling, most popular console video games have always been based on gamepads (VGChartz, 2009).

But in the late 1990s, embodied interfaces began to experience a surge in popularity, buoyed by the explosive success of arcade rhythm games[7] such as *Beatmania* (Figure 2.5) and *Dance Dance Revolution*.

[7] Rhythm games are a class of games which challenge players to perform some action (usually pressing buttons) in time to a musical beat. A player's success is dependant on how well they can synchronize their actions to the music.

Figure 2.5 – *Beatmania*: A DJ-inspired rhythm game with turntable controllers

It is unsurprising that the push for embodied interaction came from arcades, rather than from the home. Arcades had always been a showcase for unique game interfaces; the increased cost and size of arcade machines gave designers license to experiment with unconventional interaction techniques which may not have been practical in a home setting.

The bourgeoning popularity of rhythm game such as *Beatmania* did not go unnoticed by the Japanese arcade industry, which quickly flooded the market with sequels and imitators. And although North American manufacturers were slow to catch on, rhythm games became a popular trend in North America, too; imported copies of Japanese *Dance Dance Revolution* machines were a common sight in American arcades circa 2000. Although these games rose to fame in the arcades, it was not long before fans began clamoring for versions that they could play in the comfort of their homes. Starting in 1998, console ports of popular rhythm games like *Beatmania* shipped in bundles containing a scaled-down version of their arcade controllers (Figure 2.6).

Figure 2.6 – A *Beatmania* peripheral for the Sony PlayStation

These bundles were some of the first commercially-successful examples of embodied interfaces for home gaming and their success galvanized other games to follow their example. Today, this trend is exemplified by the enormously popular *Guitar Hero* and *Rock Band* franchises, whose extravagant bundles contain fully-functional drum, guitar and microphone peripherals and retail for over $200 apiece. In recent years, video games based on embodied interfaces have become some of the best-selling games on the market. *Wii Fit* – Nintendo's home-fitness game, which uses a "balance board" peripheral to support a variety of exercises – sold 18.22 million units as of March, 2009 (Nintendo Co., Ltd, 2009) making it the second-best-selling game for the popular Nintendo Wii platform.

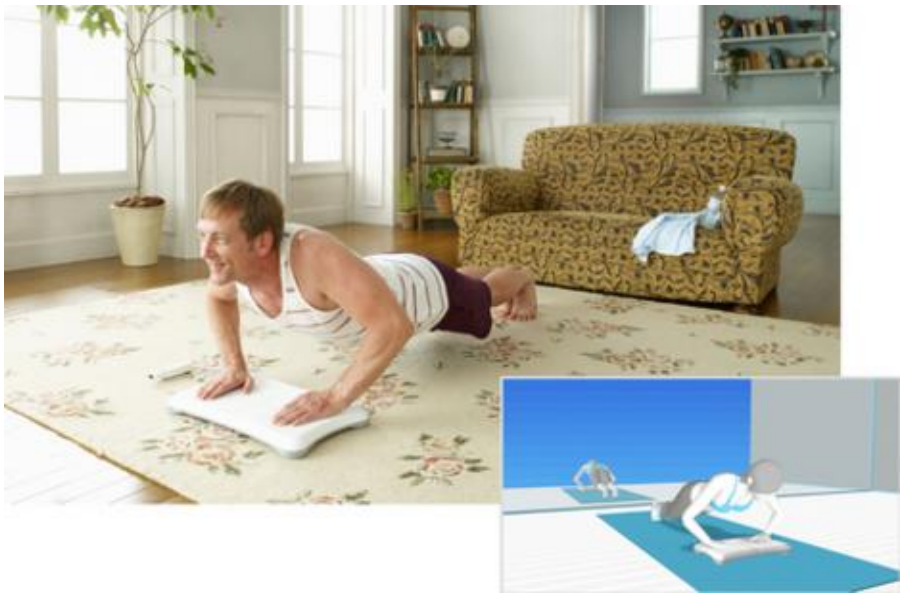

Figure 2.7 – A man does push-ups on his *Wii Fit* balance board

2.2.4 The Benefits of Embodied Interfaces

Embodied interfaces, such as those used by games like *Beatmania* and *Wii Fit* provide benefits to game developers and players alike. As I see it, there are four main incentives to use embodied interfaces in video games:

Firstly, embodied interfaces are typically more *accessible* than generic interfaces. Generic interfaces must be multifunctional in order to support a broad range of game designs. But the cost of this functionality is often elegance – modern gamepads are made up of dozens of buttons, triggers, and control sticks. Each of these buttons represents a choice – a potential action to take – and for many inexperienced gamers, this overwhelming burden of choice becomes a barrier to entry which intimidates them from picking up a new game. In contrast, embodied interfaces are typically designed with one particular game in mind. By focusing on a single game, interface designers can streamline the designs of their peripheral for maximum effectiveness. This hyper-focused design typically leads to a more simple design – one without extraneous buttons or parts.

Secondly, the operation of embodied interfaces is often highly *visible* to outside observers (Klemmer et al., 2006). In contrast to generic interfaces which usually only require fine hand-movements, operating an embodied interfaces often engage a player's entire body (as in Figure 2.7, above.) The antics of a player using an embodied interface are often entertaining in and of themselves, but this visibility has a more-useful property: observers can typically learn how to play the game merely by watching another person play. This is something which is not typically true for generic interfaces, where the players' movements are more subtle. This increased visibility positively contributes to the accessibility of the interface by allowing spectators to learn to play before they begin playing themselves.

Thirdly, embodied interfaces can make players more *sociable*. In a study conducted by Lindley et al., researchers videotaped groups of players as they played *Donkey Konga* using both an embodied interface, and a generic gamepad interface. Their results showed that players interacted with their partners more when using the game's embodied interface. Increased socialization was correlated with an increase in players' self-reported

engagement levels, suggesting that players had more fun when they were socializing (Lindley et al, 2008). Similar results were reported by Florian Mueller, in a study of his competitive multiplayer game, *Breakout for Two*. In a series of playtests, Mueller compared *Breakout for Two* under two different conditions: in the first condition, participants played using a keyboard interface, while in the second, participants played by kicking a ball against a wall-sized projection display. Mueller dubbed this second interface an "exertion interface" because it required players to physically exert themselves while they played. Not only did players who used the exertion interface find *Breakout for Two* more enjoyable, but they also described themselves as feeling "closer" to their opponents after the game had ended (Mueller et al., 2003).

Finally and perhaps most importantly, embodied interfaces create opportunities for *new gameplay*. Consider *Dance Dance Revolution*, the popular dancing game. *Dance Dance Revolution*'s gameplay is simplicity incarnate; flashing arrows pointing in one of four directions appear from the bottom of the screen, scrolling upwards (Figure 2.8). When the arrows reach the top of the screen, the player should step on the appropriate arrow of their dance pad with their foot (Figure 2.9). If the player can step in sync with the onscreen arrows, the movement of their feet will begin to approach a strange facsimile of dancing.

Dance Dance Revolution is a game which could have easily been adapted to a generic gamepad interface by mapping four buttons onto the four directional arrows. Why then did

Figure 2.8 – Gameplay screenshot from *Dance Dance Revolution*

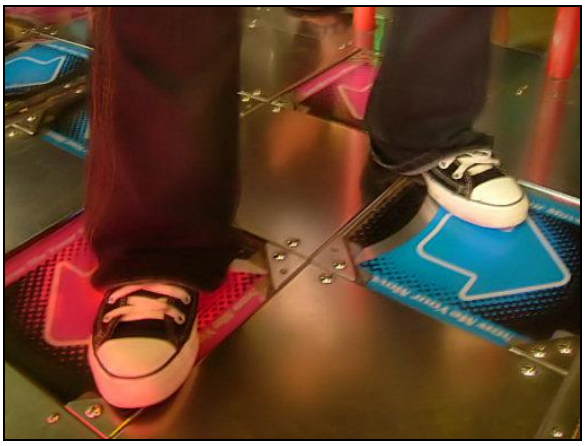

Figure 2.9 – A close-up of *Dance Dance Revolution*'s dance pad peripheral

Dance Dance Revolution's designers go to the trouble of creating these elaborate dance pads? The reason is that playing *Dance Dance Revolution* with a gamepad would fundamentally alter the experience – and not for the better. The kinesthesia, the challenge of keeping your balance and the physical exertion that comes with playing would all be lost in the move from the dance pad to the gamepad. These are the core elements which make *Dance Dance Revolution* fun and they are tied directly to the game's dance pad interface – without it, *Dance Dance Revolution* would be a different game entirely.

2.3 Summary

Video games derive their meaning from emotional attachment – a good game is a one which creates and maintains a rapport between itself and its player. As interactive experiences, all video games require an interface for communicating with their players. Historically, generic interfaces have been the most popular interfaces for game developers because of their simplicity and ubiquity. But since the late 1990s, embodied interfaces – which afford new forms of physically-embodied interaction – have been gaining popularity. Embodied interfaces contribute to games by promoting accessibility, visibility, sociability and offering new gameplay experiences. I believe that interpersonal touch – a form of embodied interaction – can leverage these benefits to further the goal of creating new forms of enjoyable gameplay.

Chapter 3. Related Work

In the previous chapter, I sought to explain that the purpose of a video game is to provide fun to its players – a good game is one which creates emotionally-satisfying experiences. Thus, I argue that in order for interpersonal touch to be an asset to gaming, it must, through some mechanism, contribute to its players' emotional satisfaction.

One of interpersonal touch's keenest strengths is that it is a fundamentally social method of interaction. To interact through touch literally requires you to make a connection with your fellow players. This, I believe, is the way in which interpersonal touch can best contribute to games. In games and in life, the positive effects of rewarding social interactions should not be underestimated.

In this chapter, I examine the connections between social interaction, video games, interpersonal touch, and human-computer interaction in order to show how the use of interpersonal touch can positively contribute to creation of enjoyable gameplay.

3.1 Social Interaction in Video Games

In "Why We Play Games: Four Keys to More Emotion Without Story", Nicole Lazarro (2004) examined thirty volunteers while they played their favorite video games in an attempt to understand what makes games fun. She encapsulated her findings in the form of four "keys" – aspects of games which were found to provoke pleasant emotional responses from players. The four keys are: Hard Fun (emotion arising from challenge), Easy Fun (emotion arising from immersion and intrigue), Altered States (escapism/stress relief) and The People Factor (emotion arising from interaction with other people.) All four keys are interesting in their own right, but The People Factor is the key most relevant to this thesis. Lazarro observed that "players in groups emote more frequently and with more intensity

than those who play on their own. Group play adds new behaviors, rituals, and emotions that make games more exciting." In fact, her findings indicate that the act of socialization may even be more important than the game itself – in many cases, players would "play games they don't like [just] so they can spend time with their friends." To bolster the effects of the People Factor in their own games, Lazzaro urges game designers to "create opportunities for player competition, cooperation, performance, and spectacle."

Amy Voida reported similar findings in her work, "Wii All Play: The Console Game as a Computational Meeting Place" (2009). Voida conducted a "qualitative study of collocated group console gaming" by observing twelve groups of gamers as they played together in their homes. The results of her study reveal that for some gamers, who you play with is often more important than what you are playing. Voida writes: "The primary motivation for group console gaming was not the games themselves, but the social interactions afforded by the collocated gameplay. The most important part of group console gaming was, very simply, 'the sociability of it.'" In fact, for many participants, socialization was not just the primary motivation for playing but the only reason: many adult females and all of the elderly participants who were interviewed for the study admitted that they only played console games in groups – never by themselves.

The purpose of a game is to provide its players with emotional-satisfaction, but there are many different routes to achieving this goal. One popular way of going about this is to provide opportunities for teamwork and cooperation amongst players. This method is clearly well-founded: the results of these studies show that, in general, player-socialization is a positive contributor to player's attitudes towards games. With this in mind, I believe that any tool which encourages social interaction in games can be an asset for game developers. As an inherently social method of interaction, I believe that interpersonal touch is such an asset.

3.2 Interpersonal Touch in Social Interaction

Touching is one of the most emotionally-significant ways in which social creatures interact. "Touch informs those touched about the feelings of the toucher and about the toucher's perception of the relationship [and it triggers] feelings or attitudes in the persons touched." (Bradac, 1984). It should therefore come as no surprise that there exists a large body of research which is dedicated to examining the role of touch in human communication and socialization, and the effects it has on those involved.

One of the most widely-recognized studies on the effects of touch comes from a psychologist named Harry Harlow. In 1958, Harlow published "The Nature of Love" – a seminal paper on the effects of touch on newborn macaque monkeys. In his now-infamous study, Harlow separated groups of newborn macaques from their biological mothers and placed them in an enclosure with two "mother surrogates" – dolls, made from cylinders of wire mesh. The two surrogates were identical, save for one important difference: while one doll was made of bare wire, the other was covered with a "skin" of tan terrycloth (Figure 3.1).

Figure 3.1 – A baby macaque clings to its cloth mother

Each mother also had space for a single nipple, from which the babies could receive milk. But the experimental participants were divided such that only *one* of the mothers would produce milk, while the other would be dry. One group was fed by the wire mother and the other by the cloth mother. In either case, the lactating mother was the babies' sole source of food during the experiment.

The experimental participants were given complete freedom to roam their cages and the amount of time they spent with each mother was automatically recorded. Contrary to conventional expectations, both groups of babies – even those fed by wire mothers – showed an overwhelming preference for the cloth mother, spending upwards of eighteen hours a day with it, as compared to one or two with the wire mother. Harlow conducted many other tests with similar results: regardless of which mother satisfied their basic physical needs, babies were emotionally closer to their cloth surrogate. Harlow's data suggests that primates (including humans) have a deeply-rooted need for touch in our evolutionary biology. As infants, regular, comforting touch is an important part of our intellectual, emotional and physical development. As Harlow himself wrote: "These data make it obvious that contact comfort is a variable of overwhelming importance in the development of affectional response" (1958).

Harlow's research proved the importance of touch in developing babies, but what of adults? As it happens, there is a wealth of research which suggests that interpersonal touch is just as influential for mature adults as it is for newborn children. A study by Burgoon et al. examined the interactions between gender, attractiveness and touch by pairing up experimental participant with an experimental confederate to discuss and analyze a series of hypothetical, morally-ambiguous scenarios (e.g. "What should you do if you discover that your sibling has stolen a valuable possession from a friend?") Participants were randomly divided up into "touch" and "no-touch" conditions; in the touch-condition studies, confederates would casually touch the participants three times over the course of the 5-7 minute study. Following their discussion with the confederate, participants were given a questionnaire asking a series of questions about the attitude and desirability of their confederate partner. When the results of these questionnaires were tabulated, they presented

"resounding [evidence of] touch [as] a potent communicative behavior." (Burgoon et al., 1992) By and large, participants who had been touched by their confederates responded much more enthusiastically than those who had not: "The presence of casual touch was interpreted as expressing greater immediacy/affection, receptivity/trust, relaxation, similarity, and informality than its absence." Touching confederates were also seen as more sociable and extroverted than their touchless peers. In fact, one of the study's most surprising results was that touch was positively received by nearly all participants, regardless of the gender or the perceived attractiveness ("valence") of the confederate touching them; only low-valence females touching males and high-valence females touching other females produced less favorable evaluations than their respective non-touching conditions. (Burgoon et al., 1992).

A series of similar studies have illustrated the appeal of touch in other contexts. Crusco et al. examined the use of touch in a restaurant setting, in a study where a group of three waitresses were instructed to briefly touch their patrons on the hand or shoulder as they delivered the patrons' change at the end of the meal (Crusco et al., 1984). Following the meal, clients were asked to evaluate their waitress under the guise of filling out a restaurant-satisfaction survey. The results of the study were quite intriguing; when the survey data was compared to a control-group of non-touching waitresses, it was found that the presence of touch did not significantly affect patrons' satisfaction ratings. However, when Crusco et. al analyzed the waitresses' tips, they found that the waitresses who touched their clients received significantly larger tips than their non-touching counterparts. How is it that the presence of touch led to an increase in tip without a corresponding increase in customer satisfaction ratings? The authors speculate that that fleeting touches such as the ones used in this study may work on a subliminal level, improving a patron's mood without their conscious awareness.

A similar study was carried out to evaluate the impact of touch in a library setting (Fisher et al., 1976). Here, library patrons were unwittingly divided into two groups; in one group, library clerks were instructed to subtly touch the patrons' hands as they returned their library cards, in the other, the clerks returned their cards without touching. As the

experimental subjects checked out, they were approached by members of the research team (posing as library workers) and asked to fill-out a questionnaire which rated their mood, along with their satisfaction with the library and its clerks. On average, subjects in the touch group reported more positive impressions of the library clerk who served them and on their mood overall. However, the results of this study were heavily skewed along gender lines – differences in female response between touch/no-touch conditions were much more pronounced than those for their male counterparts, who were relatively ambivalent. This suggests that the female respondents were far more sensitive to the presence of touch than the males. Interestingly, during post-test debriefing sessions, only 53% of the participants who had been touched recalled being touched at all, further suggesting that the affective benefits of touch operate below conscious perception.

Although it is unclear exactly how a touch works to change our perceptions, studies such as these show that the effects are nevertheless dramatic. It is amazing how something as simple as a fleeting touch from a complete stranger can significantly affect our happiness, our generosity and our perceptions of those around us.

3.3 Touch in Human-Computer Interaction

3.3.1 Mediated Touch

There are several projects in the field of human-computer interaction which have recognized the emotional importance of touch and the value of touch as a symbol of human connectedness. Many of these projects have been focused on the problem of restoring touch between partners who are physically separated.

Recognizing touch as "a fundamental aspect of interpersonal communication, […] a basic means through which people achieve a sense of connection [and] a communicator of affection", led Scott Brave and Andrew Dahley to create "inTouch" – a pair of networked devices which are synchronized to behave as a single entity (Brave et al., 1997).

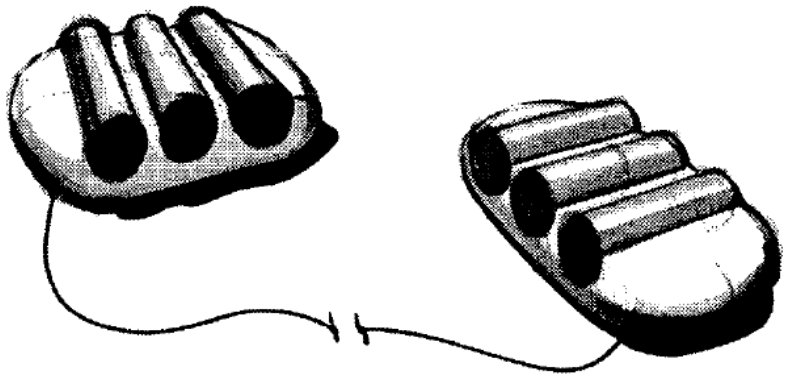

Figure 3.2 – A conceptual sketch of the inTouch devices

Each inTouch device is made up of three "rollers", which can be rotated in-place by dragging your palms or fingers across the rollers (Figure 3.2). Whenever rollers in one device are moved, motors in the second device move its rollers to "replay" this movement, effectively propagating the user's touch across devices. This "twinning" behavior allows two remote users to simultaneously interact with what is essentially a single device – allowing one user to feel another's manipulations by resting their hand softly against the rollers, or to "fight" with their partner by turning the rollers in the opposite direction. Because of its "subtle and abstract nature," many users who tried the initial inTouch prototype agreed that the communication it provided was best suited to "intimate relationships" (Brave et al., 1997).

Florian Mueller's search for a tactile and unobtrusive way to connect intimate partners separated by large distances led to the creation of the "hug vest" – a vest filled with pockets of air which could be rapidly inflated to simulate the feeling of a hug (Mueller et al., 2005). The hug vest was designed as a way for partners to discretely communicate affection – a way of privately reminding your partner that you are thinking of them without interrupting their ongoing activities. In Mueller's early prototype, the hug interaction was unidirectional – one partner wears the vest while the other partner sends "hugs" wirelessly via a handheld PDA.

Research into touch-at-a-distance is focusing not just on human couples, but on pets, as well. Poultry.Internet is a "human-poultry" interaction system, with the stated objective

of "[promoting] poultry pleasure" (Teh et al., 2005). Poultry.Internet functions quite similarly to Mueller's hug-vest – when a pet-owner wants to remotely interact with their pet, they dress it in a special jacket containing a wireless receiver and a vibrating motor before leaving their house. This vest is connected through the internet to a touch-sensitive chicken doll which the human owner keeps in their workplace. When the owner pets the doll, it activates the motors in the vest, delivering a touch-like sensation to the pet.

Strictly speaking, these three projects – inTouch, Hug Over a Distance and Poultry.Internet – are not examples of interpersonal touch. Rather, they employ a form of "mediated touch," transferring touch from one remote user to another through an intermediary device. In and of itself, mediated touch is of little interest to this thesis since it removes the tangible social presence which I am seeking to cultivate with my games. Still, I've chosen to highlight these projects because they demonstrate the emotional value of touch. These projects use touch as a way to remind and reinforce social connections – even when the participants are apart.

3.3.2 Interpersonal Touch

Although the majority of touch-research in HCI has focused on mediated touch, there have been some very exciting investigations into interpersonal touch. The most fascinating of these is Thomas Zimmerman's work in Personal Area Networks (PANs) – a paradigm which seeks to use our human bodies as biological conductors for digital information (Zimmerman, 1996). In his master's thesis, Zimmerman described how we can take advantage of the body's natural conductivity to pass data (i.e. modulated electrical signals) from one body to another through the act of touch. His thesis describes the implementation of a prototypical system where a wearable, battery-powered "emitter" allows one user to transmit their business card data to a colleague via an ordinary handshake. Although PANs have largely been supplanted by modern short-range wireless networking technologies like Bluetooth, the notion of interpersonal data transfer remains an intriguing concept.

As part of their research into "collaborative gestures" on the MERL DiamondTouch, Morris et al. explored the use of interpersonal touch in *CollabDraw* – "a [tabletop] system

for collaborative art and photomanipulation […which] allows groups of two to four users to collaboratively create diagrams, pictures, collages, and simple animations using free-form drawing and photo collage techniques." (Morris et al., 2006) Citing collaboration as a method of increasing communication, awareness and fun, Morris and her colleagues built two interpersonal gestures into *CollabDraw* as a method of encouraging inter-user interaction. The first of these interpersonal actions, the "partner" gesture, allowed two users to establish a partnership by jointly holding hands and touching the surface of the DiamondTouch. So long as two users were partnered, each user could dynamically control the width of their partner's pen stroke as their partner drew on the tabletop. Partnerships could be dissolved at a later time by performing the "partner" gesture again. The second of these interpersonal gestures was the "quit" gesture, which required all users to hold hands in a chain around the table, ensuring that the application could not be terminated without unanimous consent.

While innovative, *CollabDraw*'s use of interpersonal touch was very poorly received by the groups of coworkers who were selected to test the system. When designing for interpersonal interaction, I believe that *CollabDraw*'s developers overlooked two extremely important factors. Firstly, they failed to consider the context in which touch would be used. Social mores state that intimate gestures such as handholding are discouraged between colleagues and so there's no reason to believe that they'd be accepted here. Secondly, they failed to consider the purpose of their gestures; while handholding is a sensible way to indicate partnership, modifying the stroke-width of a partner's line is a bizarre and unnecessary form of collaboration – after all, why should another user control how you draw?

Although *CollabDraw*'s use of interpersonal touch was generally disliked by its users, that does not necessarily signify that there is no place interpersonal touch in tabletop computing. Like *CollabDraw*, my game, *Matchmaker*, also uses the MERL DiamondTouch tabletop. However, *Matchmaker* has been designed from the ground-up to present a scenario which invites interpersonal touch between its users: a romantic, lighthearted game, where the players' only objective is to have fun together.

Intimate Controllers was an art exhibit presented at “Unravel” (the SIGGRAPH 2007 fashion show) which explored the intersection between touch and games. The eponymous intimate controllers were pair of undergarments – a woman’s bra, and a man’s boxer-short – designed to be used as wearable video game controllers (Figure 3.3).

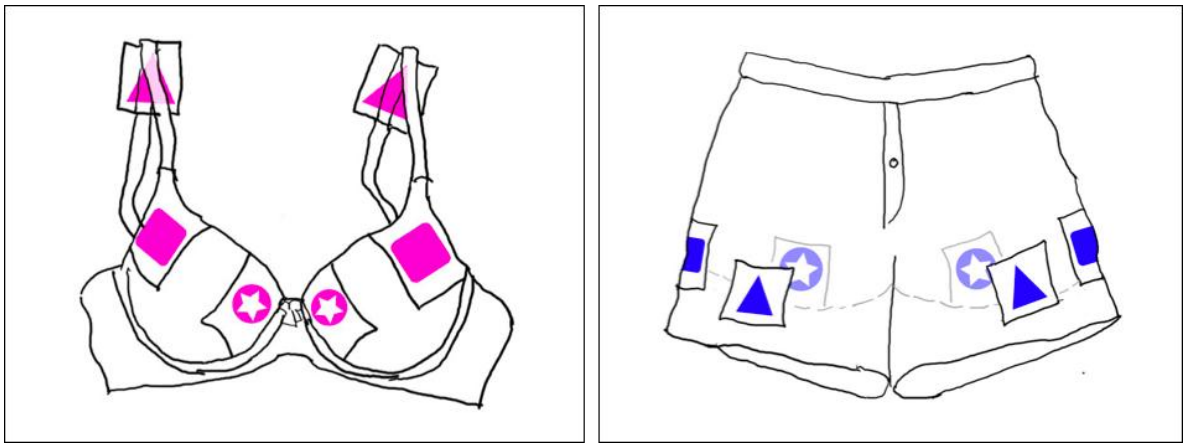

Figure 3.3 – The intimate controllers

Each controller contained a set of embedded touch sensors which were arranged from in order of increasing intimacy from triangle, to square, to star. The more intimate touch-sensors were positioned nearer to the cups of the bra and the buttocks of the shorts, respectively. These controllers were designed to be used by couples as a way of encouraging intimate interaction between the partners as they played. Each player’s inputs are located on the opposite player’s body – the male player touches his partner’s bra, and the female player touches her partner’s underpants. Due to the layout of the sensors, this leads to very sexually-explicit positioning when two partners play together. (Figure 3.4)

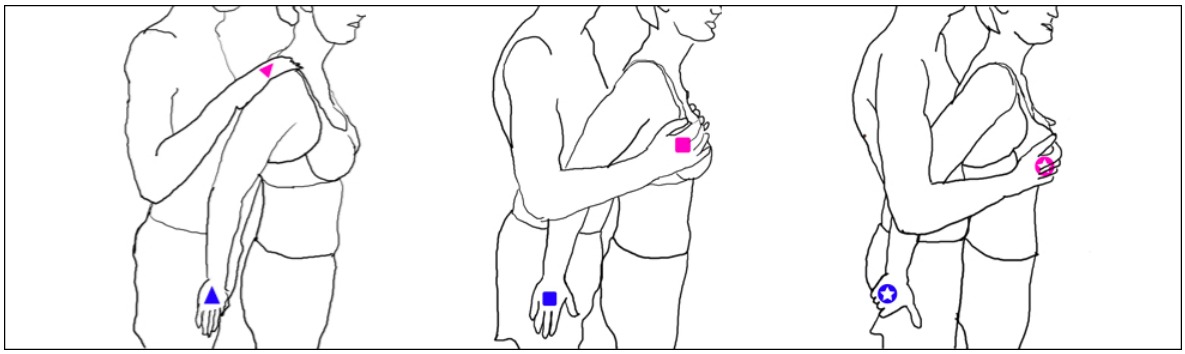

Figure 3.4 – Player positions corresponding to the three intimacy levels

These intimate controllers were accompanied by a video game entitled *'Get Lucky' Charms*. *'Get Lucky' Charms* is a straightforward adaptation of *Dance Dance Revolution*, where players must touch their partner on the appropriate spot as colored symbols scroll from the bottom to the top of the screen.

As an artistic statement, I think that Intimate Controllers is a provocative way to combine two normally-unrelated topics. But as the forebear of interpersonal touch in gaming Intimate Controllers is crass and heavy-handed. Yes, Intimate Controllers blends both touch and gaming – but it makes virtually no attempt to reconcile the two in a meaningful way. I ask you: where is the intimacy in a game that tells you where and when to touch your partner? And how is the otherwise drab gameplay of *'Get Lucky' Charms* improved by having the players stand in their underpants? By combining games and touch in such a haphazard fashion, *'Get Lucky' Charms* delivers a disjointed experience which fails to properly motivate the presence of interpersonal touch in video games.

Still, I believe that there is value in exploring how interpersonal touch can contribute to the design of video games for couples. Jennifer Chowdhury – the creator of Intimate Controllers – has described her project as a means of investigating "how game interfaces can change the way players interact with one another off the screen." This is a compelling topic, one which underscores my own research into interpersonal touch. Although *'Get Lucky' Charms* failed to reconcile the romantic and the mechanical aspects of gameplay, this need not be the case – I believe that interpersonal touch can serve both romantic and practical gameplay purposes at once. In the next chapter, I describe how *Matchmaker* – a two-player game for couples – uses interpersonal touch to support romantic interactions and an enjoyable form of uniquely cooperative gameplay.

3.4 Summary

In this chapter, I have sought to illuminate the connection between games and interpersonal touch, and to reveal how the two might complement each other. Work by Voida and Lazzaro has revealed the importance of socialization in multiplayer games and shown how

(for some gamers) the interactions outside of the game can be more satisfying than the interactions within it. Examining the role of touch in social interaction has shown how the simplest touch can have a significant positive effect on our dispositions. And selected examples of touch in human-computer interaction have demonstrated the evocative power of touch, and its connotations as a way of joining users, both physically, and emotionally. By presenting these topics in this manner, I have sought to show not just the importance of games and touch, but to hint at the possibilities of playing games through touch. The research I have presented here gives me reason to believe that introducing touch amongst players has the potential to augment players' enjoyment of video games via The People Factor, and – like any good embodied interface – open the doors to new and wholly enjoyable forms of gameplay.

Chapter 4. *Matchmaker*

Although interpersonal touch pervades many aspects of our lives, I argue that the act of interpersonal touch is most often associated with romantic intimacy. Certain forms of touch (such as cuddling and kissing on the lips) are reserved exclusively for couples, and while gestures like handholding may find an innocent expression among young children, these gestures are more often used to indicate a romantic relationship between adults. Given the prevalence of interpersonal touch in romantic relationships, it seems appropriate to begin an examination of interpersonal touch in games with a romantically-themed game. Considering their predilection towards touch, I argue that romantic couples are the audience which would be most immediately receptive towards a game based on interpersonal touch.

Hence, I present *Matchmaker*: a cooperative two-player tabletop video game for couples. Through its romantic motifs and its use of interpersonal touch, *Matchmaker* seeks to create an atmosphere which engenders intimacy between its players. In that regard, it is similar to the Intimate Controllers project described in section 3.3.2 (Chowdhury, 2007). But whereas the Intimate Controllers project focused entirely on physical intimacy, *Matchmaker* seeks to cultivate a more subtle form of emotional intimacy between its players by encouraging teamwork, cooperation, and the pursuit of a shared goal. *Matchmaker* was designed as a tribute to wide-eyed, innocent love. It is a game whose cutesy sights and sounds complement the tender appearance of its players as they talk, laugh, and hold hands together. In Matchmaker, interpersonal touch serves two purposes: is it at once a tangible expression of a cooperative gameplay mechanic but also a recognizable symbol of the love that the two players share between themselves (Figure 4.1).

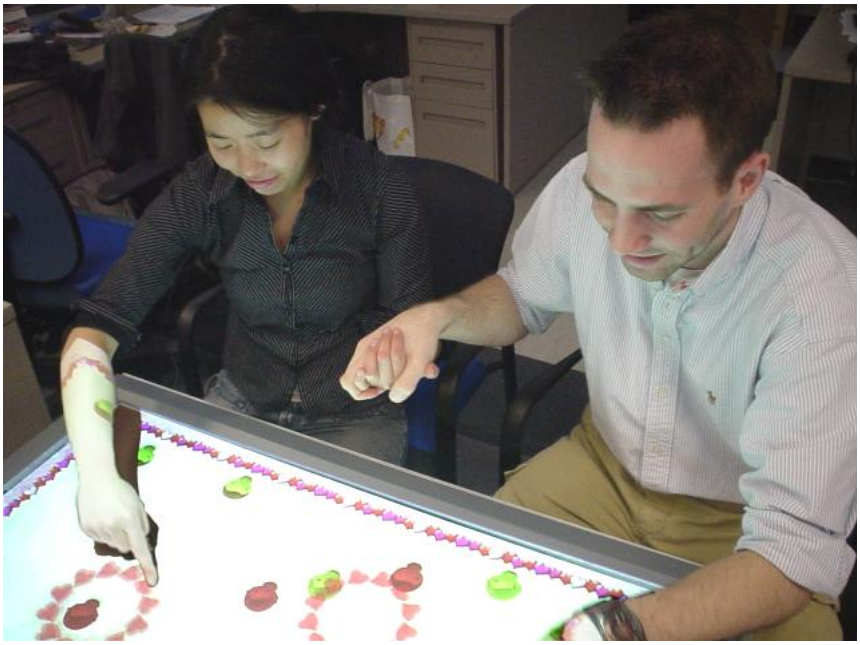

Figure 4.1 – A couple playing *Matchmaker*

4.1 The Story of *Matchmaker*

In the world of *Matchmaker*, romance is everywhere – it is a world filled with adorable, round-headed people called Peeps (Figure 4.2) whose only goal in life is to love and be loved in return.

Figure 4.2 – Peeps of different colors

But finding true love is not always easy; sometimes, love needs a little push to speed the process along. In *Matchmaker*, the players act as ethereal Cupids who work together to match up compatible Peeps and to spread love throughout the land. But the players must act quickly; if a Peep remains single for too long, the poor Peep will become depressed and lovelorn (Figure 4.3).

Figure 4.3 – Two lovelorn Peeps

When a crying, lovelorn Peep loses its faith in love, there is only one solution: the players must join hands in a loving union, and remind the Peeps of the true Power of Love!

4.2 Game Mechanics

Matchmaker's main game screen is presented as a window to the world of the Peeps (Figure 4.4). When the game begins, Peeps will begin to stream into the playing field, wandering on and off the screen in a disorderly, ambling fashion.

Figure 4.4 – *Matchmaker*'s main game screen

Players can use these onscreen Peeps to create their matches. When a player touches a Peep with their finger the Peep will stop moving and a colored halo will surround it, indicating that it is now under the player's control. While a Peep is selected in this way the player can move it to any place onscreen by dragging it there with their finger. When two players drag their selected Peeps together, a match will be created if the two Peeps are "compatible." Two Peeps are compatible if and only if they have the same color and opposite genders. Each player is allowed to select only one Peep at a time. This prevents players from matching Peeps on their own and encourages them to cooperate with their partner in order to succeed (Figure 4.5).

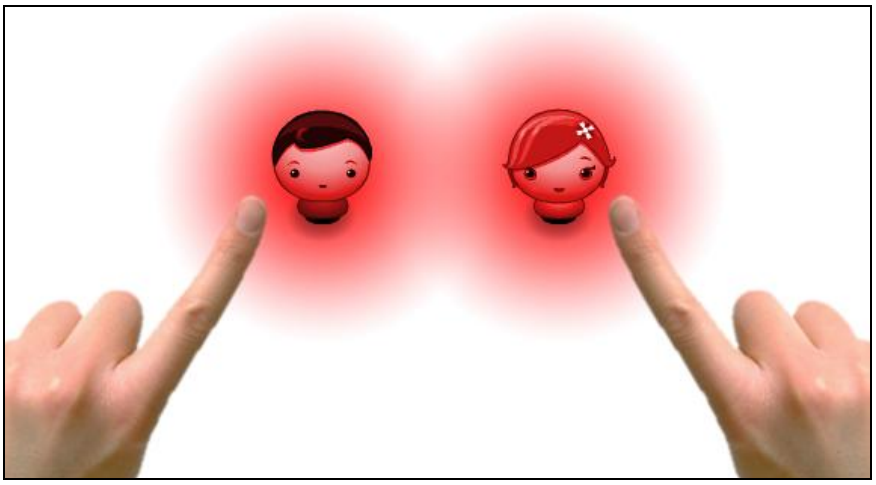

Figure 4.5 – Two players working together to match up compatible Peeps

Whenever the players make a match, a pleasing chime will play and the matched Peeps will disappear from the playing field. Two new Peeps will be created (off-screen) to take their place; this ensures that the total number of Peeps in the world stays constant. If the players drag two incompatible Peeps together, no match will occur. Instead, a buzzer will sound and the selected Peeps will simply wander away from the players' control.

Peeps who are not matched up within a certain amount of time will become lovelorn (Figure 4.3). When a Peep becomes lovelorn, it will start to cry and lose its color, becoming grey. While lovelorn, a Peep cannot be matched up, even with other lovelorn Peeps. Although players can temporarily afford to ignore lovelorn Peeps over time more and more of the Peep population will become lovelorn, making it extremely difficult to create further

matches. The only way to “cure” a lovelorn Peep is through the Power of Love. A player can activate the Power of Love by physically holding hands with their partner and then touching a lovelorn Peep (Figure 4.6). This gesture will restore the Peep’s happiness along with its original color, thereby allowing it to be matched up once again. Peeps which have been cured in this way are still susceptible to become lovelorn again if enough time elapses.

Figure 4.6 – Holding your partner’s hand imbues your touch with the Power of Love

While players are holding hands, they cannot perform normal gameplay actions such as selecting, dragging and matching Peeps; they can only cure lovelorn Peeps through the Power of Love. Although this may seem limiting, this restriction gives the game strategic depth; if the Power of Love was not mutually exclusive with other game actions, players could simply hold hands with their partner throughout the entire game. Under the current gameplay model, players must use touch strategically, forcing them to communicate about when and how they should invoke the Power of Love.

4.3 Design Themes

This thesis is dedicated to the exploration of interpersonal touch through the media of video games. Consequently, I believe that topics pertaining to effective game design are

extremely relevant to this discussion, since the effectiveness of the games that I design and subsequently study will have a direct bearing on my findings and my conclusions.

For that reason, I believe it is worthwhile to consider the importance of theme in game design. A theme is "a central idea in a piece of writing or other work of art" (*The American Heritage Dictionary of the English Language*, 2009) Themes are an important part of game design because they are the vehicles through which meaning is conveyed from the designer to the player. A game is a form of creative expression, like a story. Just as the storyteller must carefully choose their words to convey their message, so too must a designer consider the message sent by their design choices.

Strong, identifiable themes give context, meaning and motivation to the events taking place within a game. A game's identity is defined by the themes it presents – compelling themes will engage players and help them to understand the game, while incoherent themes will confuse players and drive them away. Themes are especially important for games based on interpersonal touch because the game designer is responsible for motivating the use of interpersonal touch as an interaction technique. *Matchmaker*'s use of interpersonal touch was taken directly from the behavior of real-life couples who use touch as a method of conveying affection for their partner.

Matchmaker was designed around three intertwined themes which support the vision of a fun and romantic game for couples. These themes are:

1. Touch: In *Matchmaker*, all interaction is accomplished through touch. Players touch Peeps with their fingers to select them, and they hold hands with their partners to activate the Power of Love. Regardless of how touch is used, it provides a simple and natural way for players to interact with the game and with each other. Touch also serves as tangible reminder of *Matchmaker*'s emotional message, reinforcing the theme of love and cooperation between partners.
2. Love: *Matchmaker* is a game about the search for love. Even the name "*Matchmaker*" hints at the practice of arranging a romantic coupling. Ostensibly, the players are the titular matchmakers, but I see the game itself as a matchmaker –

one which brings the players themselves closer together as the play. By encouraging players to touch as they play, *Matchmaker* promotes an atmosphere of relaxed familiarity where couples can feel comfortable about expressing their love through touch.

3. Cooperation: *Matchmaker*'s game mechanics were designed to reinforce the importance of partnership and togetherness; in *Matchmaker*, everything must be done together with your partner. Players must work together to decide what Peeps to match up and when to use the Power of Love. In fact, playing *Matchmaker* is a lot like being in a romantic relationship: if the partners do not communicate with each other, they are sure to fail. The most successful *Matchmaker* players are those who have learned to anticipate their partner's actions and who work to support them.

4.4 Game Flow

Matchmaker is divided into a series of six stages, each of which is more difficult than the last (Table 4.1). The objective of each stage is to match up a set number of Peeps within a specified time limit. Players proceed through the stages in a linear fashion; when one stage is completed, they move on to the next. If the players fail a stage, they are given the opportunity to restart the game from the beginning of that stage.

In *Matchmaker*'s first stage, Peeps come in only two colors: red and green. This relative homogeneity among Peeps allows new players to get comfortable with *Matchmaker* by ensuring that opportunities for matching compatible Peeps are plentiful. However, as the players progress through stages, the game introduces more and more colors of Peeps making it increasingly difficult to create matches. By stage five, six different colors of Peeps can appear at once, which significantly lowers the likelihood of two compatible Peeps appearing onscreen simultaneously. As opportunities for matching compatible Peeps decrease, partners must learn to act quickly and work cooperatively if they hope to succeed.

Stage	Peep Colors	Time Limit (in minutes)	Matches Required	Stage Notes
1	2	1:30	20	Peeps will not become lovelorn.
2	3	1:30	20	Peeps will not become lovelorn.
3	4	2:00	25	Peeps become lovelorn after ~25 seconds.
4	5	2:00	25	Peeps become lovelorn after ~25 seconds.
5	6	2:00	25	Peeps become lovelorn after ~25 seconds.
6	6	3:00	25	All Peeps spawn as lovelorn. Peeps become lovelorn after ~25 seconds.

Table 4.1 – A list of *Matchmaker*'s stages

In addition to controlling the color of Peeps which are created, each stage affects the rate at which Peeps become lovelorn (Table 4.1). In the first two stages, Peeps will never become lovelorn. This minimizes *Matchmaker*'s early complexity, giving new players the time to master basic mechanics such as selecting and matching Peeps before the mechanic of interpersonal touch is introduced. In stages three through five Peeps will become lovelorn if they are not matched up within approximately 25 seconds. In the final stage, stage six, all Peeps begin their lives as lovelorn. This was designed to provide a final, climactic challenge, forcing players to rapidly alternate between using the Power of Love and matching up Peeps.

4.5 Implementation

Matchmaker was written in C++ using the freely-available libraries GLUT (to perform OpenGL rendering) and FMOD (to play music and sounds.) The game runs on a MERL DiamondTouch tabletop (Dietz et al., 2001) which, during my testing, was powered by a desktop PC running Microsoft Windows XP, with an Intel Pentium 3.2 gigahertz dual core processor, an NVIDIA GeForce 7800 GTX graphics card and two gigabytes of RAM.

In *Matchmaker*, all gameplay functions are performed through the DiamondTouch tabletop. No other peripherals such as mice or keyboards are required to play. Users select Peeps by touching them with their fingers and drag them by moving their fingers over the surface of the table. *Matchmaker* detects interpersonal touch using a unique property of the

DiamondTouch tabletop which was first described in "DiamondTouch: A Multi-User Touch Technology" (Dietz et al., 2001).

The DiamondTouch detects touch using a system of electrical capacitance. Directly below the surface of the DiamondTouch lies a mesh of conductive metal antennae, each channeling a unique electrical signal. When a user touches the tabletop, they become capacitively coupled to these antennae and these same electrical signals begin to flow throughout their body (Figure 4.7). To interact with the DiamondTouch, each user must sit on a conductive pad which is connected to the host PC. These pads act as receivers for the signals coming from the table's subsurface antennae. When a user touches the table, a path is formed which allows these signals to travel from the tabletop, through the user's body, and out to the host PC. By analyzing the incoming signals coming from the receiver-pads the DiamondTouch software can identify exactly which antennae (and consequently, where on the table) each user is touching. (Dietz et al., 2001)

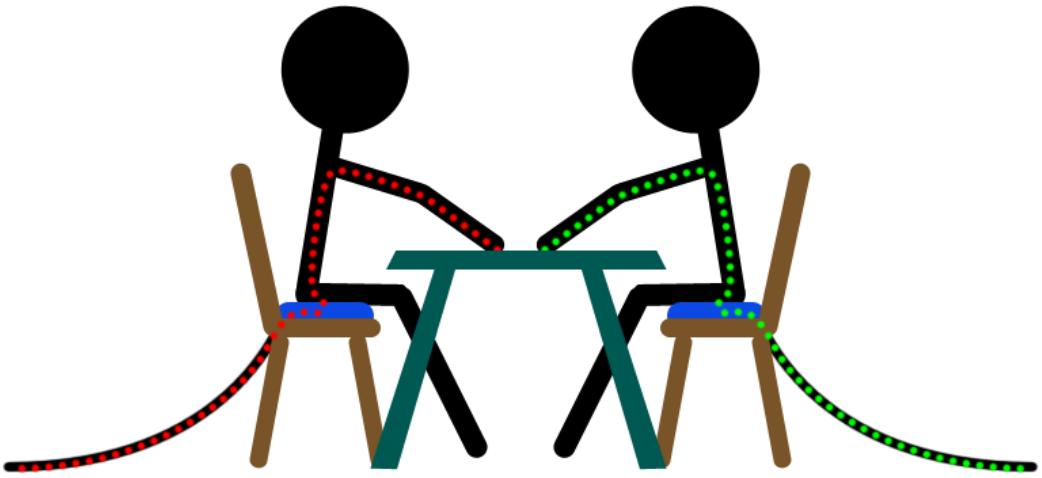

Figure 4.7 – Each user that touches the DiamondTouch conducts a unique signal

Although the DiamondTouch was not explicitly designed to sense when two users are touching each other it can be adapted for this task quite easily. Whenever two users make skin-on-skin contact, they form a connection across which electrical signals can travel. So, whenever two users are touching each other, if either user subsequently touches the surface of the DiamondTouch then *both* users will begin to conduct the signals coming from the tabletop, making it appear as though both users are touching that point on the table

simultaneously (Figure 4.8). Since it is physically impossible for two users to touch the same point on the table at once, these events can be recognized as a consequence of interpersonal touch.

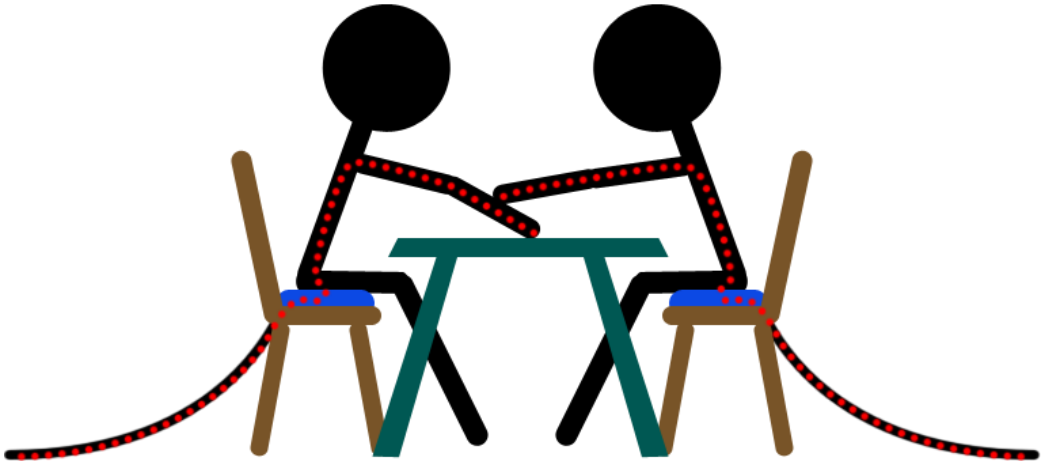

Figure 4.8 – When two users touch, they each conduct the same signal

This method of detecting interpersonal touch has one significant limitation: it cannot detect interpersonal touch unless one of the participants is also simultaneously touching the surface of the table. However this does not limit *Matchmaker*, where interpersonal touch is only relevant to gameplay when players are interacting with Peeps through the tabletop.

4.6 Evaluating *Matchmaker*

Matchmaker and its use of interpersonal touch have been evaluated using two different methods. The first of these methods was a small-scale, exploratory user study in which I invited four romantically-involved (either dating or married) couples to my lab to play *Matchmaker* for themselves. Participants in this study were required to complete a written questionnaire and to participate in a semi-structured dialog concerning their experiences playing *Matchmaker*. In addition to this formal study, *Matchmaker* has also been informally studied based on its long history of public demonstrations. Through these informal demonstrations, *Matchmaker* has been played by over a hundred unique players in the last two years.

In the following sections, I will discuss each these studies, their results and the implications of my findings in turn. I begin with a discussion of my formal user evaluation.

4.6.1 Experimental Design

In this thesis, I have so far argued that a good game is one which provides its players with an enjoyable, emotionally-engaging experience. In exploring and evaluating *Matchmaker*, my goal was straightforward: to determine whether interpersonal touch interfaces could support good games and, if so, to determine how interpersonal touch contributes to the players' emotional engagement.

Therefore, in designing this study, my primary goal was simply to determine whether players would enjoy *Matchmaker* at all – irrespective of the game's use of interpersonal touch. Though this question may seem unrelated to the broader topic of exploring interpersonal touch in games, I argue that it is actually of the utmost importance. Bear in mind that this study of *Matchmaker* was the first formal evaluation of a game based on interpersonal touch. Thus, when designing the experimental procedure for this study I took very little for granted. Although I had conducted a limited number of pilot studies between myself and my coworkers and found the game to be enjoyable, there was still a question as to whether an objective couple would feel the same way. If it happened that *Matchmaker* was simply an unenjoyable game, then surely it would make a poor case-study for examining the value of interpersonal touch in video games.

Having established that *Matchmaker* was at least reasonably enjoyable, my secondary goal for this study was to determine to what extent (and by what mechanisms) interpersonal touch was responsible for this enjoyment. Because of the exploratory nature of this study, I kept my questionnaire items (Appendix A.5) relatively open; I was curious to see what insights participants could give on their experiences of playing with interpersonal touch – or to see if participants would even mention it at all.

Because of the emphasis on fun and enjoyment, the majority of the data collected in this study was qualitative in nature. Data came from my own written observations of the participants' playing behaviors, questionnaire data and transcripts of discussions between

the participants and myself. Although the questionnaire given to participants contains a few Likert items, I argue that "fun" is difficult to quantify; the way in which participants act and the things they say – both during and after the game – should be considered just as important as any numerical analysis.

4.6.2 Participant Demographics

When evaluating *Matchmaker*, I specifically sought out participants in *Matchmaker*'s target audience: romantically-involved couples. In total, I recruited four couples; three heterosexual couples, and one homosexual male couple, making for a total of three female and five male participants. Of these couples, one was married, two were in long-term dating relationships, and one had been dating for less than a year. Participants varied in age from eighteen to thirty-seven. Seven out of eight participants had spent at least one hour in the past week playing video games on a console, a cellphone or a PC.

Participants in this study may be subject to bias; prior to this study, I had a preexisting acquaintanceship with at least one member of every couple. Furthermore, participants in this study were not compensated for their time.

4.6.3 Experimental Procedures

All four experimental sessions followed the same procedure. Upon greeting the participants, I would introduce myself and outline for them the purpose and requirements of the study. Knowing that touch can sometimes be anxiety-provoking, I was always careful to ensure that participants understood that they would be required to hold hands during the experiment. During this briefing session, participants were also informed of their rights, including the right to terminate the study if at any time they felt uncomfortable.

At this time, I would issue each participant a pre-game questionnaire (Appendix A.4). These questionnaires gathered basic demographic information from the participants, including their age, and their prior experience playing video games and using tabletop computers.

After each participant had completed their pre-game questionnaire, I asked participants to sit side-by-side at the head of the DiamondTouch so that their game of *Matchmaker* could begin. Participants were asked to act naturally – to play to the best of their ability, and to act as though an observer was not present. In order to help simulate a natural playing experience, I would not address participants past this point until the experiment had concluded. In my stead, participants received in-game instructions with information on how to play the game and how to proceed. As the participants played through the game together, I would use a notepad to record any interesting occurrences, patterns or behaviors that I witnessed from the players.

Participants were asked to play until either one of two conditions was met: either all six stages were completed and the game was won or the participants failed to complete a single stage three times in a row. Once the couple had finished playing I asked each player to complete a post-game questionnaire (Appendix A.5). These questionnaires included four Likert items, and four short answer written-response questions. All Likert items were evaluated on a seven point scale ranging from -3 (strong disagreement) to 0 (neither agreement nor disagreement) to 3 (strong agreement.) Participants were asked to fill out their questionnaires independently of their partner in an attempt to protect their responses from possible conformity between the two.

After I collected the participants' post-game questionnaires, the three of us would sit down together for an unstructured discussion. These discussions were an opportunity for me to gain additional insight on trends I had observed during the gameplay period. These were also an opportunity for participants to ask questions about the experiment, or *Matchmaker* itself. When the discussion had concluded, I would thank participants for their time, and escort them from the lab.

4.7 Results

Given this study's relatively small sample size and its potential for bias, any or trends or observations drawn from this data must be treated skeptically. More extensive studies are required before any definite claims can be made and demonstrated.

However, despite these overarching concerns, the participants' response towards *Matchmaker* was very encouraging. Perhaps the most encouraging sign of all was the participants' responses to the first statement on our questionnaire: "Overall, I enjoyed playing *Matchmaker*" (Figure 4.9).

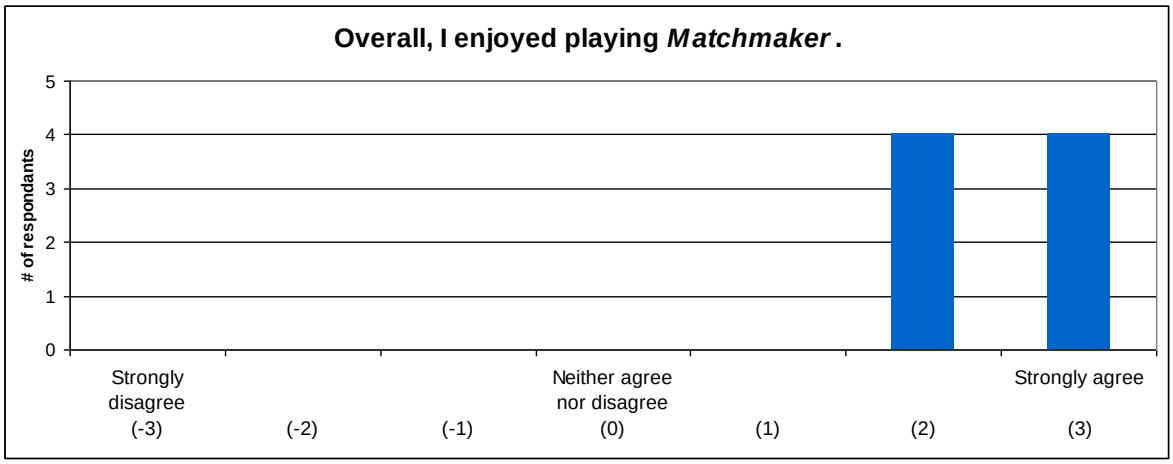

Figure 4.9 – Overall, players enjoyed playing *Matchmaker*

The players' response suggests that they enjoyed playing *Matchmaker*, and my observations of the players' corroborate this: smiling, laughing and joking during gameplay were common occurrences amongst all couples.

The players' self-reported enjoyment is especially noteworthy considering how many participants failed to complete the entire game: of the four participating couples, only one managed to beat all six stages – the other couples were unable to progress past stages three, three, and five, respectively. As a result, the game's difficulty-level received a significant amount of negative attention in players' post-game questionnaires. When asked what he disliked about *Matchmaker*, one participate wrote, simply: "[It gets] too difficult too quickly." However, the players' strong affective response in spite of *Matchmaker*'s high

difficulty-level suggests that even those who encountered difficulty with the game still found something about it to enjoy.

It is likely that the players' enjoyment of *Matchmaker* was due in part to *Matchmaker*'s presentation and themes. Not only did participants agree strongly with the statement "I liked *Matchmaker*'s themes of love and romance" (Figure 4.10), but many participants commented favorably on *Matchmaker*'s polished and "professional" appearance. One participant compared the Peeps to the stylized "Mii" characters used by the Nintendo Wii, while another praised the game for its "cutsey [*sic*] feel". I also frequently observed players spontaneously emoting (e.g. "awww!", "oh, wow!") during key gameplay moments (such as the players' first time using The Power of Love) which suggests that *Matchmaker* was successfully engaging its players on an emotional level.

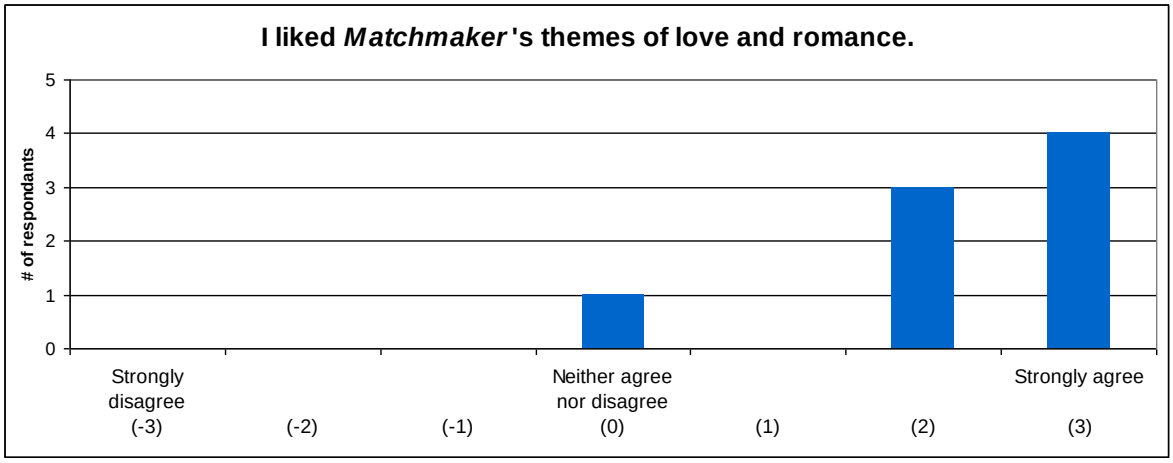

Figure 4.10 – Participants generally liked *Matchmaker*'s romantic theme

4.7.1 Tabletop Interaction

Players' feelings towards interacting with the DiamondTouch tabletop were mixed. On one hand, many participants seemed to enjoy the ease with which they could interact with the touch-sensitive surface. As one male participant wrote in his post-game questionnaire: "The multitouch surface made it easy to play; [you] just drag the Peeps together." During our interview, a female participant remarked that *Matchmaker*'s tabletop interface made it "accessible" to gamers of all stripes since only required simple skills such as touching and

dragging, as opposed to the complex, multi-button control schemes required to play many modern games.

However, *Matchmaker*'s tabletop interaction also came with an unexpected drawback: in their post-game questionnaires, two of the eight participants wrote that playing *Matchmaker* had hurt their fingers. Based on my observations, this phenomenon is most likely related to the Peeps high movement-speeds. When players needed to grab an important Peep before it could escape off-screen, they often lunged at high speeds, causing them to jab the tabletop surface with their fingers. Although a firm touch is no more accurate than a soft touch, most participants did not seem to recognize this and, in their excitement to grab Peeps, they were prone to these painful stabbing gestures.

4.7.2 Interpersonal Touch

Of all the Likert items I posed to participants, "I feel that *Matchmaker* made use of interpersonal touch in a significant way (i.e. the game would not be the same without it)" received the most highly varied responses (Figure 4.11). Though the graph reveals an overall trend towards agreement, there is no obvious consensus on the issue.

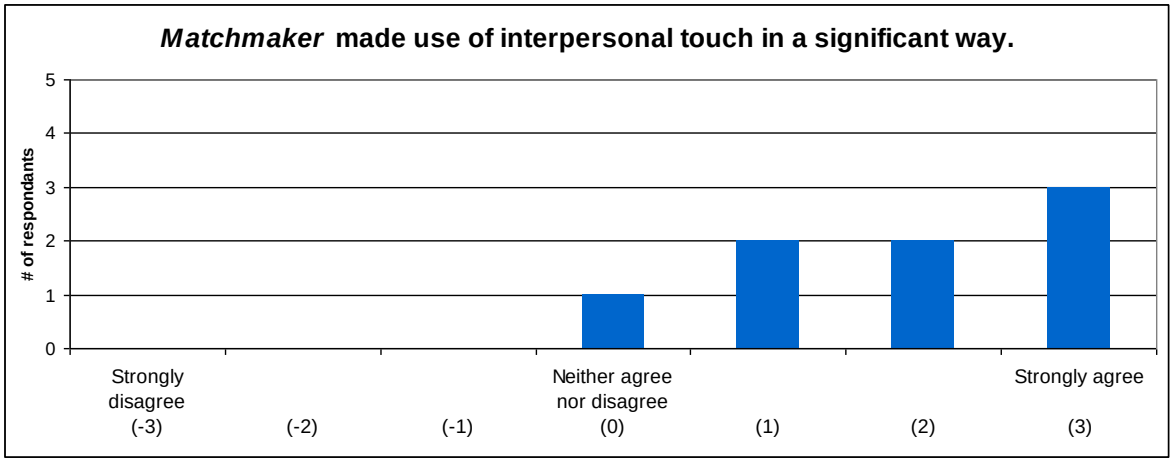

Figure 4.11 – Participants revealed varying opinions on *Matchmaker*'s use of touch

4.8 Discussion

Although players were generally appreciative of *Matchmaker*, the formal evaluation brought to light some issues which have important implications for the design of *Matchmaker* and other games based on interpersonal touch.

4.8.1 Game Difficulty

Matchmaker's prohibitively high difficulty-level is very much at odds with the experience *Matchmaker* was designed to provide. *Matchmaker* was designed to provide couples with a light-hearted, breezy experience – the goal was to encourage and reward players, not to beat them down. The fact that only one out of four couples could complete the entire game is problematic; although a typical game may take days or even weeks to complete, *Matchmaker* was designed to provide a quick, one-time experience suitable for demonstrating the use of interpersonal touch in games.

Many factors contributed to *Matchmaker*'s excessive difficulty. Peeps moved too quickly and vanished off-screen before players could use them to make matches. They also became lovelorn too quickly, overwhelming players with the dual responsibilities of matching up Peeps and invoking the Power of Love. Finally, stages ended too quickly, causing players to fail when they only had one or two matches left remaining.

I believe that future versions of *Matchmaker* could benefit from the addition of a user-controlled adjustable difficulty level – this would allow less-skilled players to tone down the difficulty of the game so that they could comfortably work through the game with their partners in a single sitting.

4.8.2 Interpersonal Touch

What could account for players' mixed reactions towards *Matchmaker*'s use of interpersonal touch? I believe that there are several factors which may have influenced participants' feelings. One of these factors may be *Matchmaker*'s unbalanced difficulty. Consider this: four out of eight participants in this study never made it past level three – the

level in which interpersonal touch is first introduced. It may be that players who lost the game at this early stage simply did not have enough time to play with interpersonal touch and to become accustomed to it. The statistics support this theory to some extent: there is positive correlation ($\rho = 0.54$) between the number of stages a player completed and their response to the statement "I feel that *Matchmaker* made use of interpersonal touch in a significant way." However, due to study's small sample-size, this finding cannot be considered statistically significant.

Another factor which may have colored participants' opinions towards interpersonal touch is the fact that touching your partner prevents you from selecting and dragging Peeps. A male participant conveyed his dissatisfaction with this mechanic in his questionnaire when he wrote: "It was […] confusing. It's counter-intuitive to have to let go [of my partner's hand] to match up couples." In another couple, I observed the female participant frequently touching her partner without any forewarning, preventing him from selecting Peeps until she let go. Having control wrested away from him clearly upset this player – in his questionnaire, he wrote: "It was frustrating trying to coordinate touches when you notice a pair [of compatible Peeps] and your partner doesn't." Although I can see how players may get frustrated by this use of touch, this is one aspect of *Matchmaker* which is unlikely to change. The goal of game design is not always to make the game easier; oftentimes, making the game more challenging ultimately makes it more fun. Part of the challenge of *Matchmaker* is learning to communicate with your partner about when and how interpersonal touch should be used. As one insightful participant wrote: "[Interpersonal touch] made the game more challenging in an interesting way. It was less about the actual act of contact, and more about the coordination challenge." Although a game where you could touch your partner and match up Peeps simultaneously would certainly be easier, it would not be more fun. In fact, such a game would actually detract from the value of interpersonal touch, as there would be no compelling reason to let go of your partner's hand.

Despite these reservations, players were largely positive about interpersonal touch in their written comments. When describing touch's contribution to *Matchmaker*, participants

mentioned both the romantic and cooperative aspects of touch. A female participant expressed her appreciation for the romantic aspects of touch when she wrote: "[Touching my partner made me feel] like I was sharing my love in a corny but fun way." In contrast, her partner praised interpersonal touch's cooperative aspects when he wrote: "[Interpersonal touch] really made the game more collaborative. Both players really needed to work together to be successful."

4.8.3 *Matchmaker* as an Icebreaker

Although *Matchmaker* was never explicitly designed as a way to woo romantic interests, it can certainly function as such. Inviting a partner to play *Matchmaker* can be seen as a form of casual flirtation; it is an opportunity for two players to playfully touch each other in a way which is still respectful of social boundaries. Although *Matchmaker* is designed around touch, it does not encourage players to focus on the act of touch – instead, *Matchmaker* provides players with a fun, collaborative activity which the partners must work together and strategize to overcome, and it integrates touch as a meaningful part of that collaboration.

Because of *Matchmaker*'s potential as a way to demonstrate playful affection, I believe imagine that *Matchmaker* installations could be very popular in dating venues such as pubs and movie theatres. One can easily envision a young couple agreeing to play "that silly matchmaking game" with the ostensible purpose of killing time before their movie, but with each partner secretly delighting in the promise of guiltless handholding.

4.9 Informal Evaluations of *Matchmaker*

Because of its unique gameplay and its hands-on nature, *Matchmaker* has become one of the most popular demos of my research group. Thus, in addition to the eight participants who played *Matchmaker* through the aforementioned formal evaluation, more than one hundred participants have also played the game through the series of informal demonstrations I have conducted over the last two years. From 2007 to 2009, *Matchmaker* has been demonstrated to students, visiting researchers, guest lecturers, businesspeople and

academic committees. These demonstrations have ranged from very personal *tête-à-têtes* to presentations to crowds of ten to fifteen people. I feel that the best way to understand *Matchmaker* is to try the game for yourself and so these demonstrations usually take the form of hands-on playtests; if I am presenting to a single individual then they and I will play together – otherwise, I will usually ask my audience for two volunteers. I am always careful to warn my participants ahead of time that playing *Matchmaker* will involve holding hands with their partner, but so far no one has refused to play on those grounds.

These demonstrations are typically short, approximately 10 minutes on average. This provides me with time to describe the game, to introduce players to the mechanics of touching and matching and to culminate with a demonstration of interpersonal touch and the Power of Love. In spite of their brevity, these casual demonstrations (and the discussions which occur afterwards) are the reasons I feel confident to describe *Matchmaker* as a fun game which makes effective use of interpersonal touch. Time and time again, I have listened to visitors giggle, smirk and laugh as I introduced the game, and I've watched them gasp in amazement the first time they witness The Power of Love in action. I've even had players ask if they could return at a later date to play *Matchmaker* with their significant other.

One of the most memorable demonstrations of *Matchmaker* occurred during a tour of our laboratory by a departmental review committee. A group of serious and formally-dressed officials had assembled around the DiamondTouch table when I called out a request for players. Two distinguished men volunteered and as they sat, I explained the game to them. But when it came time to explain *Matchmaker*'s handholding mechanic, a quiet hush fell over the attending crowd. How would these professional men handle this distinctly unprofessional situation? After a second of silence, one man grinned broadly, turned to the other, and said: "I'm game if you are." And from that point on, the crowd was all smiles; from the observers to the players themselves, everyone laughed and cracked jokes and they enjoyed the absurdity of the two platonic business associates playing this romantic game together.

In its history of demonstrations *Matchmaker* has provoked everything from bawdy jokes to academic discussion, but it has very rarely provoked disinterest. Over time, these demonstrations have helped me to understand *Matchmaker* strengths and validated its cooperative approach towards interpersonal touch.

4.10 Conclusions

In this chapter, I have introduced *Matchmaker*, a two-player, cooperative tabletop game which explores the use of interpersonal touch interaction in a romantically-themed setting. *Matchmaker* uses touch as both a symbol of romantic love, and as a way to bring its players together in cooperation, enhancing the social aspects of play through the physical connection that players share.

Based on the results of a controlled user study and of dozens of informal demonstrations, *Matchmaker* was found to be a highly enjoyable game, with an appealing take on the theme of romance. Further examination of these results suggested that interpersonal touch played a key role in shaping *Matchmaker*'s unique appeal, accentuating both the game's romantic theme, and its cooperative gameplay.

Chapter 5. *Prism Squad: GO!*

Watching players interact with *Matchmaker* had convinced me that the topic of interpersonal touch in games was ripe for further study. Despite a lack of rigorous formal analysis, it was clear to me that players enjoyed *Matchmaker*'s cooperative gameplay – and it seemed as though collaborating through interpersonal touch was a meaningful part of that enjoyment.

Yet, for all its strengths, *Matchmaker* also had its limitations. Designing a romantic game was a relatively cautious way of approaching interpersonal touch in games since the couples who played it were already receptive to the idea of touching their partners. Although *Matchmaker* was well-liked by its players, one could argue that its success tells us little about the effectiveness of interpersonal touch in more general gaming contexts; is interpersonal touch an interaction technique which is only useful in romantically-themed games, or can it positively contribute to other genres of games as well? *Matchmaker* was a tentative way for me to get my feet wet with interpersonal touch, but now that I had seen players' positive reactions to the game and it use of interpersonal touch, I was eager to explore the use of touch in new gameplay scenarios.

Matchmaker was also cautious in the way that it limited gameplay to just two players. Among two players, interpersonal touch is a binary state – either the players are touching, or they are not. But as the number of players increase, the total number of possible "touch-states" increases dramatically. With three players there are five unique touch-states and with four players there are twelve. With more players involved, decisions surrounding when, who and how to touch can potentially become more complex. This complexity may open up interesting avenues of game design, but may also introduce unintended consequences. In either case, the number of players involved is certainly a relevant

consideration for designing interpersonal touch interaction in game design, and one which I was interested to explore in my follow-up to *Matchmaker*.

Taken together, these two considerations led directly into the development of *Matchmaker*'s successor: *Prism Squad: GO!* Like *Matchmaker*, *Prism Squad: GO!* is a cooperative, multiplayer game based on interpersonal touch. However, *Prism Squad: GO!* pushes the boundaries of interpersonal touch interaction by putting it at the center of a three-player, science-fiction shoot-'em-up.

Prism Squad: GO! uses interpersonal touch to facilitate a cooperative gameplay mechanic called "color blending". In *Prism Squad*, each player's body is metaphorically infused with its own color of supernatural energy. When two players touch, their "energies" flow between them, combining in their bodies to form an altogether new color of energy. Though this may sound like a strange idea, the concept of transferring energy through interpersonal touch stretches back more than two thousand years. Jesus himself is said to have healed the sick by laying his hands on them (e.g. Matthew 8:2-3, Matthew 8:14-15). Similarly, practitioners of *Reiki* (the Japanese art of spiritual healing) believe that they can channel *ki* (life energy) from their body into a patient through touch (International Center for Reiki Training, 2009).

Prism Squad: GO! is played using Nintendo Wiimotes, and a large-screen display (Figure 5.1). Although *Prism Squad: GO!* was designed to make use of interpersonal touch

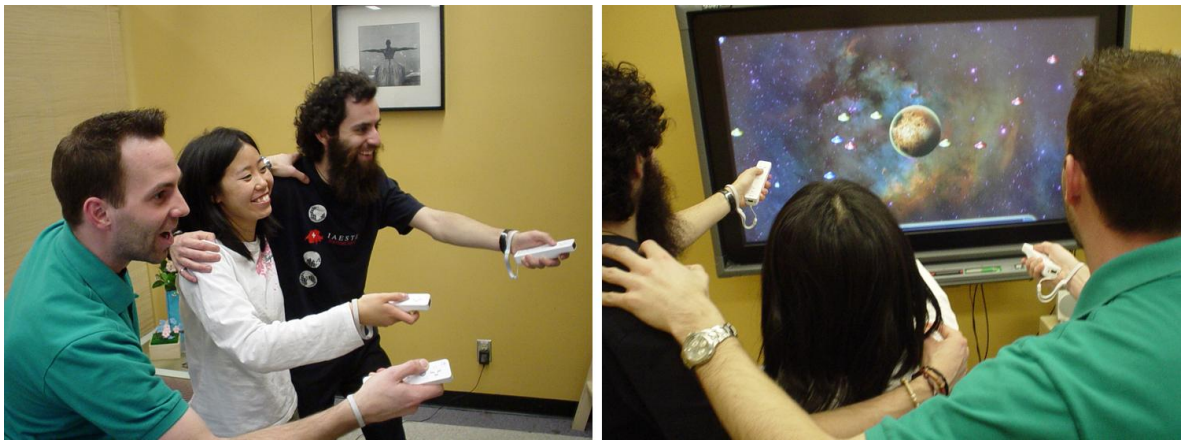

Figure 5.1 – A conceptual photo, depicting three players playing Prism Squad: GO!

between players, the implementation of *Prism Squad: GO!* presented in this thesis does not include a working touch-sensor. Detecting when two people are touching each other is a non-trivial engineering problem and as of this writing there are no simple, ready-made solutions available to the public. I started developing *Prism Squad: GO!* before I had a reliable method of detecting interpersonal touch because I was confident that, by the time I was finished, a solution could be found. Sadly, this never came to pass and as of this writing, research into a solution for detecting interpersonal touch is still an ongoing effort within my research group. I discuss the current progress of this research effort in section 5.5.2 and provide details on our next steps in section 7.2.1.

To address this limitation, the version of *Prism Squad: GO!* reported in this thesis uses a form of "simulated touch" in its gameplay. In this implementation of *Prism Squad*, the 'A' button on each player's Wiimote has been designated as the "touch" button. Whenever two (or three) players hold this button simultaneously, *Prism Squad: GO!* acts as if those players are touching each other and blends their colors together. Admittedly, this method of simulating touch is imperfect because it eliminates the players' need to physically interact with each other. However, it still serves as a way for players to cooperate between themselves. For this reason, I believe it is prudent to consider *Prism Squad* as a case study of how interpersonal touch can potentially foster cooperation between teammates, rather than as a complete examination of the benefits and drawbacks of interpersonal touch in video games.

5.1 The Story of *Prism Squad: GO!*

In the year 2101, humanity's peaceful isolation was shattered by the arrival of the Spek'Tral armada – an alien war machine hell-bent on subjugating the Earth and all of its inhabitants. Though the forces of Earth fought valiantly against the invading Spek'Tral, the tide of war quickly turned against them. In a desperate final bid for survival, the Earth Defense Coalition assembled three of the planet's most celebrated space fighters in an elite fighting force codenamed "Prism Squad."

Through a series of daring tactical strikes, Prism Squad accomplished what many thought impossible; they disrupted the Spek'Tral's supply lines, forcing them to retreat from the battlefront. Following their victory over the Spek'Tral, Prism Squad left the Earth for parts unknown, vowing to pursue the remnants of the Spek'Tral forces wherever they fled.

Centuries have passed since then, and the children of Earth have all but forgotten the horrors of war. But one fateful day, when a Spek'Tral scouting party is unexpectedly spotted hovering near Venus, the Earth Defense Coalition realizes that their planet is in peril once again. With heavy hearts, the Earth Defense Coalition sends a distress signal to their protectors in the sky: "Prism Squad! Come in Prism Squad! The Earth needs your help once more!"

5.2 Game Mechanics

Prism Squad: GO! is a two-dimensional shoot-'em-up where three players work together to protect the galaxy from the invading Spek'Tral. (Figure 5.2)

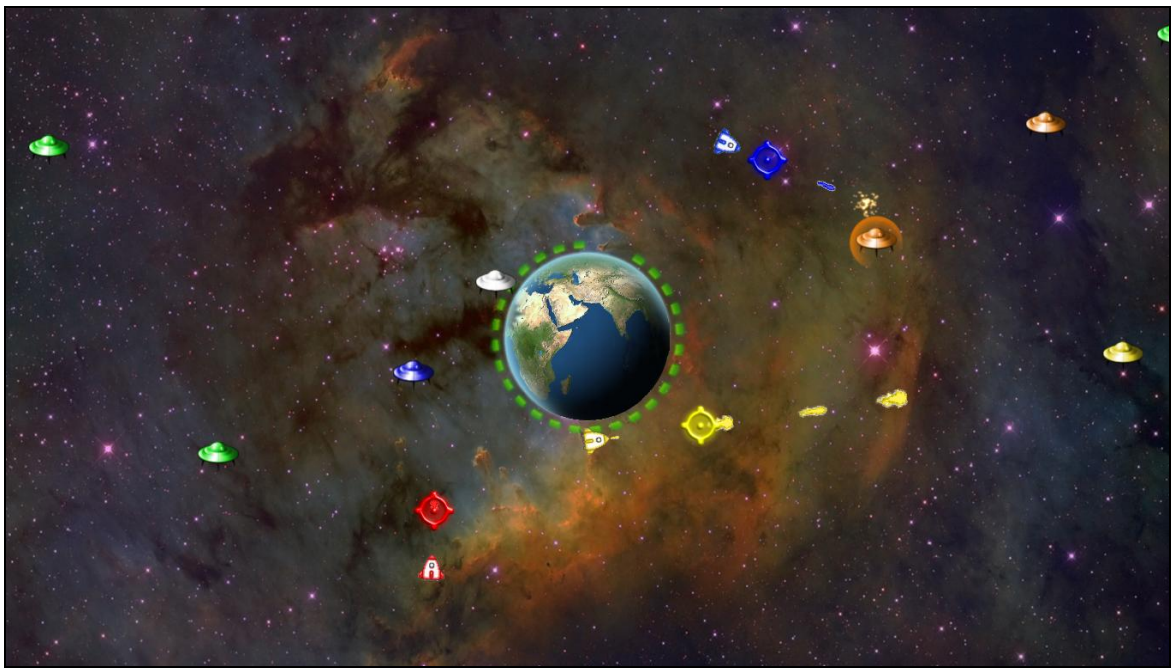

Figure 5.2 – *Prism Squad: GO!*'s main game screen

Prism Squad is made up of three members, known only by their codenames: Prism Red, Prism Yellow and Prism Blue. In *Prism Squad: GO!* each player controls one of these team members as they pilot their brightly-colored spaceships across the galaxy. Players control the movement of their ships using the pointing functionality of the Nintendo Wiimote. When the player aims their Wiimote at a location onscreen, the player's ship will automatically move towards that location in a straight line. Players can temporarily stop their ship from moving by pressing and holding the "down" button on their Wiimote.

Prism Squad: GO! is broken up into a series of stages, each of which is based around defending one of the planets in our solar system. In each stage, the "planetary objective" appears at the center of the stage, surrounded by a circular green halo which represents the planet's health. During the game, enemies will attempt to attack your objective by crashing directly into it. Whenever an enemy successfully collides with the planet, the enemy will explode and the planet's health will decrease. As a planet's health decreases, the circular halo will "unwind" in a clockwise pattern, changing from green, to yellow, to red. As planets become increasingly damaged, pillars of smoke will erupt from their surface (Figure 5.3). When a planet's health has disappeared completely, the planet has been destroyed and the players have lost the game.

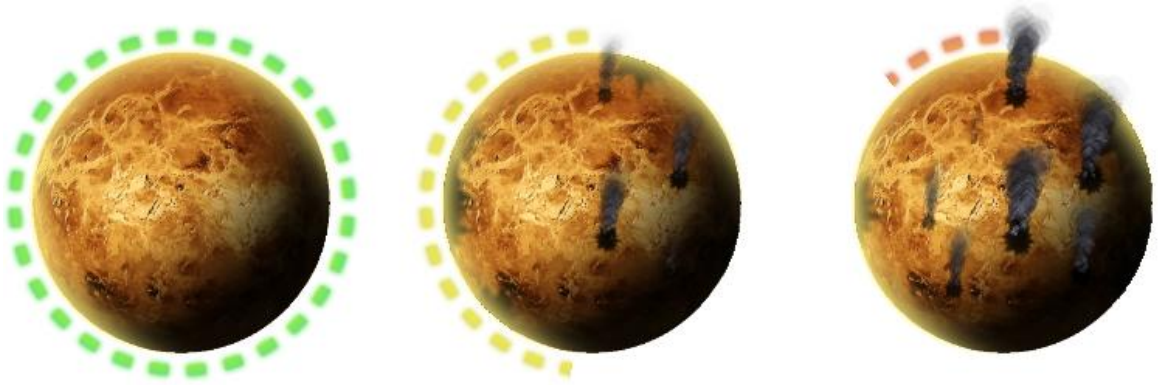

Figure 5.3 – Smoking craters appear as a planet becomes progressively more damaged

The players' goal in each stage is to protect their objective by shooting down incoming enemies before they can reach the planet. At any time, a player can shoot a colored laser from the nose of their ship (Figure 5.4) by pressing the 'B' button on their Wiimote. Each

ship produces lasers which correspond to the color of the ship itself; players cannot change the color of their laser, except by blending with their teammates (described in section 4.2.1, below.)

Figure 5.4 – Each member of Prism Squad fires a different-colored laser beam

In *Prism Squad*, there are eight different types of enemies (Figure 5.5). The most basic enemy is the meteor. Meteors are not agents of the Spek'Tral, just ordinary space debris. Still, if left unchecked they can damage your planetary objective. A single shot from any player will destroy a meteor.

Figure 5.5 – *Prism Squad*'s enemy roster

The remaining seven enemies are UFOs. Unlike a meteor, a UFO can only be destroyed by a laser which matches the color of the UFO itself. Lasers of any other color will be nullified by the UFO's energy-shield, leaving the UFO unharmed.

Red, yellow and blue UFOs are called "primary" enemies. The colors of these enemies correspond to the individual colors of Prism Squad. To destroy a primary enemy, the appropriately-colored player must shoot it once with an appropriately-colored laser.

Orange, green, purple and white enemies are called "secondary" enemies. Unlike primary enemies, which can be destroyed by a single player working alone, secondary enemies can only be destroyed by two or more players working in tandem. In order to produce the orange, green, purple and white lasers required to defeat these secondary enemies, players must combine their colors using *Prism Squad: GO!*'s blending system.

5.2.1 Blending

In 1810, the German artist, scientist and philosopher Johann Wolfgang von Goethe published *Zur Farbenlehre* (*Theory of Colours*), his treatise on the nature of color, and a rebuttal to Isaac Newton's own observations. Where Newton believed that white light was comprised of individual colored elements, Goethe proposed a system where white light was pure and indivisible, and color arose only through the interaction of light and shadow. Goethe's observations led him to propose what is today known as the RYB ("red, yellow, blue") color model – a subtractive system of color, wherein the three color primaries red, yellow and blue blend together to create new colors. Goethe's color wheel depicts the three primaries, separated by the three secondary colors which they combine to create: red and yellow make orange, yellow and blue make green, and blue and red make violet (Figure 5.6).

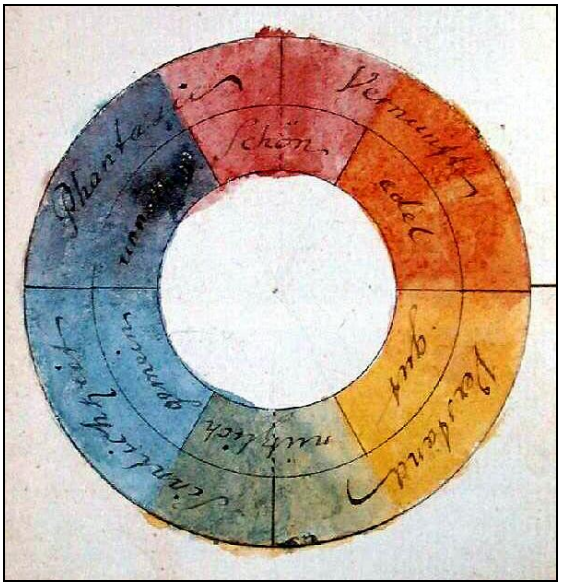

Figure 5.6 – A color-circle depicting the RYB color model (Goethe, 1810)

Although Newton's theories on color were ultimately shown to be correct, the RYB color-model remains well-known because it accurately models the effects of blending subtractive media such as paints and dyes. In fact, most people have an intuitive understanding of the RYB color model because of their early-life experiences mixing paints in art class.

Figure 5.7 –Red and yellow paints blend to make orange, as in the RYB model

Prism Squad: GO! leverages players' intuitive understanding of the RYB model in its blending mechanics. At any time during the game, if two or more players simultaneously hold down the 'A' button on their Wiimote, their colors will be combined according to the RYB model: red and yellow make orange, yellow and blue make green, and red and blue make violet. When all three players blend at once, their colors combine to make white[8]. So long as the players hold down the 'A' button, each participating player's ship will glow with their blended color and any lasers their ship produces will be of the blended color as well (Figure 5.8).

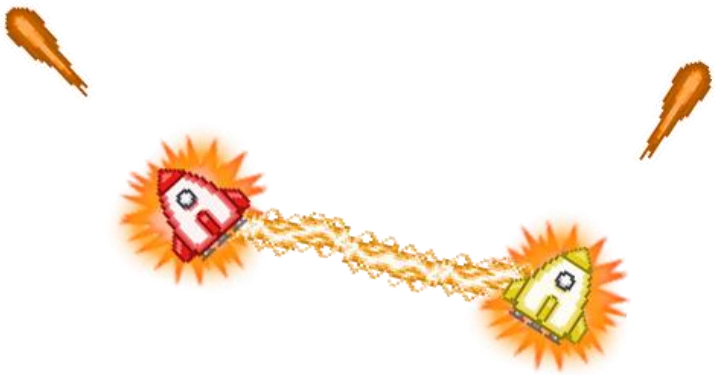

Figure 5.8 – Prism Red and Prism Yellow blend their colors to produce orange lasers

[8] This is a departure from the traditional RYB color model in which red, yellow and blue combine to make black. Unfortunately, black objects are harder to track against a dark, starry background, so for the sake of the players, *Prism Squad: GO!* uses white instead.

Much of the excitement in *Prism Squad: GO!* comes from deftly coordinating blends with your teammates to take on an ever-changing onslaught of colorful Spek'Tral ships. Needless to say this requires great coordination – but it also requires discretion: if all players try to blend colors at once, the resultant color will be white, and no player will be able to get the color they need. Sometimes, being a good teammate means stepping back and letting your partners blend while you wait your turn. By being polite and giving each player time to form the blends they need, you can ensure your team's success.

5.3 Game Flow

5.3.1 The Stage Model

Prism Squad: GO! is broken into a series of stages which follow the Prism Squad's ongoing fight against the Spek'Tral. The game begins on Venus, where the Spek'Tral are first sighted, and then progresses to Pluto, Callisto, Mars, Io and the Moon, before culminating in a final showdown high above the Earth (Figure 5.9).

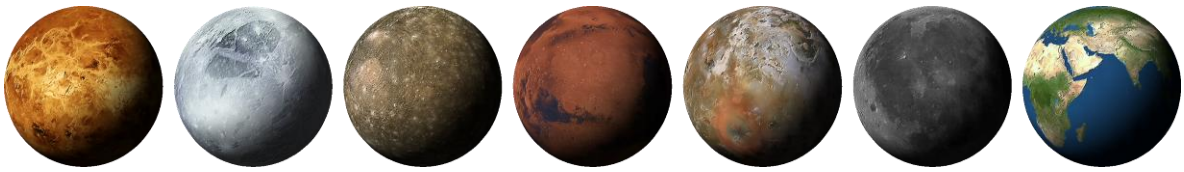

Figure 5.9 – The seven planets of *Prism Squad: GO!*

In each stage, the players' goal is simply to "hold out" for the required time limit – to protect the planetary objective from harm until the Spek'Tral's attack falters. If the Spek'Tral can reduce the planet's health to zero before the time limit expires, then the players have failed – the planet is destroyed and the players will be given the opportunity to retry the from the beginning. However, if at the end of the stage's time limit the planetary objective still has some health remaining then the team has successfully defended the planet and they can advance to the next stage.

Prism Squad: GO! assumes a gradual difficulty-curve, becoming more and more challenging as the team advances through the stages. The first stage, Venus, is designed to give the team an introduction to *Prism Squad*'s basic gameplay mechanics such as moving

Planet	Time Limit (in minutes)	Hits Allowed	Types of Enemies Appearing in this Stage
Venus	1:00	25	
Pluto	1:00	30	
Callisto	1:00	30	
Mars	1:00	30	
Io	2:00	40	
Moon	2:30	40	
Earth	3:30	40	

Table 5.1 – Details for *Prism Squad: GO!*'s seven stages

and shooting before more complicated mechanics (such as blending) are required. The individual color blends are then introduced to players one-by-one over the course of the next three stages; this gradual introduction was designed to ingrain the color-combinations in players' minds, as the remainder of the game relies on the players' mastery of these combinations. Table 5.1 details *Prism Squad*'s seven stages – it includes the name of each planet, the time limit for that stage, the number of hits a planet can absorb before it is destroyed and the types of enemies which will appear in that stage. For example, in the first stage (Venus) the team has to battle an assortment of meteors, as well as red, yellow and blue UFOs. The second stage, Pluto, is similar to Venus, except that orange UFOs will also periodically appear in the mix.

Each stage of *Prism Squad: GO!* features a briefing, a fight scene, and a conclusion (Figure 5.10). At the beginning of each stage, Commander Wolfgang – the Earth Defence Coalition's liason to Prism Squad – will appear to brief Prism Squad on their next objective. This briefing scene motivates the coming fight, and advances the plot of the game. Briefings occasionally also hint at which colors of enemies will appear in the forthcoming stage, giving players the opportunity to prepare their strategies before the stage begins. After Wolfgang's briefing, the game transitions to the fight scene. During this phase of the game, enemies will appear in a continuous stream from both the left and right sides

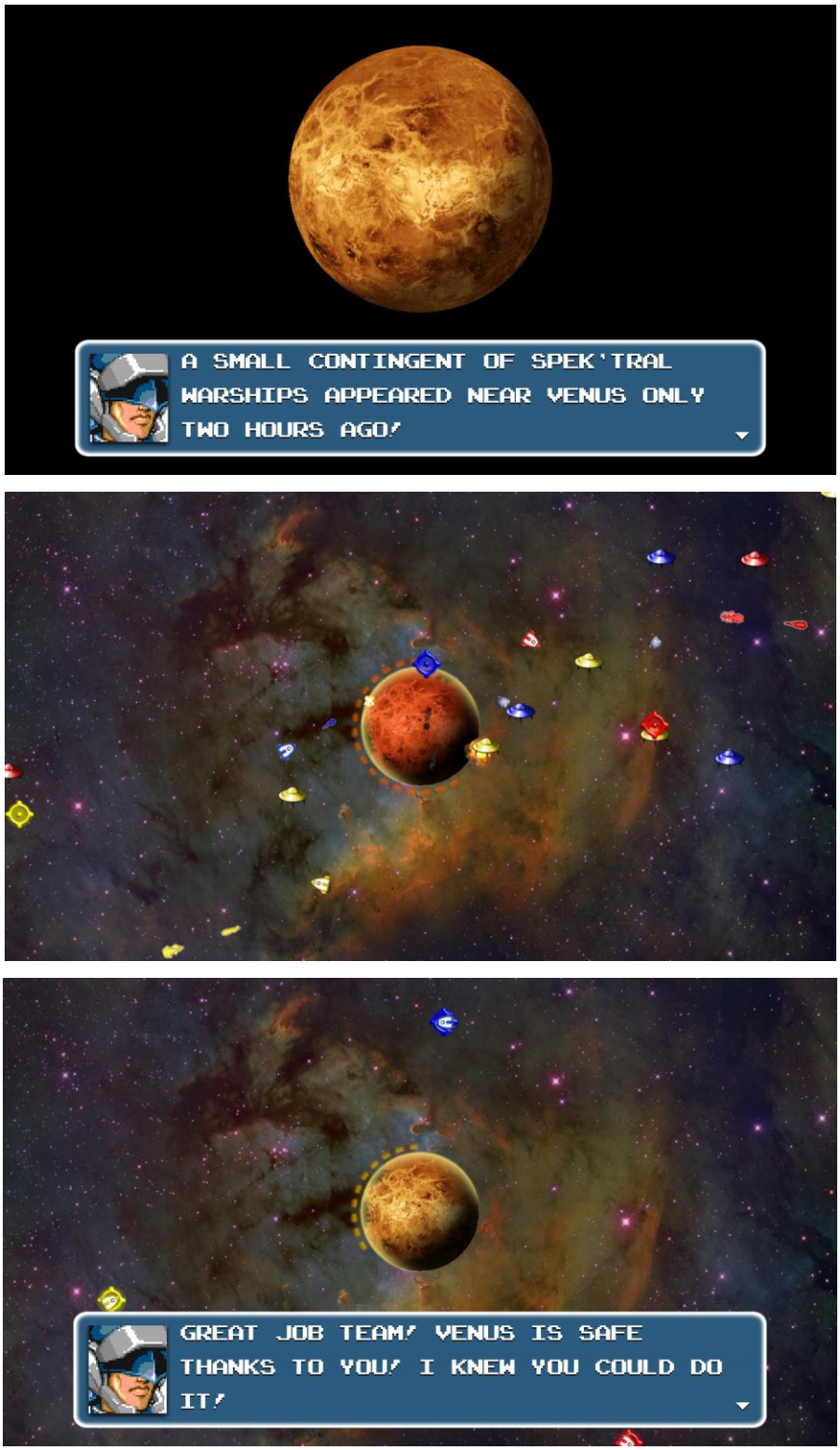

Figure 5.10 – The sequence of events for a typical stage in *Prism Squad: GO!*

of the screen, all of them travelling on a collision course with the planetary objective. In this phase, the players must steer their ships, shoot their lasers, and blend colors with their partners in order to protect their objective. If at any time during the fight scene the planet's health is reduced to zero then the scene will immediately fade to black and Commander Wolfgang will appear to chide the team on their performance. Players are then offered the chance to try the stage again from the beginning. However, if the team can protect their objective for the required amount of time, then a victory fanfare will play and Wolfgang will appear to offer his congratulations to the team. These congratulations are always short-lived though, as they are inevitably interrupted by an emerging crisis on another planet. This leads the team back to briefing room, starting the cycle over on a new planet.

5.3.2 "Flow" and the Adaptive Difficulty System

Maintaining an appropriate difficulty-level throughout the course of an entire game is one of the most challenging – and important – aspects of game development. As Jesper Juul wrote in his book, *Half-Real*: "Part of the attraction of a good game is that it continually challenges and makes new demands on the player's repertoire." (Juul, 2005). Ralph Koster took these comments a step further in his book, *A Theory of Fun for Game Design*, stating: "True fun is the emotional response to learning." (Koster, 2005) Koster wrote that learning is fun. But in games, as in life, we can only learn when we are challenged. Thus in order to be fun, a game must continuously provide its players with challenging situations[9].

Both Koster's and Juul's writings on fun have been inspired by the work of Hungarian psychologist, Mihály Csíkszentmihályi and his book, *Flow: The Psychology of Optimal Experience* (1990). Csíkszentmihályi describes flow as a "rare state of consciousness [where] challenges are high and personal skills are used to the utmost." Flow is something we have all experienced at one time or another. Colloquially, it is known as being "in the zone" (Csíkszentmihályi, 1997). Flow is not just related to gaming; it can occur whenever we are pushing the limits of our skills – from practicing piano to playing

[9] This highlights an interesting difference between video games and other software applications. In a typical software application, everything is designed to be as simple as possible. However, in the case of video games, it is often necessary to make things *harder* for the player in order to create a more enjoyable final product.

football. But the theory of flow is of particular interest to game developers because of the way it relates challenge and ability (Figure 5.11).

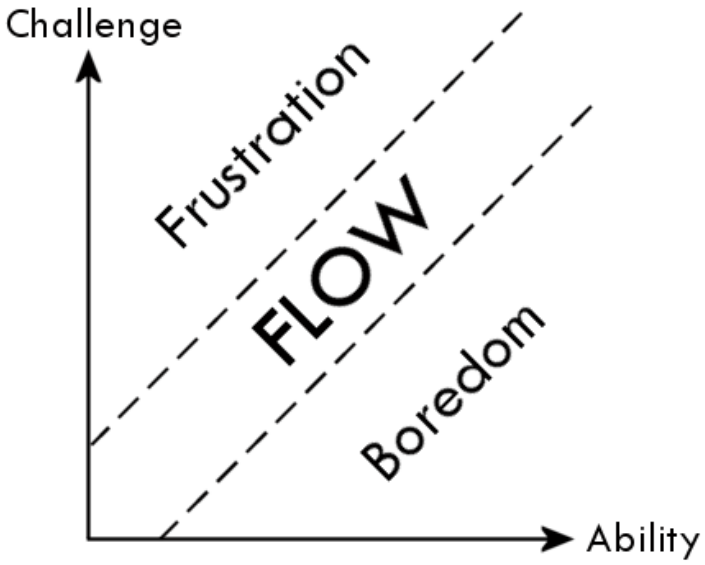

Figure 5.11 – The relationship between challenge, ability and flow

When we find ourselves in a situation where the challenge outpaces our ability, we will become frustrated. On the other hand, if our ability far exceeds the challenge, we will become bored and under-stimulated. Only when challenge squarely meets ability do we feel the gratifying sensation of flow. But maintaining flow through the course of an entire game can be quite difficult. As a player works their way through a game, they inevitably become more and more skilled. Challenges which once seemed difficult will quickly become trivial and boring. Thus, in order for a video game to maintain flow it becomes necessary to present the player with greater and greater challenges as the game goes on.

The problem with this method is that every player learns at their own rate – while one player may advance their understanding quite quickly, other players may need repeated exposures before they can fully internalize a new idea. This leads to one of the fundamental questions of game design: how can we advance a game's difficulty in a way which will make all players happy?

Prism Squad's solution to this problem is to use an adaptive difficulty system – a rudimentary artificial intelligence which covertly modifies the game's difficulty in response

to the players' ongoing performance. In *Prism Squad,* the adaptive difficulty system tracks a running handicap based on the team's history of successes and failures. The handicap is initialized with a value of 0 when the game begins. Whenever the players fail a stage, the system adds a fixed value, *x*, to the handicap. Whenever the players win on their first attempt at a new stage, *x*/2 is subtracted from the handicap. As the players' handicap increases, the adaptive difficulty system subtly slows the rate at which new enemies appear while simultaneously increasing the number of hits a planet can take before its destruction. Although adaptive difficulty is a simple feature, I believe it is also very important because it allows teams of various skill levels to play at a level which is matched to their ability.

5.4 Design Themes

Like *Matchmaker*, Prism Squad: GO! was designed around three themes which were designed to emphasize its overarching message of teamwork through interpersonal touch. Those themes are:

1. Interpersonal Touch: *Prism Squad: GO!* was specifically designed to investigate how interpersonal touch can contribute to cooperative, team-based gameplay. In fact, *Prism Squad*'s most significant cooperative mechanic – color-blending – was designed as a way to encourage touch between players. Wherever possible, I sought to provide players with plenty of opportunities to work together through color-blending. It really is the heart of *Prism Squad*'s gameplay.
2. Teamwork: *Prism Squad: GO!* encourages teamwork by emphasizing interdependence between teammates. The variety of enemies presented in *Prism Squad* is more than what one player can handle alone: through playing, players must learn to destroy the enemies they can, and to rely on their partners to destroy the enemies they cannot. In *Prism Squad,* each player is given a unique ability which no other players share – for example, the red player is the only player who can destroy red UFOs. This forces the red player to take individual responsibility for a specific subset of the threats that appear. However, players also have a

responsibility to their teammates too – for example, the red player must also assist the yellow player to destroy orange UFOs, even if it is the yellow player who fires the killing shot. The challenge in *Prism Squad: GO!* comes from learning to balance your individual responsibilities with your responsibilities to your team.

3. Color: In *Prism Squad*, the notions of color and color-blending are central to gameplay. For this reason, the game pays homage to color wherever possible; the eponymous squad is named after a prism – a device which splits white light into its component colors. The insidious Spek'Tral are a pun on the word "spectral", which refers to the rainbow of colors in the spectrum of visible light. Finally, Prism Squad's commanding officer is named in honor of Johann Wolfgang von Goethe, who proposed the RYB color model on which the game's color-blending mechanics are based.

5.5 Implementation

5.5.1 Hardware Specifications

Prism Squad: GO! was written in C++ using an game-engine framework of my own design. While the majority of *Prism Squad*'s code is original, the game also makes use of some freely-available software libraries to simplify difficult tasks. OpenGL rendering and keyboard/mouse input is handled through the GLUT library. Playback of music and sound files is handled through the FMOD library.

Prism Squad has been tested on a variety of PC configurations, but its target platform was a desktop PC running Windows XP with an Intel Core2 2.4 gigahertz quad-core processor, an NVIDIA Quadro NVS 290 graphics card and 3.25GB RAM. This system was connected to a 62" Flat-Panel SMART Board interactive whiteboard running at a resolution of 1360 x 768 (Figure 5.12).

Figure 5.12 – SMART board with Nyko wireless sensor bar (inset)

Prism Squad: GO! is played using three Nintendo Wii "Wiimote" controllers – one per player. The Wiimote is a one-handed remote control device with seven face-buttons, a directional pad, and a trigger on the underside (Figure 5.13). Each Wiimote also contains an embedded infrared camera which, when paired with a Nyko wireless "sensor bar", allows the Wiimotes to identify where they are pointing on-screen. Wiimotes connect to the host PC wirelessly over Bluetooth.

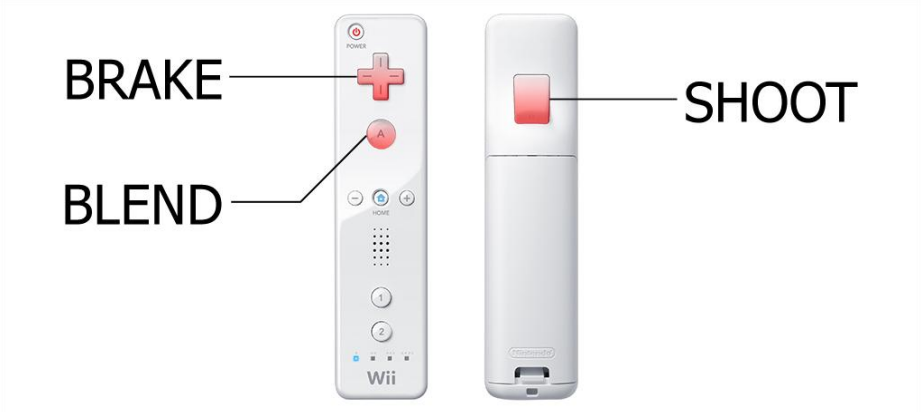

Figure 5.13 – Nintendo Wiimote with *Prism Squad: GO!* control mappings

5.5.2 Touch-Sensing

My research group examined two different approaches to detecting interpersonal touch in *Prism Squad: GO!* Each of these approaches were designed as "hacks" to the Nintendo Wiimote – by integrating our touch-sensing into the Wiimotes, we had hoped to send our touch-data wirelessly by piggybacking on the Wiimotes' Bluetooth connection to the host PC. We had planned to remove the Wiimote's '2' button and hijack the signal to serve as an indicator of touch – whenever two or more players touched, the embedded touch-sensors would activate the '2' button on those players' Wiimotes. Since each player is coupled to their own Wiimote, monitoring the status of each Wiimote's '2' button would allow us to detect who was touching who, and when (Figure 5.14).

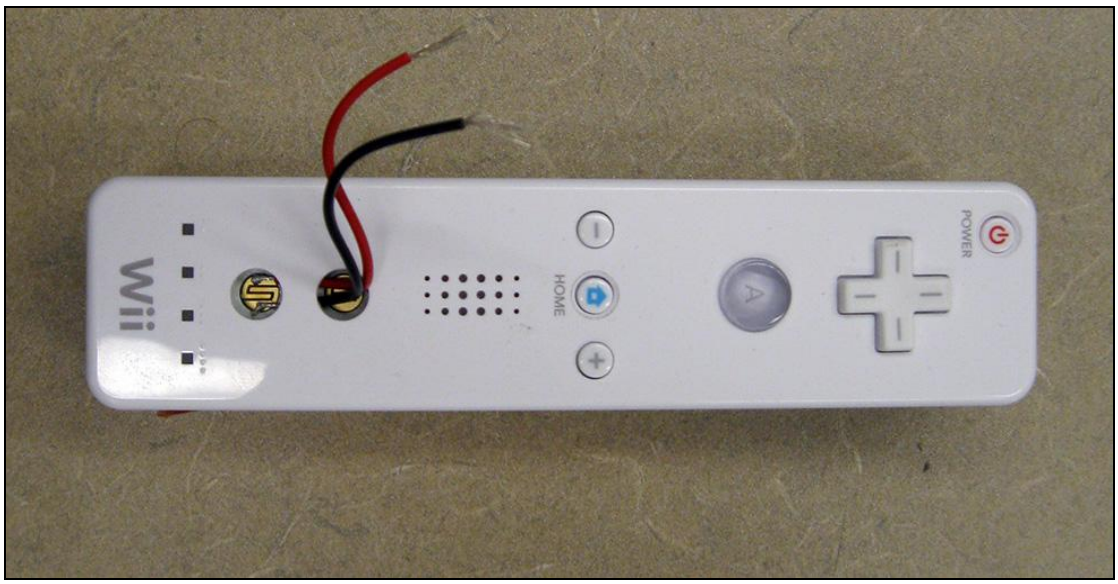

Figure 5.14 – A hacked Wiimote, with wires leading to the missing '2' buttons

The Frequency Approach

Our first attempt to detect interpersonal touch in *Prism Squad: GO!* (hereafter referred to as "the frequency approach") was based on a system of capacitive coupling, similar to the system used by the DiamondTouch tabletop (Dietz et al., 2001). The surface of the DiamondTouch contains a lattice of conductive antennae through which modulated electrical signals are sent. When a user touches the tabletop, they become capacitively coupled with these antennae and the signals travel from the tabletop through the user's

body and into the sensor pad upon which the user sits. Signals from the sensor pad feed into a signal processing unit which analyzes the signals to determine where on the table the user is touching.

Our frequency approach was effectively a simpler form of the DiamondTouch's touch-sensing technology. The DiamondTouch uses thousands of antennae conducting thousands of unique frequencies to provide the spatial resolution necessary to detect exactly where on the table each user is touching. Since our approach was only concerned with when and not where the users were touching, we required only three frequencies – one per player. Let's call these three frequencies *x*, *y* and *z*. Under our proposed system, each player would be capacitively coupled to a small electrical device consisting of one frequency generator and two frequency detectors. Each of these devices would continually generate its own unique frequency while listening for the other two: for example, player one's device might generate signal *x* and listen for signals *y* and *z*, while player two's device generated signal *y* and listened for signals *x* and *z*. Whenever two players touched, the signals from their generators would travel through their connected bodies and activate both detectors, thus signaling that the two players had touched.

The drawback to this method was that it was susceptible to ambient electrical noise. In the real world, players are not only coupled to the other players, but to everything around them as well. This is particularly problematic when you consider that the electrical main lines in any building pulse at a constant 60Hz. This, and many other sources of ambient noise, affected our detectors' ability to recognize the signals that were being sent from player to player, which led us to consider a different approach.

The Current Approach

Our second attempt at detecting interpersonal touch was based on using the players' bodies to control the flow of current through a simple electrical circuit. Consider the circuit diagram below, consisting of a battery and a light bulb:

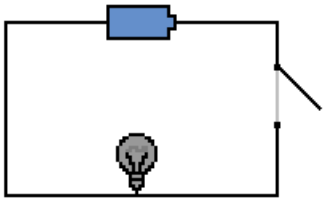

Figure 5.15 – A simple electrical circuit

Imagine two players sharing a common ground, where one player is connected to an emitter (the battery) and the other is connected to a detector (the light bulb). The circuit diagram representing these two players might look something like the circuit above. The switch between them represents the state of their touch; when player one and player two are not touching, then the circuit is broken and current cannot flow from the battery to the light bulb. However, when the players touch, the switch completes the circuit and current flows from the emitter to the detector, causing the detector to trigger, as depicted below.

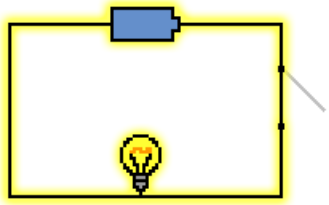

Figure 5.16 – When the players touch, current flows from the emitter to the detector

This simplified model of touch-sensing works very well for two players – but these dedicated emitter/detector roles break down when three or more players are involved – after all, if a player can only be an emitter or a detector, then the system will be unable to detect when an emitter touches another emitter or a detector touches another detector. In a system of three or more players, it is no longer possible for players to serve a dedicated role; each player must carry with them an emitter and a detector, and they must be able to switch from role to role as needed. Figure 5.17 below shows a simplified circuit diagram representing three players as an emitter/detector pair.

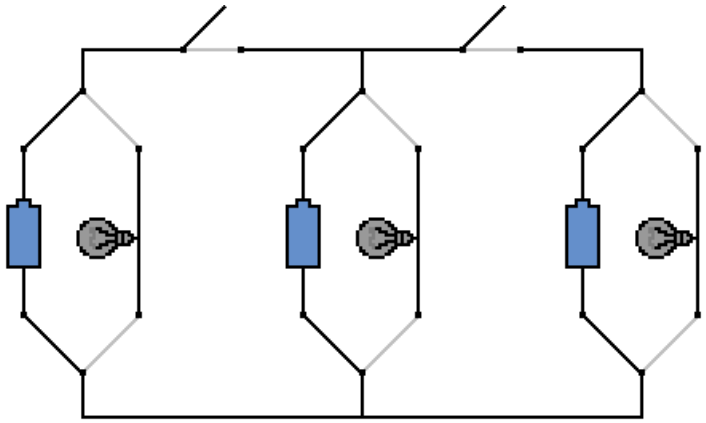

Figure 5.17 – Three players, each represented as an emitter-detector pair

With three or more players involved, there are additional constraints that must be observed in order for the touch-sensing to function properly:

1. At any given moment in time, a player can only function as an emitter, or a detector, not both This is necessary to eliminate false positives – if any one player had both their emitter and detector engaged simultaneously then they would constantly detect themselves. In Figure 5.17, above, switches are used to control the player's role: when the emitter is switched into the network, the detector is disconnected, and vice-versa.

2. At any given moment in time, there can only be one emitter. This is necessary to eliminate ambiguity – if two or more players were emitting when the third player's detector went off, it would be impossible to determine which of the emitters touched the third player and caused their detector to trigger. By controlling the system that only one emitter is active at time, we can unambiguously determine that any player whose detector was triggered was touched by the actively-emitting player.

This second constraint can be implemented through a system of "time-division multiplexing" where each device takes a turn as the emitter while the other two act as detectors. Using small, fixed time steps, we can coordinate the devices so that as soon as one emitter turns on, the others turn off and go into listening mode. By rapidly changing which device is the current emitter, we avoid situations where a touch between two

detectors would go undetected – if at any time two detectors are touching, then at the start of the next time step one of them will become the current emitter and as soon as they do the touch between them will be instantly recognized. If the time steps are sufficiently small (say, less than 1/120th of a second) then the switching occurs so quickly as to never miss a touch – it will almost be as if all devices are detecting simultaneously.

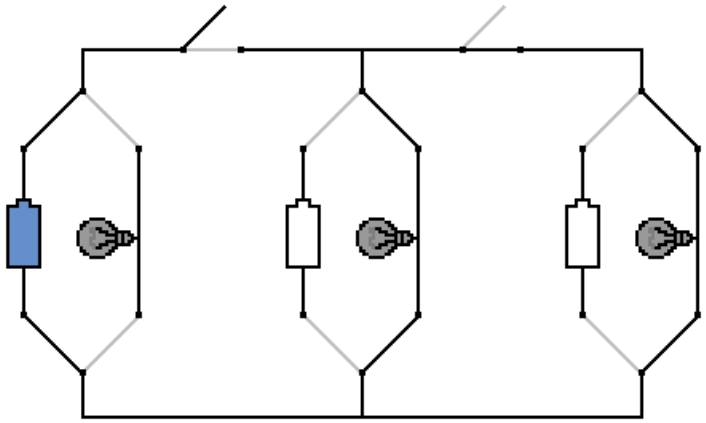

Figure 5.18 – Touch between P2 & P3 is undetected because P1 is the current emitter

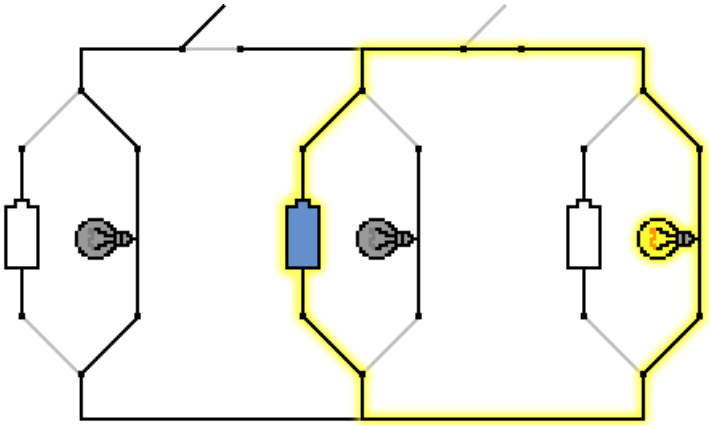

Figure 5.19 – P2 becomes the emitter during the next time step; the touch is detected

This sensing approach relies on detecting a current passing between any two players. As such, a complete circuit loop is required to provide a path for that current to flow between each detector and emitter device. While the skin-to-skin touch contact provides one such connection, a second "ground" connection is also required. In order to provide this ground, we covered a large plywood board with conductive metal tape and created slippers with metal soles (Figure 5.20). By connecting our emitter/detector devices to the soles of these

slippers, we established the common ground necessary for the individual sensor circuits to function together as a complete system.

Figure 5.20 – The metal board, with metal-soled shoes (inset)

Unfortunately even with the large metal board, this approach to detecting touch is slightly more difficult than I have let on. Human bodies are not perfect conductors – they all impede the flow of current to some extent. Exactly how much depends on many factors, including the way the body is positioned and the sweatiness of its skin. As a result, body conductivity varies from player to player and can even change from moment to moment. This unpredictability presents a very serious problem for the current approach – depending on the players involved, or even the way they stand, detecting the flow of current may be difficult or impossible. Because of this issue, the current approach was found to be unfit detecting touch in *Prism Squad: GO!* As of this writing, touch-sensing remains an ongoing research effort in our group.

5.6 Preliminary Pilot Studies

While developing *Prism Squad: GO!* I conducted a series of pilot studies as a method to refine and iterate my game design. These pilot studies were invaluable as a method for

brainstorming new ideas, balancing game difficulty, and exposing areas where *Prism Squad* still required further development. In total, more than 15 pilot studies were conducted with around 30 different pilot participants.

These pilot studies took the form of casual play tests conducted with visitors and members of my research lab. Whenever possible, I would recruit participants who had never played the game before in order to get feedback from as many perspectives as possible. Usually, I would also participate as a player in these pilots, but on certain occasions I merely observed. During these playtests, I encouraged testers to vocalize their thoughts while they played – afterwards, the playtesters and I would discuss the major problems we observed while playing, and take turns brainstorming possible solutions.

5.6.1 Notable Changes

Feedback from these pilot studies drastically altered the course of the game, transforming it from twitchy, chaotic arcade-shooter, to a more nuanced game with a greater emphasis on teamwork, color-blending, and interpersonal touch. The most significant changes which occurred as a result of these pilot studies include:

Adaptation of the RYB color-model: Originally, *Prism Squad: GO!* was based on an RGB (red, green, blue) color-model – the color-model most commonly used in computer graphics. In the RGB model, red and green combine to make yellow, red and blue make magenta, and green and blue make cyan.

Although the RGB system is perfectly logical to those who understand it, it is not at all intuitive – especially for those without backgrounds in computer graphics. During pilot studies, many players had difficulty recalling which colors led to which combinations, creating needless confusion. Upon switching to the more intuitive RYB system, it immediately became easier for players to identify which colors produced which blends.

***Prism Squad*'s seven stages:** Preliminary designs for *Prism Squad* called for a very short game. Originally, the game only had four stages, broken down as in Table 5.2:

Stage	Types of Enemies Appearing in this Stage
1	
2	
3	
4	

Table 5.2 – *Prism Squad: GO!*'s original four stages

This early version of the game started out very easy but quickly became overwhelmingly difficult. While players could typically handle the first two stages without issue, the third stage – which introduced all three secondary-colored enemies at once – proved far too complicated for players. To provide the game with a more gradual learning-curve, I created three new "teaching stages" (Pluto, Callisto and Mars) each of which introduced one new secondary colored enemy at a time (either orange, green or purple.) These teaching stages allowed players to comfortably gain familiarity with the various color-combinations before being forced to contend with them all at once. (For *Prism Squad*'s final stage chart, please refer to Table 5.1)

Removal of power-ups: "Power-ups" – temporary items which imbue your spaceship with new abilities – are a common sight in shoot-'em-up games like *Galaga*, *Gradius* and *R-Type* but which were notably absent from *Prism Squad: GO! Prism Squad*'s design did not originally call for power-ups, but after pilot testers repeatedly questioned the absence of this staple genre mechanic, I decided to give them a trial run. The first power-up I added to the game was a "nuke" – a glowing symbol which would destroy all onscreen enemies when touched by a player's spaceship (Figure 5.21).

Figure 5.21 – The nuke power-up icon

However, after pilot-testing the nuke, it became clear that the nuke was causing more problems than it was solving. Players would frequently touch the nuke icon without even

realizing that it was there, causing a massive explosion to engulf the screen and leaving all three players thoroughly confused as to what just happened. Furthermore, nukes added little in the way of strategic decision-making – whenever a nuke appeared, the only sensible move was to immediately grab it.

Although both of these problems could have been addressed with further testing, they occurred sufficiently late in development that it was ultimately wiser to remove power-ups than risk introducing new problems into the game.

Removal of statistics-tracking: The statistics-tracking screen was originally designed as a way to keep players' interest-levels high as they worked their way through the game. At the end of each successful stage, the game would present players with a kill-count, and a letter grade based on their overall contribution to the team (Figure 5.22).

Figure 5.22 – The stats screen assigned each player a grade based on their performance

I had hoped that these statistics would energize players by giving them a target to beat on the next stage – but in practice, the effects of the statistics screen were more negative than positive. Playtest groups would often form where one team member was significantly less effective than their teammates. Although the poor performance of the weaker player might

have ordinarily gone unnoticed, the statistics screen which ranked each player made the reality of the situation plain for all to see. After participating in several games where the same player was consistently at the bottom of the rankings, it became obvious that the statistics screen was a source of shame for some players. This convinced me to remove the statistics screen from the final version of the game. The idea of singling out a player for derision is antithetical to the very essence of *Prism Squad* – wherever possible, I sought to portray the players as members of a team, rather than as individuals.

Although information on players' performances was removed from public view, the *Prism Squad* game engine still tracks noteworthy information on every gameplay session in an external log file. Such information includes the time that the game began and the time that it ended, a record of stages that were completed and failed, the team's handicap level throughout the game, and kill counts for each player.

The removal of "push-back": In *Prism Squad,* when an off-colored laser hits a UFO, nothing happens. The UFO continues on its established path, obliviously to any attack. This was not always true. For a brief period in the development of *Prism Squad*, when a UFO was hit by an off-color laser, the force of the impact would repulse the UFO, pushing it backwards a short distance. In practice, this allowed players to protect the planet from any color of enemies – even if they could not destroy the enemy outright, they could at least push it away until the appropriately-colored player could finish it off for good. Although this feature was very fun (pushing enemies around felt quite satisfying) a few short pilot-tests made it clear that push-back had to be removed.

The ability for players to push enemies away compromised one of *Prism Squad*'s greatest challenges: inevitability. The most important skill in *Prism Squad* is the ability to intelligently prioritize targets under difficult constraints. Quite often, enemies of several different colors will be approaching your objective simultaneously and you have to deal with all of them at once. But with push-back, players could pick and choose targets at their leisure, pushing away targets they could not deal with for a later time. This dramatically lowered the urgency in the game and reduced the amount of teamwork necessary to

succeed. In order to maintain the importance of teamwork in *Prism Squad: GO!* push-back was removed from the game.

5.6.2 Summary of Changes

Prism Squad was designed to explore the effects of interpersonal touch in a game which emphasized teamwork, unity and communication, and it was these core concepts which guided the pilot-testing process. Whenever a new feature was being tested, my playtesters and I were forced to ask ourselves: "How does this feature encourage interpersonal interaction? How does this feature promote teamwork?" If we could not answer these simple questions, then it was obvious to us that the feature in question needed to be reworked or removed.

As a result, many of the most significant changes to *Prism Squad: GO!* involve the removal of existing features rather than the addition of new ones. Although it can be painful to remove a feature that you've worked hard to include, this sacrifice is often necessary in order to deliver a more focused, more effective final product. By removing the features which distracted from or downplayed the cooperative aspects of *Prism Squad: GO!* I believe that the game has benefited overall.

5.7 Evaluating *Prism Squad: GO!*

After conducting numerous pilot studies, I began a formal user study on *Prism Squad: GO!* For this study, I recruited thirty participants from on campus to come to my research lab and to play *Prism Squad: GO!* for themselves.

5.7.1 Experimental Design

In designing a study to evaluate *Prism Squad: GO!*, my primary objective was to explore how the game's use of interpersonal touch shaped its players' experience with the game. Unfortunately, without a working touch-sensor, interpersonal touch could not be studied directly, and it so it became necessary to examine ancillary factors instead. In *Prism Squad: GO!* interpersonal touch was intended to serve as a form of tangible cooperation – a

physical reminder of the players' intangible bond as they fought and struggled as a team. Thus, in the absence of touch, I was very interested to see how the players' teamwork and interdependence would express itself in their interactions with each other. I was particularly interested to see how players' cooperative interactions would evolve over the course of the entire game. Although *Prism Squad* starts out as a very loosely-coupled game, as the game progresses it requires increasingly sophisticated teamwork to survive. I was curious to see whether players would perceive this change themselves and how it would manifest itself in the atmosphere of their group. For this reason, many of the questionnaire items (Appendix B.4) were adapted from Fiedler's Group Atmosphere Scale (Fiedler, 1962) – a scale designed to measure participants' attitudes towards their membership within a larger group.

I was also interested to hear players' thoughts on the benefits and drawbacks of using interpersonal touch in *Prism Squad* as opposed to the generic interface they had become accustomed to.

Although this study was focused on primarily quantitative phenomena (teamwork, enjoyment) both qualitative and quantitative data was gathered. Quantitative data came from the game's internal log files and Likert items on the player's questionnaires, whereas quantitative data arose from my own written observations, written items on the questionnaires, my verbal interviews with the participants themselves, and video recordings of the participants playing *Prism Squad: GO!*

5.7.2 Participant Demographics

Unlike *Matchmaker* which was designed with a particular group in mind, *Prism Squad: GO!* had no presupposed audience and so recruitment was handled strictly on a volunteer basis. Participants were solicited through faculty-mailing lists at the University of Calgary, posted fliers on campus, and word-of-mouth. Although I made no effort to solicit particular groups within the university, the vast majority of my participants were graduate students, many of whom were members of the faculties of Computer Science or Engineering. Volunteers who were colorblind or with whom I had a preexisting relation were ineligible for this study – however, no participants were turned away for these reasons. All

participants were required to sign-up to participate in a group of three, so one can reasonably assume that the participants within a testing group were relatively familiar with each other prior to the experiment. In total, sixteen female participants and fourteen male participants took part in this study.

5.7.3 Experimental Procedures

After introducing myself to the participants, I would outline the study, including a description of the game, the post-game questionnaire, and the verbal interview. Provided there were no questions at this point, I would then issue each participant a copy of the informed consent form (Appendix B.2), which they read and signed.

After the forms had been signed, I gathered the participants before the large display, and handed each of them a Wiimote. At this point I would launch the control demo – a limited version of *Prism Squad: GO!* which contains all the functionality of the real game, but no enemies. The program was designed to teach players to the rules and controls of *Prism Squad* before the experiment began. After each player had had time to familiarize themselves with the rules and controls of *Prism Squad*, I would terminate the control demo and launch *Prism Squad: GO!* At this point, the game's internal logging system would immediately begin logging data. If all three participants had consented to be video-taped, this is also the point at which I would turn on the video camera and begin recording. In total, eight out of the ten groups consented to be video-taped.

During gameplay, participants were asked to act naturally – to play to the best of their ability, and to act as though an observer was not present. At no point were participants ever made to understand that the game they were playing was designed around interpersonal touch; to the best of the participants' knowledge, they were playing the game "as intended". In order to help simulate a natural playing experience, I did not address or guide the participants while they played. As the participants worked their way through the game, I would record any interesting occurrences, patterns or behaviors that I witnessed from the players on my notepad.

After the participants had completed the game, I would turn off the video camera, collect each player's Wiimote, and issue each player a post-game questionnaire (Appendix B.4). These questionnaires included ten Likert items, and four short-answer written-response questions. All Likert items were evaluated on a seven point scale ranging from -3 (strong negative response) to 0 (neutral or ambivalent response) to 3 (strong positive response.) Participants were asked to fill out their questionnaires independently of their group-mates in an attempt to protect their responses from possible conformity biases within the team.

As each participant finished their questionnaire, I would collect it from them. When all three participants had finished, the four of us would sit down together for a semi-structured discussion. At this point, if the participants consented, I would turn on the video camera once more to record our discussion. These discussions were an opportunity for me to gain additional insight on trends I had observed during the gameplay period. During these discussions, I would also take the opportunity to ask players for their insights into how the inclusion of interpersonal touch would affect *Prism Squad: GO!* When my discussion with the participants ended, I would turn off the camera, and give each participant their $10 payment. After each participant had been paid, I would thank the participants for their time, and escort them to the door.

An extended version of these procedures is available in Appendix B.3.

5.8 Results

In response to the questionnaire statement: "Overall, how would you describe your experience playing *Prism Squad: GO!*?" participants were very positive in their response. All thirty agreed that the game was at least somewhat enjoyable, with seventeen out of thirty participants describing it as "very enjoyable" (Figure 5.23). On average, female participants reported slightly higher levels of enjoyment than their male counterparts with median ratings of 2.71 and 2.31, respectively. Although this difference was not quite

statistically significant (a two-tailed Mann-Whitney U-test yields a p-value of 0.08), the suggestion of a disparity between the sexes is nevertheless intriguing.

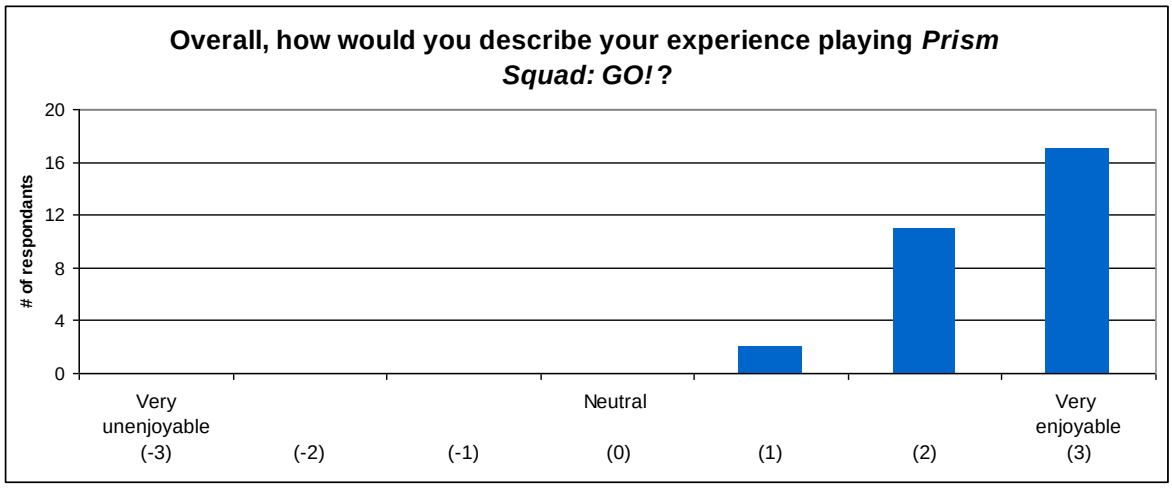

Figure 5.23 – Most participants said playing *Prism Squad: GO!* was "very enjoyable"

These high enjoyment ratings are consistent with the comments participants wrote in their post-game questionnaires. When participants were prompted for any final thoughts on *Prism Squad: GO!* twenty-three of the twenty-six participants who chose to leave a comment summarized their feelings about *Prism Squad* in a complimentary manner, stating variously:

Is there anything else you'd like to tell us about *Prism Squad: GO!*?

- "Really cool game. Keep it up."
- "It is a pretty cool concept of a game and very original."
- "Awesome game!"
- "It was energetic and fun! Good job!"

5.8.1 Teamwork and Communication

In their post-game questionnaires, players demonstrated a substantial affinity for the cooperative aspects of *Prism Squad: GO!* In response to the question "What did you enjoy most about *Prism Squad: GO!*?" twenty-three out of thirty participants mentioned some variation of the words "teamwork", "communication", or "cooperation" in their responses. Here is a sample of these responses:

What did you enjoy most about *Prism Squad: GO!*?

- "The fact that it forced the players to communicate."
- "A lot of fun to play in a group!"
- "The cooperative play, working together towards some objective, communicating and laughing."
- "The teamwork it required to succeed."

Indeed, the impact of teamwork was unmistakable in my observations: as the game became tougher, and players were increasingly required to work together, I witnessed participants talking amongst themselves more and more. In fact, this increase in communication was not just limited to periods of intense gameplay; as a group worked their way through the game, I would see them idly chatting in the periods of calm in between stages and celebrating with relief after overcoming particularly difficult challenges.

These changes in the players' behaviors did not go unnoticed by the players themselves. During the interview period, when I asked the participants' if their teamwork had improved over the course of the game, they agreed without exception. The following interview excerpt is particularly telling for the way it relates teamwork and communication:

I: "Do you think that your teamwork improved as you played through the game?"
All: "[*emphatically*] Yes."
P18: "Definitely."
I: "And why do you think so? How can you tell?"
P18: "We started talking. Like, [when we first started to play] it was just quiet."

Results from the player's post-game questionnaires seem to support observations of talkativeness. Figures 4.24 and 4.25 reveal how participants described their group as a whole shortly after playing through *Prism Squad: GO!* The graphs reveal that, in general, participants perceived their groups as being very talkative, and very enthusiastic.

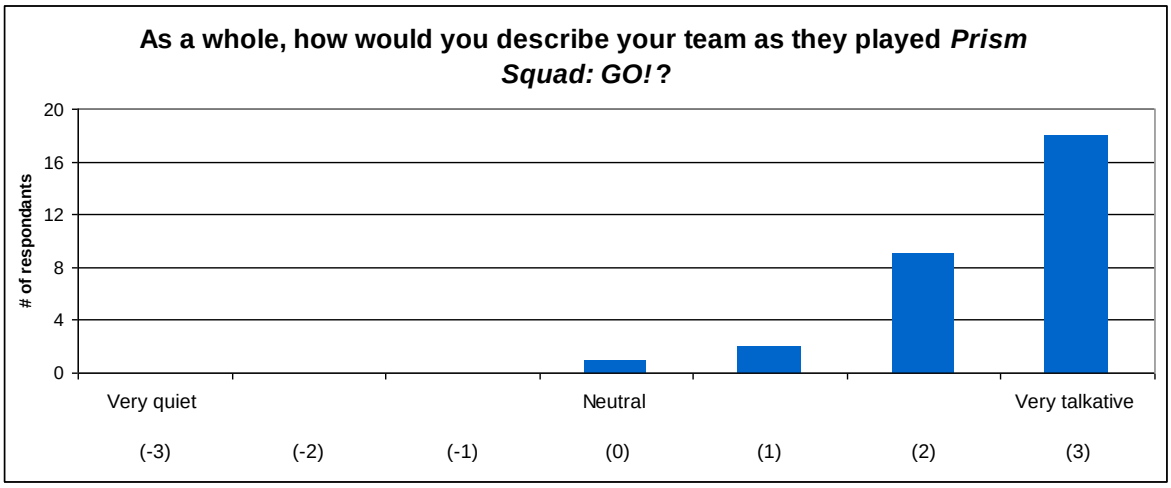

Figure 5.24 – In general, players reported that their teams were "very talkative"

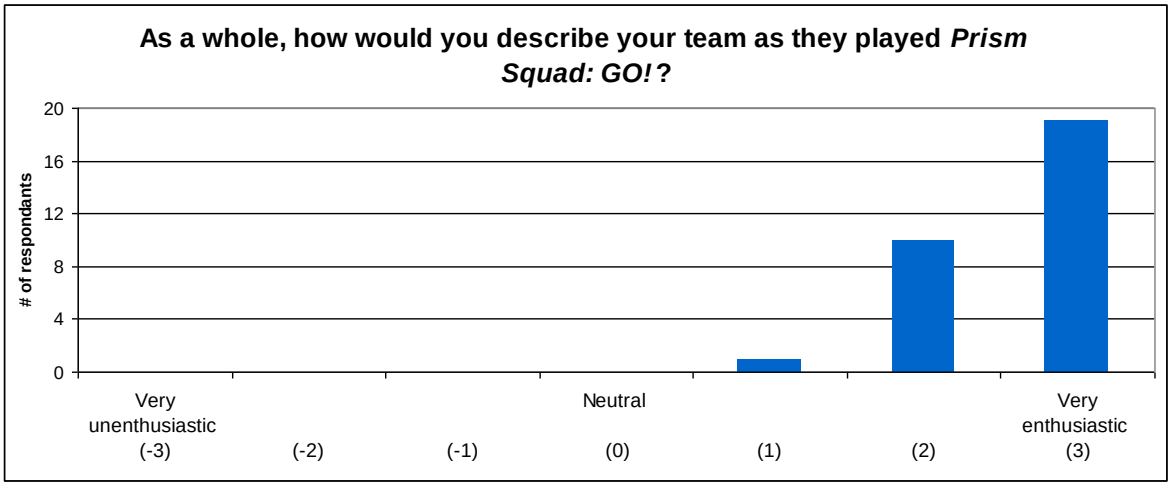

Figure 5.25 – Most players described their teams as being "very enthusiastic"

Interestingly, despite the players' professed enthusiasm for cooperation and teamwork, players' ratings for group cooperation were, on average, slightly lower than their ratings for talkativeness and enthusiasm (Figure 5.26). I believe this disparity may reflect this difficulty that players experienced trying to cooperate with their partners in practice. For an expanded discussion of this topic, please see section 5.9.2.

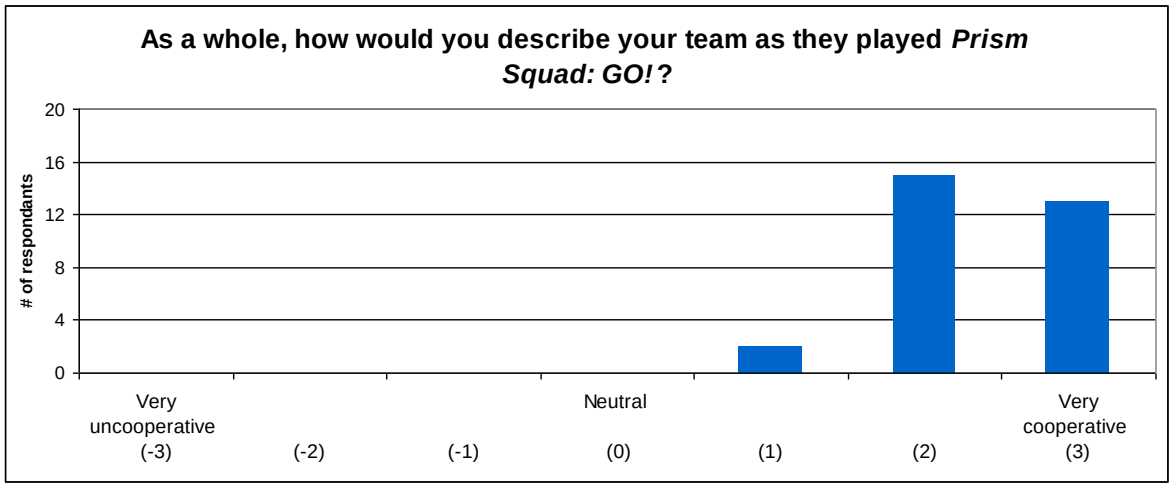

Figure 5.26 – Players described their groups as being mostly cooperative

5.8.2 Game Difficulty

Nearly all of the groups which participated in this study benefited from *Prism Squad*'s adaptive difficulty system. Of the ten groups who participated, only one managed to play the game from start to finish without losing a single stage – every other group had to retry a stage at least once. However, players rarely reattempted the same stage more than once and never more than twice, which suggests that the adaptive difficulty system was fulfilling its intended purpose and allowing each group to progress through the game without it becoming unduly frustrating.

Throughout the study, players gave no indication that they recognized an adaptive difficulty system was at work. In fact, even in situations where players were being significantly assisted by the game's AI, players generally attributed their ongoing successes to perseverance, rather than the game deliberately easing up on them:

> **I:** "When you repeated a level, did you feel like the level of difficulty was similar?"
> **P1:** "We cooperated way more the second time."
> **P2:** "Yeah, 'cause it's like we didn't want to lose again."

Although *Prism Squad* was fairly effective at increasing the difficultly level at a gradual pace, many groups had difficulty with the game's fifth level (Io) which is the first stage to feature all three secondary-colored (green, violet and orange) enemies at once. The

difficulty of Io may have been compounded by the presence of meteors, which players often ignored in their zeal to destroy the colored UFOs.

Figure 5.27, below shows the average number of times a stage was repeated in a single play-through. The graph reveals how *Prism Squad*'s difficulty spikes at Io. Another spike occurs on Earth, but considering that the Earth stage was designed to provide a challenging final battle, this is not particularly worrisome.

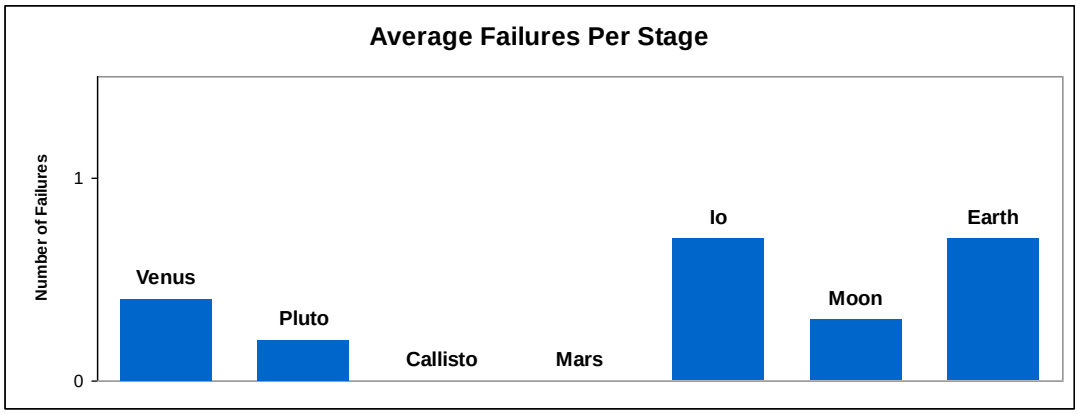

Figure 5.27 – Most groups' defeats came from either Io or Earth

5.8.3 Opportunities for Improvement

In their post-game questionnaires, players varied in their suggestions of how to improve *Prism Squad: GO!* Many participants suggested adding new content as a way of extending *Prism Squad*'s replay-value and lasting appeal – players wanted to see more types of enemies, more stages, new challenges, and varied graphics. I view such suggestions as a very positive sign: the participants' desire to see *Prism Squad*'s expanded and evolved suggests that *Prism Squad* captured players' attentions and engaged their imaginations. It also suggests that *Prism Squad*'s core gameplay is sufficiently robust to support future exploration. Examples of features suggested by players include:

How would you change *Prism Squad: GO!* to make it better?

- "I'd add bosses to the levels to make it more climactic."
- "A boss at the end of each level, icons that can give special weapons, etc... options for ships to take damage."
- "More levels, difficulty settings, score, save game, powerups."

- "There really ought to be more levels :)"

Ironically, power-ups and stats-tracking – features which were removed from the game during pilot-testing – were two of the participants' most-requested features. Potential power-ups suggested by players included the ability to shoot multiple lasers at once, the ability to produce "rainbow shots" which would destroy any enemy, and one-shot nukes which would destroy all onscreen enemies.

5.8.4 Interpersonal Touch

I concluded each interview by asking participants how they felt *Prism Squad: GO!* would change if interpersonal touch, rather than simultaneous button-pressing, was used to blend colors between partners. Their responses spanned a gamut of emotions, from enthusiasm to reserved skepticism.

Broadly speaking, most groups could see the allure of adding interpersonal touch to the *Prism Squad*:

I: "Say instead of using button presses, you had to touch the person you wanted to blend colors with?"
All: [*laughter*]
P5: "That'd be awesome!"

Many participants believed that interpersonal touch would make *Prism Squad* more fun, citing benefits such as enhanced physical expression, increased interaction with teammates, and increased awareness of the game state:

I: "What if, in order to blend colors, two players had to touch each other. How do you think that would affect the game?"
P18: "Easier."
P17: "Stronger feeling."
I: "Better feedback you mean?"
P17: "Yeah, because you're feeling instead of just seeing."
P18: "Sometimes I [would shout] 'Oh! Purple! Purple!' but [my ship would] still [be glowing white]. But if I feel two people touching me, then I know [why my ship is] white."

Participants also seemed to enjoy the idea of being able to act independently; to be able to force a blend by reaching out and touching a teammate or to shrug off a partner to stop an

undesirable blend – something which simply is not possible through the button-pressing method. But although participants were generally intrigued by the idea of interacting with their partners through touch, many participants expressed concern that adding interpersonal touch to *Prism Squad* could introduce undesirable side effects. The side effects which participants described typically fell into two categories: logistical concerns, and social concerns.

Logistical concerns sprang from the inherent difficulty of positioning three players around a video display such that they could easily touch each other without interrupting their gameplay. During their playtest sessions, participants were arranged facing the screen in a row, like so:

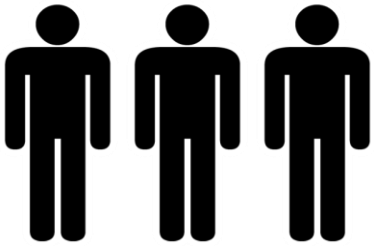

Figure 5.28 – During playtesting, players stood side-by-side

This configuration is well-suited for normal gameplay activities since it affords each player a clear view of the screen. However, as many participants remarked, this configuration would be poorly-suited for interpersonal touch because it makes it very difficult for the players on each end to touch each other:

> **I:** "Say that you had to touch your partner you blend colors, how would that affect the game?"
> **P11:** "I think that'd be pretty sweet."
> **P10:** "It might be a bit easier too."
> **P12:** "Well, [it] depends. Because, like, if [P10] was standing pretty far from me and we had to get in really quickly, I'd have to reach over [P11] and block his way, right? Then maybe that would make things uncomfortable for him and he couldn't aim as well."

But some participants embraced the challenge of coordinating touch between distant partners as part of the fun:

P5: "It'd be really chaotic depending on how you're standing. It'd be like: [*pantomimes reaching for someone far away*]"
P6: "It'd be nuts; it'd be a lot of fun."
P5: "It'd be fun, yeah."

While I think that the challenge of constantly repositioning players could add an interesting new dimension to *Prism Squad*'s gameplay, it certainly should not become the players' main focus. Although it is difficult to predict how players could position themselves to take advantage of interpersonal touch in *Prism Squad: GO!* I expect that an optimal configuration would resemble the "triangle" setup depicted in Figure 5.29, which puts all players within arm's-length of one another without unduly blocking anyone's view.

Figure 5.29 – A "triangle" configuration would put all players within arm's-length

Another logistical challenge raised by participants was the importance of looking where you are touching – a responsibility which could distract players from the game itself:

I: "If you had to touch to play, do you think the game would be easier or harder?"
P7: "I'd say harder."
P8: "I think it'd be harder."
P7: "Because now you're looking where you partner is and [you're] looking away from the screen."
P8: "And [while you're looking for your partner] then your controller might go off the screen."

Study participants also expressed concern over the social issues surrounding interpersonal touch. These concerns were mainly a function of preexisting societal norms which specify when, where and how it is appropriate to touch another person. One of the more common rules about touch is that it is inappropriate to excessively touch people with whom you are unfamiliar. During their interview, a group of female players told me that while

interpersonal touch could work between friends, its inclusion would damage *Prism Squad*'s ability to be enjoyed with new people:

> **P1:** "[If touch was involved] I can't see playing with strangers; that'd be uncomfortable."
> **I:** "But within your group, you think something like this could work?"
> **All:** "Yeah."

Other social issues raised by participants dealt with the effects of gender on touch. It is commonly held that men dislike being touched by other men, whereas women are comparatively more open to being touched by other women – this may be related to touch's role as an indicator of dominance and status (Henley, 1973). Evidence of this belief occurred frequently in group interviews, with several participants (both male and female) suggesting that interpersonal touch might be considered invasive in male-male pairings. Interestingly, one male participant stated exactly the opposite – that, for cultural reasons, he'd feel more comfortable touching with other males:

> **P30:** "I think [interpersonal touch] would make the game more much more interesting and fun. But... it will put restrictions on the gender of the players. [...] I would like to play it with three other guys [...] but with females involved in the game it might be... I don't know..."
> **I:** "A little inappropriate?"
> **P30:** "Yeah. But... maybe that's just my cultural background."

Even in the absence of touch, male participants reported feeling less comfortable playing *Prism Squad* with same-sex partners than women. When, in their post-game questionnaires, participants were asked: "How would you feel about playing *Prism Squad: GO!* with friends of your own gender?" female participants responded with an average value of 2.64, compared to the average male response of 2.25. However, with a p-value of 0.277 this finding cannot be considered statistically significant.

5.9 Discussion

Based on my own personal observations and the results of the participants' questionnaires and interviews, I believe that *Prism Squad: GO!* is a highly-enjoyable game with

significant potential for future expansion and a few recurring but eminently fixable problems.

5.9.1 Gender Differences in *Prism Squad: GO!*

Prism Squad was never consciously designed to appeal to one gender over the other, so it was surprising to see evidence suggesting that *Prism Squad: GO!* might be more enjoyable to female participants than to males. If anything, I would have expected just the opposite since the members of Prism Squad and their commanding officer are all male.

There is little hard data to suggest why female players would enjoy the game more – according to most other metrics, males and females were quite alike. In the absence of other explanations, I am inclined to believe that this discrepancy amongst genders is due to *Prism Squad*'s cooperative gameplay. There is well-known a gender stereotype which claims that women typically prefer cooperative forms of gameplay to the competitive games typically favored by men. In fact, it is believed that one of the reasons *The Sims*[10] became the best-selling PC game of all-time (Electronic Arts, 2002) was because its socially-constructive gameplay appealed to the traditionally hard-to-reach female gamer market. Indeed, this old stereotype may have some truth to it: in her study of the sex differences in the games that children play, Janet Lever found that fifth-grade girls opted for cooperative forms of play more often than fifth-grade boys (Lever, 1976).

Could it be that cooperative nature of *Prism Squad* endears the game to a female audience? In an interview period, a participant from an all-female group leant credence to this theory when she said offhandedly: "This game is better for girls – I don't like playing alone. And, even if you're bad, your teammates help you [to] win." In another all-female group, one participant contrasted the cooperative aspects of *Prism Squad* against the abundance of competitive games on the market when she said: "[Playing *Prism Squad: GO!*] was different 'cause, like, in a lot of video games you're, like, against each other when you play, but [in *Prism Squad: GO!*] everybody's on the same team. I thought that was

[10] *The Sims* is freeform "life simulator" – players can create families of virtual humans ("Sims"), build and decorate homes for their Sims to live in, buy furniture, take jobs and interact with other Sims. *The Sims* is a classic example of a "sandbox" game: instead of providing the player with explicit goals it allows players to explore and to have fun in their own way.

really cool." Despite what these anecdotes may suggest, no statistically-significant differences between all-male, all-female, or mixed-gender teams were found.

Although it is impossible to reach any substantive conclusions at this point, I believe that the role of gender in players' perceptions of *Prim Squad: GO!* would be an interesting topic for future study.

5.9.2 Strategies for Effective Cooperation

Prism Squad: GO! is a paradoxically-difficult game. Though the game itself is relatively simple, the challenge of *Prism Squad: GO!* comes not from the game, but from the players themselves – the game merely puts players into difficult situations where they are liable to work against each other.

In my observations, disorganization was by far the most common source of group-failure. Far too often I witnessed players arguing over what color the team should blend next while UFOs of all colors were taking advantage of their indecision and destroying their objective. Although these disagreements were typically minor, the inherent difficulty of effective cooperation and the arguments caused by this may explain why participants' ratings for group cooperation (Figure 5.26) were on average slightly lower than corresponding ratings for talkativeness and enthusiasm.

Each group developed their own strategies to tackle the problem of disorganization in their groups. Although each group developed their strategies independently, identical strategies naturally evolved among many different groups. In my observations, the two most common strategies were:

1. The leader approach: Before each stage, the team would talk amongst themselves and choose one player to act as the team leader for the next battle. The leader's job was to coordinate the team by calling out colors while the other two players remained silent. This strategy was designed to eliminate the confusion that occurred when two players called out a color at once. Although several groups tried this strategy, they rarely stuck with it for long; the hectic pace of *Prism Squad: GO!* is more than one player can handle and the subordinate players often "broke

rank" to yell out a color when they felt that their leader had missed something important. When players began to call out colors out of turn, the leader approach usually fell apart, giving way to the egalitarian approach, described below.

2. The egalitarian approach: Under this system, all players shared the responsibility of calling out colors. Any player could call out any color at any time and when they did their partners would (hopefully) oblige them. This strategy is a chaotic one and it commonly led to deadlocks in situations where two players called out a color simultaneously. But to paraphrase an old maxim, three heads are better than one. With all three players calling out threats as they saw them, the egalitarian approach led to increased team awareness overall, which gave teams more flexibility to react to changing circumstances.

Based on my observations, most teams chose to adopt a strategy which fell somewhere in between these two extremes. Generally, teams favored a quasi-egalitarian approach, with all players contributing to a greater or lesser extent. However, in teams where one player was especially assertive the other players would sometimes defer to their commands, making them the *de facto* leader.

5.9.3 Removal of Statistics-Tracking

Even though many players expressed a desire to see their performances tracked and ranked over the course of the game, I still believe that it was correct to remove statistics-tracking from *Prism Squad* in the pilot-testing phase. I say this because of an exchange I observed between two players during their playtesting session. The playtest group was made up of two males (P22 & P24) and one female (P23). Participant 23 was by far the least effective member of her group. It was clear from my observations that she was confused about how to play and this was reflected in her kill-count – she only scored 128 kills over the course of the game, as compared to her teammates' kill-counts of 243 and 264. On at least two occasions, she paused to exclaim, "Oh my god! I'm so bad at this!" And yet, that never seemed to temper her enthusiasm – I also recorded her saying: "I like this game!"

Just after finishing Io – arguably the most difficult level in the game – the following exchange took place:

> **P22:** "I wanna see stats!"
> **P23:** "[*groans*] Ohhh, I don't want to see stats!"

It is a short conversation, but it encapsulates very clearly why statistics-tracking was removed from the game. Participant 23 recognized that she was less effective than her teammates and she obviously felt some anxiety over this, as evidenced by her resistance to the idea of seeing gameplay statistics. Hiding this sort of performance information from players protects the ego of players like Participant 23 and allows them to enjoy them game without fear of being judged by their teammates.

Still, enough participants made mention of statistics-tracking during the study that it would be foolhardy to ignore their requests entirely. I think that presenting statistics which reflected the performance of the overall team rather than its individual members would be a satisfying way to provide players feedback without singling anyone out for judgment.

5.9.4 Limitations

Although participants were generally positive towards *Prism Squad: GO!*, the game's movement system received a lot of negative attention in the participants' post-game questionnaires. When participants were asked what frustrated them most about *Prism Squad*, several cited an inability to properly control their spaceship:

> **What frustrated you most about *Prism Squad: GO!*?**
> - "I'm not great at directing the ship with a Wii remote."
> - "Sometimes it's hard to get my ship to go to the place I want it to be."
> - "Sometimes the steering was hard, but it probably just takes getting used to..."

Prism Squad makes use of a unique control system which combines the actions of moving, turning and aiming into a single pointing gesture with the Nintendo Wiimote. By combining three actions into a single unified gesture, it allows players do with one hand what they would normally do with two, freeing up the player's other hand for interpersonal

touch interaction. Unfortunately, the drawback of this technique is that the players' spaceships are constantly in motion. This can lead to problems when players are shooting at targets which are near to their ship, as even small movements can drastically throw off their aim. Sometimes these small movements can be the difference between destroying an enemy and allowing it to hit its mark which often caused needless frustration for the players. Although *Prism Squad* includes a "brake" button which allows players to remain stationary while they aim and shoot, very few playtesters made use of it in my observations.

Rather than assigning a dedicated "brake" button, I think a more effective approach to this problem would be to surround each player's ship with a circular "dead zone" which would dampen the ship's motion. So long as the player's cursor lay within this dead zone, the player's ship would rotate to face it, but not move towards it (Figure 5.30). Only when the cursor went outside the dead zone would the player's ship follow it. This system would effectively replace the current braking system by causing players to stop whenever they targeted an enemy within the range of their dead zone.

Figure 5.30 – A dead zone system would help players to target nearby enemies

5.9.5 Interpersonal Touch

Participants were divided in their opinions towards the idea of using interpersonal touch in *Prism Squad: GO!* Although participants were generally enthusiastic about touch's potential to increase awareness and promote interaction between players, concerns over the social appropriateness of touch kept participants guarded.

Interpersonal touch is definitely not for everyone but I believe that, through careful design, the taboo social aspects of interpersonal touch can be turned into positives.

Consider the party game *Twister*, another multiplayer game which makes prominent (albeit incidental) use of interpersonal touch (Figure 5.31).

Figure 5.31 – A group of teens playing *Twister*

Twister is a very niche game – it is not the type of game which you would want to play with your boss or your grandma. But despite its niche appeal, *Twister* is a very popular party game, largely because its use of interpersonal touch. Playing *Twister* can be embarrassing, but the embarrassment is part of the attraction – by making a spectacle of yourself, you provide amusement for yourself and those around you. Games like *Twister* and video games like *Dance Dance Revolution* and *SingStar* have rose to fame by taking potentially embarrassing activities such as dancing or singing in public, and turning them into enjoyable party games. In some ways I see *Prism Squad: GO!* as a digital successor to *Twister* – while it is not for everyone, I think it could prove to be a very popular party game in casual, coeducational settings. As one group of participants said in their interview:

> **P5:** "I'd find it easy to play [*Prism Squad: GO!*] with strangers because-"
> **P6:** "Icebreaker"
> **P5:** "Yeah, it's an icebreaker. It's a way of communicating, it's a way of working together."

5.10 Conclusion

In this chapter, I have presented *Prism Squad: GO!*, a three-player, cooperative video game inspired by interpersonal touch. *Prism Squad: GO!* is a game focused on teamwork and cooperation; in order to succeed, players must learn to communicate and negotiate with their partners through the mechanic of color-blending.

Through a series of playtests, questionnaires and interviews, I conducted a thirty-person evaluation of *Prism Squad: GO!* In general, participants reported that *Prism Squad* was a "very enjoyable" game, thanks to its uniquely cooperative gameplay. By and large, participants were very enthusiastic about playing and even quiet groups became quite talkative as the game went on.

A method to detect interpersonal touch in *Prism Squad* could not be developed in time for publication and as of this writing research to integrate interpersonal touch into *Prism Squad* is still ongoing. However, based on players' reactions towards the idea of including touch in *Prism Squad*, I believe that – if used among friends – interpersonal touch could further enhance the cooperative aspects of *Prism Squad* which players enjoyed.

Chapter 6. Heuristics for the Effective Use of Interpersonal Touch in Video Games

6.1 Introduction

Like all interaction techniques, interpersonal touch has its own pitfalls, limitations, and best practices. However, interpersonal touch remains a largely unexplored area of human-computer interaction. The dearth of projects using interpersonal touch leaves us with very few opportunities to study this interaction technique in practice. This places game designers who are interested in creating video games based on interpersonal touch at a disadvantage; without a common understanding how to use interpersonal touch effectively, every designer must – through trial and error – devise their own best practices from scratch.

This chapter is my attempt to rectify this situation. Here, I present my guidelines for the effective application of interpersonal touch interfaces to video games. These heuristics come directly from the lessons I learned designing, developing, refining and evaluating *Matchmaker* and *Prism Squad: GO!*

When designing a video game based on interpersonal touch, one must always keep in mind the ultimate goal of game design: to produce a game which its players will enjoy. If your game's use of interpersonal touch somehow contributes to the players' overall enjoyment, then it can be said to be a "good" use of interpersonal touch. Conversely, if your use of touch detracts from the player's enjoyment, then it is a "bad" use of interpersonal touch. For a designer to make good use of interpersonal touch, they must leverage its advantages while taking steps to minimize its disadvantages. Using interpersonal touch effectively requires you to make educated decisions about your game, your audience, and the interactions between them.

The heuristics, which I will detail in the following subsection, are as follows:

i. *Use Touch to Streamline Collaborative Interactions between Players*
ii. *Use Touch to Create Enjoyable Challenges*
iii. *Use Touch to Encourage Socialization between Players*
iv. *Consider the Social Meanings of Touch*
v. *Design for the Physical Limitations of Touch*

These heuristics are not designed to stand alone; they merely provide guidelines for the effective application of interpersonal touch to video games. It is entirely possible for a game to make an effective use of interpersonal touch while still remaining a bad game for unrelated reasons.

6.2 Heuristics

i. Use Touch to Streamline Collaborative Interactions between Players

One of the understated advantages of interpersonal touch is that it is a simple and natural way for two players to interact with each other. In any case where two or more players are performing some action which affects them jointly, touch is a quick and effective way to link these players for the duration of their action without relying on cumbersome pairing systems such as in-game menus, or simultaneous actions.

ii. Use Touch to Create Enjoyable Challenges

Although interpersonal touch can sometimes streamline interactions between players, touch is not always the fastest or most efficient way to interact – at times, forcing players to interact through touch can also be a way of handicapping them, making their gameplay more difficult. Forcing players to move and interact with their partners in the real world takes time, energy and coordination especially when more than two players are involved. Thus, interpersonal touch can be used to make ordinarily simple tasks more challenging – especially in cases where when players must act quickly.

Though this added challenge may seem like something to avoid, consider the purpose of game design: our goal is not to make a game which is easy, but a game which is fun. It has been said that "true fun is the emotional response to learning" (Koster, 2005). But players can only learn when they are placed in difficult situations. Challenging your players is often necessary to maintain their interest and enjoyment. Interpersonal touch challenges players by forcing them to split their attention between the digital world and the physical one. This additional layer of difficulty provides players with new opportunities to strategize, learn and triumph – ultimately, new ways to enjoy themselves.

iii. Use Touch to Encourage Socialization between Players

Interpersonal touch is an inherently social gesture – at least in the sense that it requires two or more players to occur. An act of interpersonal touch quite literally forms a connection between those involved, and there is a large body of research which suggests that this connection is as much emotional as it is physical (Harlow, 1958, Crusco et al., 1984, Burgoon et al., 1992). The value of player-to-player socialization should not be underestimated; for many gamers, socializing is as rewarding – if not more – than the actual act of play (Voida et al., 2009, Lazarro, 2004). By encouraging your players to interact through touch, you create a catalyst for ongoing social interaction. A shared touch between two players tacitly breaks down social barriers and encourages further dialogue. For this reason, I believe that games based on interpersonal touch could be an effective way of breaking the ice between strangers in social gatherings.

Depending on how interpersonal touch is used in your game, the very act of touch can also open the lines of player-to-player dialogue; in *Matchmaker* and *Prism Squad: GO!*, discussions about who, how and when to touch were common among players. Although these strategic discussions were purely utilitarian, I believe that this ongoing communication also contributed to a social atmosphere between players. Based on my observations, the more players strategized, the more they talked with their teammates, even during periods of "down" time.

iv. Consider the Social Meanings of Touch

For better or for worse, the act of interpersonal touch is laden with meaning and each player will approach your game with their own predefined ideas of what touch means to them.

Most commonly, touch is seen as a symbol of connection, or attachment, of intimacy, or love. These preexisting connotations can work to your benefit, or your detriment. In a romantically-themed game, loving gestures such as handholding can be used to reinforce the game's message, and strengthen its emotional impact. However, in other games, interpersonal touch may be seen as undesirable or even inappropriate – players may feel uncomfortable about touching members of the same sex or players with whom they are not well-acquainted. Cultural and religious background will also play a role in determining how players feel about interpersonal touch.

I do not believe that this means that interpersonal touch should be strictly relegated to romantically-themed games. But it does mean that designers should be mindful of their players' attitudes. If your players might be uncomfortable with touching their partners, then it may behoove you to consider less intimate forms of interpersonal touch, such as touching on the shoulder or back.

v. Design for the Physical Limitations of Touch

Interpersonal touch is subject to many physical limitations, which can constrain the types of interactions that touch can support. Most of these limitations stem from the fact that, in order to for two or more players to touch they must be in close physical proximity. The implications of this simple fact are wide-ranging. Most significantly, a game based on interpersonal touch can only be played by collocated groups – there is no such thing as a single-player interpersonal touch game. However, a game based on interpersonal touch cannot be too populous, either; as more and more players become involved it becomes more and more difficult for two players to touch at any given time, simply because of the increasing number of bodies in the way. In games with more than two players, the designer must take careful steps to avoid creating situations where one player can interrupt another

by reaching for a third. This is especially true for tabletop games, where players may need to reach across the table to touch someone on the opposite side.

Finally, in order to touch their teammates, all players must have at least one hand free. This restriction makes it quite difficult to use interpersonal touch in conjunction with two-handed controllers, such as gamepads. In contrast, one-handed interfaces such as tabletop computers or the Nintendo Wiimote compliment interpersonal touch quite well.

6.3 Evaluation

In this section, I use these proposed heuristics as a framework to evaluate four projects which have been previously introduced in this thesis: *CollabDraw* (by Morris et al.) *'Get Lucky' Charms* (by Chowdhury), *Matchmaker* and *Prism Squad: GO!* In performing these evaluations, I seek to illustrate how these heuristics can reflect meaningfully on interpersonal touch in practice. In the following section, whenever I make reference to a design heuristic I will follow it with its heuristic number in parentheses, e.g. (ii).

6.3.1 *CollabDraw*

CollabDraw is "a [tabletop] system for collaborative art and photomanipulation" (Morris et al., 2006) which supports up to four users at a time. Unlike the other projects examined in this section, *CollabDraw* is not a video game, and thus, these heuristics were not written with it in mind. However, *CollabDraw* is still as an example of interpersonal touch in human-computer interaction and many of these heuristics still apply.

CollabDraw's use of interpersonal touch makes sense, at least on paper. The focus of *CollabDraw* was on encouraging collaboration between users and interpersonal touch is certainly well-suited to this task (iii). *CollabDraw* contains two touch-based gestures – the "partner" gesture, in which two players hold hands to create a link between them, and the "quit" gesture, in which all players hold hands together to terminate the application. The partner gesture is a quick and sensible way to join two players (i) which plays on the notion of touch as a symbol of connection (iv). However, the "quit" gesture is unnecessarily cumbersome. I am hard-pressed to imagine a situation in which one user would attempt to

sabotage their fellow users by quitting without their consent. Although these interpersonal gestures may require players to reach across the tabletop and disrupt their fellow users, their relatively infrequent use suggests that this would probably not be disruptive in practice (v).

The interpersonal touch-based interactions in *CollabDraw* were generally disliked by the groups of coworkers who were selected to test the system. Many participants wrote that they felt uncomfortable holding hands with their coworkers (iv). Based on the feedback from participants, the authors concluded that: "Gestures that require skin contact might be appropriate for certain types of entertainment applications that are used among friends, but would clearly not be acceptable for more formal environments and purposes" (Morris et al., 2006).

6.3.2 *'Get Lucky' Charms*

'Get Lucky' Charms is a game by Jennifer Chowdhury which uses Intimate Controllers – touch-sensitive bras and boxer shorts – to support intimate gameplay for couples. *'Get Lucky' Charms* is a pioneer of interpersonal touch – together with *Matchmaker*, it represents the very first application of interpersonal touch to video games.

'Get Lucky' Charms does many things right with regard to its use of interpersonal touch. It presents a very powerful narrative about touch's role in love, intimacy and sexuality – everything from the title of the project, to the design of the intimate controllers themselves suggests a playful eroticism where interpersonal touch is very much at home (iv). Even the name *'Get Lucky' Charms* playfully hints at the intimate aspects of the game, while the game-over screen which states "Better date next time!" gives a conspiratorial wink to the notion of gameplay-as-foreplay. The game is clearly designed for couples and it takes advantage of its couples-only status by using peripherals which force the players to stand with their bodies pressing against each other (v). The sensors on the intimate controllers are positioned to encourage players to touch their partners' breasts and buttocks, which is designed to evoke feelings of intimacy between the players (iii).

Although it is clear that great care has been spent on the design of *'Get Lucky' Charms*' interface, comparatively little attention has been spent on the design of the accompanying game. In fact, the game itself has very little substance and seems to exist for no other reason than to get the players touching – the gameplay is nothing more than a series of prompts to touch your partner in a specific location on their body. As a result, the game requires absolutely no collaboration between its players (i). In *'Get Lucky' Charms* each player acts a dumb receptor for their partner's touch and so there is never a need for players to strategize or communicate about their gameplay at all (iii). It seems as though the entire point of the *'Get Lucky' Charms* simply to touch your partner in a sexualized way. But if that is the case, then why make a game of it? Certainly, there are more intimate ways to touch your significant other – ways which do not even require you to get dressed in sensor-equipped undergarments first.

6.3.3 *Matchmaker*

Like *'Get Lucky' Charms*, *Matchmaker* is a romantically-themed game. But whereas *'Get Lucky' Charms* puts its emphasis on overt, sexual romance, *Matchmaker* focuses on the "cute" aspects of love. In *Matchmaker*, interpersonal touch comes in the form of handholding – a gesture which is frequently used among couples to demonstrate affection and togetherness (iv). *Matchmaker* is played directly on the surface of the DiamondTouch tabletop with the players sitting side-by-side – a configuration which easily allows players to hold hands with their partner (v). Although the game is designed for couples, its relatively inoffensive use of touch means that it could also be enjoyed by other players, such as a parent and their child.

In *Matchmaker*, interpersonal touch serves two purposes. The first purpose is to promote an atmosphere of love and romance. In *Matchmaker*, handholding serves as a tangible symbol of the love that the players share. *Matchmaker* encourages players to touch as a way of showing their love for each other (iii). Interpersonal touch also serves as a form of cooperative interaction between players (i). Handholding activates the Power of Love, which allows players to cure lovelorn Peeps so that they can be matched up again. The Power of Love is a crucial part of *Matchmaker*'s gameplay – not only does this mechanic

provide much of *Matchmaker*'s challenge (ii) but it also forces players to communicate to decide when and how it will be used (iii).

However, *Matchmaker*'s use of interpersonal touch can, at times, be confusing. When two players hold hands they cannot match up Peeps, and they are thus forced to let go of their partners' hands in order to play. This was deemed necessary to give *Matchmaker*'s gameplay some strategic depth (otherwise, why should you ever let go of your partner's hand?) but it is somewhat incongruous for a game which seeks to promote love (iv). Perhaps a future version of *Matchmaker* could use a touch-sensor which only triggered when a player affectionately squeezed their partner's hand, thus allowing players to hold hands while they match up Peeps.

6.3.4 *Prism Squad: GO!*

Although the implementation of *Prism Squad: GO!* presented in this thesis does not recognize interpersonal touch between its players, one can very easily imagine a future instance of *Prism Squad: GO!* where players blend colors through touch rather than button-presses. Let us consider how these heuristics would apply to such an instance.

Prism Squad: GO! is a team-based combat game which places significant emphasis on cooperation between players. In *Prism Squad*, this cooperation primarily manifests itself through the mechanic of color-blending – each player embodies a particular color, and when two players touch, their colors combine. Interpersonal touch provides players with a simple and direct way to blend colors with their partners (i), although it remains to be seen if blending colors through touch would be easier or harder than through button-presses (as in the current implementation). Color-blending (and by extension, interpersonal touch) is very important to *Prism Squad: GO!* – coordinating touch between three players at once provides the game with plenty of challenge (ii) and serves as a source of ongoing strategic discussion between players (iii).

Unlike *Matchmaker* or *'Get Lucky' Charms*, a three-player game like *Prism Squad: GO!* does not have an ready-made audience who would be receptive to the idea of touching as they played. Existing gaming groups who might otherwise enjoy playing with together

may be turned off from *Prism Squad* because of its use of interpersonal touch (iv). During my study of *Prism Squad: GO!* several participants mentioned that *Prism Squad* would be an enjoyable party game, and I agree that parties are the best opportunity for *Prism Squad* to find its niche. The cooperative aspects of *Prism Squad: GO!* combined with its use of interpersonal touch could make *Prism Squad* an unique icebreaker (iii).

Prism Squad's interface presents its own unique problems to a group of three. It is very difficult to position three players in front of a screen in such a way that they can all see the screen, all have enough personal space to use their Wiimotes and can all touch each other at a moment's notice (v). Depending on how you see it, this can either be an obstacle or a contributor to players' enjoyment. Personally, I believe that this "metagame" of constantly reorganizing your group to put different members within arm's reach has the potential to be a rewarding challenge in and of itself (ii).

6.4 Summary

In this chapter, I have presented my heuristics for making effective use of interpersonal touch in video games. I have also demonstrated how these heuristics apply in practice by applying them to four examples of interpersonal touch in human-computer interaction.

The heuristics which I have presented in this chapter are broad in their definition and rightly so – there is no single path to making an effective use of interpersonal touch. What all these heuristics have in common is that they stress careful examination when working with interpersonal touch. Touch is a unique form of interaction – one which can quite easily go astray if used improperly. By taking the time to consider how interpersonal touch fits with your players, your environment, and your game, you can avoid common pitfalls and reap the benefits of touch interaction.

Chapter 7. Conclusion and Future Work

In this thesis, I have presented an inquiry into the topic of interpersonal touch as a human-computer interface for video games. In my writing, I have described interpersonal touch as a form of embodied interaction and I have argued for the value of embodied interaction in games. I have shown the importance of socialization in games, and I have related the value of interpersonal touch as a method of encouraging socialization between players. Through *Matchmaker* and *Prism Squad: GO!*, I have illustrated the process of designing a game based on interpersonal touch and through my studies of these two games I have provided insight into how interpersonal touch shapes players' experiences. Based on my findings from my studies of *Matchmaker* and *Prism Squad: GO!*, I have created a set of design heuristics to lead towards effective uses of interpersonal touch in video games.

7.1 Thesis Contributions, Revisited

In section 1.5 of this thesis, I proposed to make five research contributions related to interpersonal touch in gaming. Those contributions, with my comments, are as follows:

1. **The very first academic exploration of interpersonal touch as an embodied interface for video games and its place in the current state of the art**: Though interpersonal touch has previously been studied in various contexts, this thesis is the first dedicated attempt to rigorously justify, study and evaluate interpersonal touch in video games. This exploration is rooted in chapter two of my thesis, where I discussed the purposes and goals of video games, and the ways in which game interfaces have shaped these goals over time. In my discussion of game interfaces, I described the advantages offered by embodied interaction and in so doing, motivated the discussion of interpersonal touch for the coming chapters.

2. **A thorough discussion on the role of interpersonal touch from the perspective of human-computer interaction**: In chapter three, I presented a discussion on the intertwined nature of touch and socialization and their implications for the field of human-computer interaction. By examining specific uses of touch in the history of human-computer interaction, I sought to convey the importance of touch as a symbol for connection and sociability – and to convey the intrinsic usefulness of these factors in game design.

3. **An exploration of the first original video game designed specifically for interpersonal touch**: In chapter four, I introduced *Matchmaker*, the two-player game of love and romance. In *Matchmaker,* interpersonal touch serves as both a cooperative gameplay mechanic and as an enduring symbol of love between the two players. To the best of my knowledge, *Matchmaker* is the first original video game designed to be played with interpersonal touch.

4. **The first exploration of interpersonal touch in a three-player cooperative video game**: In chapter five, I introduced *Prism Squad: GO!*, a video game whose game mechanics were designed to encourage interpersonal touch interaction among three cooperative players. Although the implementation of *Prism Squad* presented in this thesis did not include a functional touch-sensor, chapter five included a description of my research efforts to develop touch-sensing in *Prism Squad: GO!* and a thorough discussion on how the future inclusion of interpersonal touch might affect *Prism Squad*'s cooperative gameplay.

5. **A set of design heuristics for the effective application of interpersonal touch to video games**: In chapter six, I presented a set of five heuristics intended to guide designers in the effective application of interpersonal touch to video games. These heuristics emerged based on players' feedback to *Matchmaker* and *Prism Squad: GO!* In order to demonstrate these heuristics, I examined four examples of interpersonal touch in human-computer interaction using the heuristics as a guide.

7.2 Future Work

The research presented in this thesis hints at the potential of interpersonal touch in video games, but many unanswered questions remain. Here, I present a variety of short, medium and long-term research goals which could be used to extend this work in the future.

7.2.1 Add Touch-Sensing Functionality to *Prism Squad: GO!*

Although interpersonal touch was planned to be a core part of *Prism Squad: GO!*'s gameplay, a reliable method of detecting touch in *Prism Squad: GO!* did not materialize in time for publication. While the absence of touch-sensing has not crippled *Prism Squad*'s usefulness, it has placed severe restrictions on what can be learned from the game. Going forward with this research, one of my first goals would be to correct this omission and add touch-sensing functionality to *Prism Squad: GO!*

As I discussed in section 5.5.2, my group investigated two different methods of detecting interpersonal touch – one based on transmitting frequencies through capacitive coupling (the "frequency approach") and the other based on transmitting current through a multiplexed system of emitters and detectors (the "current approach".) Although neither approach bore a working prototype, we believe that the frequency approach is more robust, and thus more likely to produce useful results in the future.

The advantages of the frequency approach are twofold. First, unlike the current approach, the frequency approach is not affected by the players' bodies – a touch-sensing device based on the frequency approach will work with all players, regardless of their body type. Second, the frequency approach scales gracefully to more than three players – each additional player requires only one additional unique frequency to identify them. Although the current approach can also be generalized to higher numbers of players, its performance suffers with each additional player because of its dependence on time-division multiplexing (see section 5.5.2).

Our first attempt at implementing the frequency approach failed because the frequency-detectors we used were unsophisticated, and thus easily confused by ambient

electrical noise. Going forward with this research, we intend to examine the use of digital signal processors – similar to those used in the DiamondTouch tabletop. These signal processors are capable of isolating and detecting specific frequencies within an incoming signal and should allow us to detect touch even in the presence of ambient noise.

7.2.2 Perform a Comparative Study on *Prism Squad: GO!*

Though results from my user study of *Prism Squad: GO!* hinted that touch interaction could contribute to the cooperative aspects of *Prism Squad: GO!* which players enjoyed (see section 5.9.5) the full consequences of applying touch interaction to *Prism Squad: GO!* are difficult to predict. Experimental knowledge is required before one can adequately assess the full effects of introducing interpersonal touch to such a team-based, cooperative game.

Supposing that an adequate method of touch-sensing could be developed, I would find it extremely interesting to perform a second, comparative user study which compared players' responses to both the touch and no-touch versions of *Prism Squad: GO!* Such a study would have the potential to reveal the specific mechanisms by which interpersonal touch affects players' thoughts and feelings. Would blending colors through touch make the game easier, or hard to play? Would increased physical contact lead players to feel closer to their teammates? Would touch interaction amplify gender differences amongst players? All these questions could be explored through a comparative study on *Prism Squad: GO* – and their answers would have significant implications for the designs of future games based on interpersonal touch.

7.2.3 Further Evaluate *Matchmaker*

My history of demonstrating *Matchmaker* to the public has convinced me that there is something valuable about the way *Matchmaker* intertwines touch, romance and cooperation. Unfortunately, though my informal evaluations of *Matchmaker* have been quite extensive (see section 4.9), my formal evaluations of the game have been comparatively small, leaving me unable to decisively prove my claims.

In the future, I would like to revisit *Matchmaker* – to make it easier for players, in accordance with the suggestions of the study participants. Perhaps this could be

accomplished with an adaptive difficulty system, similar to the one used in *Prism Squad: GO!*

Following this, I'd like to conduct an expanded user study of *Matchmaker* with more couples coming to play the game. Such a study would allow me to obtain a broader understanding of how players feel about *Matchmaker* and its use of interpersonal touch. This study could also be used to examine other factors which were not considered in my first evaluation. For example, it may be interesting to consider the role of familiarity in player's reactions to *Matchmaker* – how is interpersonal touch perceived differently between couples which have been dating for a month versus couples which have been married for five years?

It would also be interesting to examine how players interact with *Matchmaker* in more natural, public settings. In my discussion of *Matchmaker*, I suggested that the game could be popular in "date" settings, such as movie theatres, bars or speed-dating venues. I would be quite interested to test this theory by setting up a *Matchmaker* kiosk in such a location and observing players' interactions with it.

7.2.4 Explore Touch in Pervasive Gaming

Interpersonal touch is a physical interaction technique. As a result, most games which make use of interpersonal touch – games like tag, hide-and-seek and flag football – are physically-active. Traditionally, video games have lacked the mobility of these physically-active games. But with the popularization of mobile computing and wireless networking, a new class of computer-assisted pervasive video games are emerging, which allow players to play even as they live and move in the real world (Dreher, 2008). In the future, I'd be interested to explore how interpersonal touch could be used as a method of human-to-human interaction in pervasive games.

Consider the game, "Assassin". Assassin is a real-world pervasive game which is often played among schoolmates. The game begins with a call for participants, during which time participants can volunteer to play. After a set sign-up period, each participating player is assigned another random player in the game who they must "assassinate".

Assassins must stalk and "kill" their quarries by touching them. When an assassin kills their quarry, they take on the victim's quarry. The game proceeds in this fashion until only one assassin is left remaining. Games of Assassin last days or even weeks – a player is liable to be assassinated at any time.

Now, imagine a computer-aided version of Assassin where the cellphones in the players' pockets can immediately recognize when an assassin has touched his quarry. Such touch-sensing technology could enormously improve atmosphere of intrigue and paranoia surrounding a game like Assassin – upon a successful kill, the victim's phone could immediately send out a "distress signal" to all other players, alerting them that a murder had taken place nearby. Meanwhile, the assassin's phone could immediately update with the name and picture of their next target.

Pervasive games like Assassin present a radically different context than the one found in cooperative games like *Matchmaker* and *Prism Squad: GO!* I believe that exploring the use of interpersonal touch in pervasive games could lead to new perspectives on the value of touch in video games.

7.2.5 Explore Alternate Dimensions of Touch

In this thesis, interpersonal touch has been treated as a binary phenomenon: either two players are touching, or they are not. In truth, this is a gross simplification of touch. Touch can be soft, or it can be forceful, it can be brief, or it can be long-lasting. Where and how two people touch can also be significant; slapping someone on the back is dramatically different from gently patting it.

Due to the current state of interpersonal touch-sensing technology, many of these nuances are lost to the game designer. A game like *Matchmaker* cannot distinguish a hug from a handshake. Intimate Controllers uses touch-sensors to establish some sense of touch location, but it can only recognize touch on those sensors and nowhere else (Chowdhury, 2007).

In the future, I would like to explore how games could integrate these subtleties of touch into their gameplay mechanics. Some of the most elaborate forms of interpersonal

touch-based gameplay are the cooperative “clapping games” often played by young girls (Figure 7.1). In these clapping games, players touch their partners using the backs, the palms, and the sides of their hands, usually in time with a rhyming verse. They require fast, coordinated handwork to succeed.

Figure 7.1 – Two girls play a clapping game

“Secret handshakes” are the adult form of these clapping games – they are typically complex, multi-stage gestures which require practice and memorization (Figure 7.2). Mastery of these handshakes is used to demonstrate a connection between the two participants – usually mutual membership in a group or club.

Figure 7.2 – Three stages in a secret handshake

I think it would be interesting to develop a game which teaches players to perform these elaborate handshakes; within the context of the game, handshakes could serve as “magic rituals” which allow players to unlock doors, or to unleash special powers. Such highly-

interactive gestures would be an amusing way to push cooperation and interactivity through interpersonal touch.

7.3 Closing Remarks

In this thesis, I have proposed the concept of using interpersonal touch as a human-computer interface for video games. Through an examination of video games, of interfaces, and of human sociology, I have argued that including interpersonal touch in games can reward players and game developers alike. Through my work on *Matchmaker* and *Prism Squad: GO!*, I have sought to show that touch is an unconventional but effective method of encouraging cooperation, communication and closeness among teammates in cooperative multiplayer games.

Throughout this thesis, I have dedicated myself to the topic of touch – but touch has merely been my focus for a much broader message. Interpersonal touch is nothing but an interface – a way for humans and computers to communicate and interact. Touch, like any interface, has the potential to offer new interaction possibilities, new ways to cooperate with your friends, new gameplay mechanics and – most significantly – new ways to have fun. By exploring touch in this way, I have sought to illuminate how video games can benefit from leaving the comfortable confines of traditional, generic interfaces and exploring new forms of interaction. But interpersonal touch is just one interface – just one small aspect of human behavior. Human social practice is filled with thousands of satisfying, nuanced behaviors which are still untapped. I hope that these explorations of interpersonal touch have demonstrated the value of these untapped interactions and encouraged the pursuit of future research in this domain.

Appendix A. *Matchmaker* Materials

This appendix contains material related to the *Matchmaker* user study described in section 4.6 of this thesis. It includes:

- Approval from the University of Calgary's Conjoint Faculties Research Ethics Board to perform the study in question.
- The informed consent form given to participants who participated in this study.
- The experimental protocol, which describes the actions taken by the experimenter while they administered the study
- The pre-game questionnaire which was issued to participants before they began to play *Matchmaker*.
- The post-game questionnaire which was issued to participants after they finished playing *Matchmaker*.

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A.1 Ethics Approval

UNIVERSITY OF CALGARY

MEMO

CONJOINT FACULTIES RESEARCH ETHICS BOARD
c/o Research Services
Main Floor, Energy Resources Research Building
3512 - 33 Street N.W., Calgary, Alberta T2L 1Y7
Telephone: (403) 210-9863
Fax: (403) 289 0693
Email: rburrows@ucalgary.ca
Tuesday, May 06, 2008

To: **Cody A. Watts**
Computer Science

From: Dr. Janice P. Dickin, Chair
Conjoint Faculties Research Ethics Board (CFREB)

Re: **Certification of Institutional Ethics Review:** Evaluating Interpersonal Touch in Video Games

The above named research protocol has been granted ethical approval by the Conjoint Faculties Research Ethics Board for the University of Calgary.

Enclosed are the original, and one copy, of a signed **Certification of Institutional Ethics Review**. Please make note of the conditions stated on the Certification. A copy has been sent to your supervisor as well as to the Chair of your Department/Faculty Research Ethics Committee. In the event the research is funded, you should notify the sponsor of the research and provide them with a copy for their records. The Conjoint Faculties Research Ethics Board will retain a copy of the clearance on your file.

Please note, an annual/progress/final report must be filed with the CFREB twelve months from the date on your ethics clearance. A form for this purpose has been created, and may be found on the "Ethics" website, http://www.ucalgary.ca/research/compliance/ethics/renewal

In closing let me take this opportunity to wish you the best of luck in your research endeavor.

Sincerely,

Russell Burrows
For:
Janice Dickin, Ph.D., LLB., Faculty of Communication and Culture and
Chair, Conjoint Faculties Research Ethics Board

Enclosures(2)
cc: Chair, Department/Faculty Research Ethics Committee
Supervisor: Ehud Sharlin

A.2 Informed Consent Form

Name of Researcher, Faculty, Department, Telephone & Email:
Cody Watts, Department of Computer Science (wattsc@cpsc.ucalgary.ca)

Supervisor:
Ehud Sharlin

Project Name:
Evaluating Matchmaker

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the study:
This study was designed to evaluate "Matchmaker" – a two-player, cooperative computer game which makes use of physical touch between players to drive gameplay. Our goal is to determine how players react to physical touch in the course of gameplay, as well as players' attitudes to Matchmaker in general.

What will I be asked to do?
As a participant in this study, you will be asked to play a game of Matchmaker with your partner to the best of your ability. This involves using a touch-screen to match small color-coded people. At certain points during the game, you will be required to make physical contact with your partner (e.g. by touching hands) for approximately 5 seconds at a time.

After you and your partner finish playing the game, the experimenter will ask you to complete a two-page questionnaire, which will be followed by a short verbal interview.

Your participation in this experiment is strictly voluntary. If, at any time you feel uncomfortable or unable to continue, you may withdraw from the study without penalty or loss of benefits to which you are otherwise entitled (see the "Risks & Benefits" section for further details.) Because the study requires two participants to operate, withdrawal of one participant shall be taken as a withdrawal of both participants. The entire experiment is expected to take roughly an hour.

What Type of Personal Information Will Be Collected?
Should you agree to participate in this study, you will be asked to provide your name, age and gender. Your name will not be published if you agree to participate, however your gender and may be used to describe your persona in quotations which you have provided, or for statistical purposes.

I grant the experimenter permission to quote me: Yes: _____ No: _____

Are there Risks or Benefits if I participate?
Participating in this study involves no foreseen risks. However, it is suggested that individuals who feel uncomfortable with interpersonal touch do not participate in this study. Each participant will be paid $10.00 as compensation their time, even if you or your partner chooses to withdraw from the study before its conclusion.

What Happens to the Information I Provide?
No one except the researchers themselves will ever see your personally identifiable information. All data relating to this study (including questionnaires and other written notes) will be kept in a locked cabinet only accessible by the researchers. Anonymous data will be stored for three years on a computer disk, at which time, it will be permanently erased.

If you choose to withdraw the study before its completion, your data will be retained for analysis by the researchers.

Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name (please print) _____

Participant's Signature _____

Researcher's Name (please print) _____

Researcher's Signature _____

Date _____

Questions/Concerns:
If you have any further questions or want clarification regarding this research and/or your participation, please contact:

Cody Watts
Department of Computer Science
(403) 210-9502
wattsc@cpsc.ucalgary.ca

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

UNIVERSITY OF CALGARY

This study has been approved by the Conjoint Faculties Research Ethics Board. Please direct any ethics-related concerns to:

Bonnie Scherrer
Ethics Resource Officer
220-3782
bonnie.scherrer@ucalgary.ca

A.3 Experimental Protocol

Introduction
Thank you both for coming today. With your help, we will be conducting a usability study of a computer game called Matchmaker.

Description of Matchmaker
Matchmaker is a two-player, cooperative game. That means that the two of you will be working together, as a team. The game is played on the DiamondTouch, [gesture to the touch-sensitive DiamondTouch computing surface], which is a touch-sensitive device. Playing Matchmaker is very simple – as the game begins, you will see tiny, color-coded "Peeps" walking across the screen. Your task is simply to match them up according to color and gender. For example, you can match a red guy with a red girl, a green guy with a green girl, and so on. To create a match, simply touch a Peep, and drag it into the Peep held by your partner.

Matchmaker is divided into a series of stages, each of which is more difficult than the last. In order to pass each stage, you will need to make a certain number of matches within the stage's time limit. If you fail a stage, you will be given the opportunity to repeat it. The experiment will run until you complete the game, or you fail a stage three times in a row, whichever comes first.

Matchmaker is more complicated than I have revealed – there will come a point in the game where you will be required to make physical contact with your partner to perform special actions. This physical contact can be anything which involves skin-on-skin contact, for example, touching two fingers together or holding hands. While this contact does not have to be intimate, interpersonal touch will be required as part of the gameplay, and for this reason I would like to reemphasize that if either of you feel uncomfortable with this, you are free to discontinue participation in the experiment at this time.

Experiment Description
Our goal today is to observe how people play and react to Matchmaker. The study is divided into three sessions. During the first section, I will administer to each of you a pre-test questionnaire. The purpose of this questionnaire is to give us insight into the skills and experiences you are bringing with your into this experiment. During the second phase of the experiment, the two of you will be asked to play Matchmaker to the best of your ability. During this time, I will be observing your performance, and taking written notes. After you have concluded playing, I will administer a short questionnaire to each of you, which is an attempt to gauge your reactions to the experience of playing.

Now, if you'll take your seats, the experiment will begin. These are the pre-test questionnaires. [Give a questionnaire to each participant.] I'll ask that you fill these our now. Once you have completed these, the experiment can begin.

A.4 Pre-Game Questionnaire

Your Age: _____

It is your right not to answer any of the following questions. Please do not answer a question if it makes you feel uncomfortable.

1. In the past week, on which of the following platforms have you spent at least one hour playing video games? (Check all that apply)

- ☐ Console (e.g. Xbox 360, Playstation 3, Wii)
- ☐ Handheld (e.g. Nintendo DS, PSP)
- ☐ Cellphone
- ☐ Personal Computer
- ☐ Web (including Flash and browser-based games)

2. Have you ever used a touch-sensitive tabletop computer?

☐ Yes ☐ No

3. Are you physically affectionate with your partner? (E.g. Do you hold hands or hug?)

☐ Yes ☐ No

A.5 Post-Game Questionnaire

Please answer the following questions as honestly as possible. We are not just looking for information on where Matchmaker succeeds, but where it fails as well.

It is your right not to answer any of the following questions. Please do not answer a question if it makes you feel uncomfortable.

1. **Overall, I enjoyed playing Matchmaker.**

Strongly disagree			Neither agree nor disagree			Strongly agree
•	•	•	•	•	•	•

2. **I liked Matchmaker's themes of love and romance.**

Strongly disagree			Neither agree nor disagree			Strongly agree
•	•	•	•	•	•	•

3. **I found Matchmaker difficult to play.**

Strongly disagree			Neither agree nor disagree			Strongly agree
•	•	•	•	•	•	•

4. **I feel that Matchmaker made use of interpersonal touch in a significant way (i.e. the game would not be the same without it.)**

Strongly disagree			Neither agree nor disagree			Strongly agree
•	•	•	•	•	•	•

5. **In Matchmaker, it is common for one player to take a dominant role. The dominant player is the one who initiates interpersonal touch, and decides which Peeps to match. While playing Matchmaker, who do you feel was the dominant player?**

☐ Myself ☐ My partner ☐ Neither/We took turns

6. **How did the need to physically touch your partner affect your experience of Matchmaker, if at all? Did it make the game more or less enjoyable for you?**

_____
_____
_____
_____
_____

7. **What, if anything, did you particularly like about Matchmaker? Is there anything you would like to see more of?**

_____
_____
_____
_____
_____

8. **What, if anything, did you particularly dislike about Matchmaker? Are there any parts of the game where you felt frustrated or bored?**

_____
_____
_____
_____
_____

9. **If you have any further comments on Matchmaker, please list them here.**

_____
_____
_____
_____
_____

Appendix B. *Prism Squad: GO!* Materials

This appendix contains material related to the *Prism Squad: GO!* user study described in section 5.7 of this thesis. It includes:

- Approval from the University of Calgary's Conjoint Faculties Research Ethics Board to perform the study in question.
- The informed consent form given to participants who participated in this study.
- The experimental protocol, which describes the actions taken by the experimenter while they administered the study
- The post-game questionnaire which was issued to participants after they finished playing *Prism Squad: GO!*

B.1 Ethics Approval

UNIVERSITY OF CALGARY

MEMO

CONJOINT FACULTIES RESEARCH ETHICS BOARD
c/o Research Services
Main Floor, Energy Resources Research Building
3512 - 33 Street N.W., Calgary, Alberta T2L 1Y7
Telephone: (403) 220-3782
Fax: (403) 289 0693
Email: rburrows@ucalgary.ca
Monday, June 08, 2009

To: **Cody A. Watts**
Computer Science

From: Dr. Janice P. Dickin, Chair
Conjoint Faculties Research Ethics Board (CFREB)

Re: **Certification of Institutional Ethics Review:** Evaluating Prism Squad: GO!

The above named research protocol has been granted ethical approval by the Conjoint Faculties Research Ethics Board for the University of Calgary.

Enclosed are the original, and one copy, of a signed **Certification of Institutional Ethics Review**. Please make note of the conditions stated on the Certification. A copy has been sent to your supervisor as well as to the Chair of your Department/Faculty Research Ethics Committee. In the event the research is funded, you should notify the sponsor of the research and provide them with a copy for their records. The Conjoint Faculties Research Ethics Board will retain a copy of the clearance on your file.

Please note, an annual/progress/final report must be filed with the CFREB twelve months from the date on your ethics clearance. A form for this purpose has been created, and may be found on the "Ethics" website, http://www.ucalgary.ca/research/compliance/ethics/renewal

In closing let me take this opportunity to wish you the best of luck in your research endeavor.

Sincerely,

Russell Burrows
For:
Janice Dickin, Ph.D., LLB., Faculty of Communication and Culture and
Chair, Conjoint Faculties Research Ethics Board

Enclosures(2)
cc: Chair, Department/Faculty Research Ethics Committee
Supervisor: Ehud Sharlin

B.2 Informed Consent Form

Name of Researchers, Department & Email:
Cody Watts, Department of Computer Science (wattsc@cpsc.ucalgary.ca)
Ehud Sharlin, Department of Computer Science (ehud@cpsc.ucalgary.ca)
Eileah Trotter, Department of Psychology (ilabexp@ucalgary.ca)

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

Purpose of the study:
This study was designed to evaluate "*Prism Squad: GO!*" – a three-player, cooperative video game. Our goals are twofold: to determine how players cooperate while playing *Prism Squad: GO!* and to examine players' attitudes to *Prism Squad: GO!* in general.

What will I be asked to do?
As a participant in this study, you will be asked to play a game of *Prism Squad: GO!* with your partners to the best of your ability. This involves using a Nintendo Wii Remote to control the action occurring on a large plasma display.

After you and your partners finish playing the game, the experimenter will ask you to complete a four-page questionnaire, which will be followed by a short verbal interview.

Your participation in this experiment is strictly voluntary. If, at any time you feel uncomfortable or unable to continue, you may withdraw from the study without penalty or loss of benefits to which you are otherwise entitled (see the "Risks & Benefits" section for further details.) Because the study requires three participants to operate, withdrawal of one participant shall be taken as a withdrawal of all three participants. The entire experiment is expected to take roughly an hour.

What Type of Personal Information Will Be Collected?
Should you agree to participate in this study, you will be asked to provide your name and gender. Your name will not be published under any circumstances; however your gender may be used to describe your persona in quotations which you have provided, or for statistical purposes.

With your permission, your play session will be recorded on video. If you consent, parts of this video may be used to demonstrate or promote *Prism Squad: GO!* If you consent to allow your video footage to be used, your absolute anonymity cannot be assured, as you will be recognizable to those that know you. Furthermore, once video images are publicly displayed, the researchers will have no further control over the use of those images and there is the possibility that those images may be reproduced and displayed in other contexts without your express permission, such as on the internet.

I grant the researchers permission to quote me. (Quoted participants will not be identified by name – only by gender.)	☐ Yes	☐ No
I grant the researchers permission to record me playing Prism *Squad: GO!* on video.	☐ Yes	☐ No

I grant the researchers permission to use my video footage to demonstrate or promote *Prism Squad: GO!* at their discretion. ☐ Yes ☐ No

Are there Risks or Benefits if I participate?
Participating in this study involves no foreseen risks. Each participant will be paid $10.00 as compensation their time, even if you or one of your partners chooses to withdraw from the study before its conclusion.

What Happens to the Information I Provide?
No one except the researchers themselves will ever see your personally identifiable information. All data relating to this study (including questionnaires and other written notes) will be kept in a locked cabinet only accessible by the researchers. Anonymous data will be stored for three years on a computer disk, at which time, it will be permanently erased. Please note that any promised anonymity is limited by the fact that your identity will be known to the two other participants in your experiment group.

If you choose to withdraw the study before its completion, your data will be retained for analysis by the researchers.

Signatures (written consent)

Your signature on this form indicates that you 1) understand to your satisfaction the information provided to you about your participation in this research project, and 2) agree to participate as a research subject.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

Participant's Name (please print) _____

Participant's Signature _____

Researcher's Name (please print) _____

Researcher's Signature _____

Date _____

Questions/Concerns:
If you have any further questions or want clarification regarding this research and/or your participation, please contact Cody Watts at (403) 210-9502 or at wattsc@cpsc.ucalgary.ca.

A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

This study has been approved by the Conjoint Faculties Research Ethics Board. Please direct any ethics-related concerns to Bonnie Scherrer (bonnie.scherrer@ucalgary.ca)

B.3 Experimental Protocol

When the participants arrive, sit them down together as a group. Your first task is to explain the study.

Introduction

"Hi everyone. My name is Cody; thank you all for coming in today.

Today, with your help, we'll be conducting a study of a three-player cooperative video game called *Prism Squad: GO!* The game is played on this large, plasma display [gesture to the display] using these Nintendo "Wiimotes" [gesture to the Wiimotes]. The purpose of this study is to help us to understand how players' feel about playing *Prism Squad*.

Our experiment is broken down into three phases:

During the first phase, you and your partners will play *Prism Squad: GO!* together while our experimenters observe and record your behavior. The game is short, and this stage of the experiment is expected to take roughly 30 minutes.

After you have completed the game, each of you will be issued a short, written questionnaire. This questionnaire is designed to help us understand your impressions of *Prism Squad: GO!*

Finally, after the questionnaires are completed, there will be an unstructured interview period, where you and the experimenters can discuss the game and ask any questions which may have come up during the experiment.

The entire experimental process is expected to take around one hour. Does anyone have any questions so far? [Take questions.]

At this point, I'm going to give everyone an informed consent form. Please take the time to read and understand these forms. Once you have filled out these forms, the experiment will continue."

How to Play

"Before the experiment begins, I want to give you a short tutorial on how to play. [Launch the demo program now.]

This is *Prism Squad: GO!* As you can see, the game is a top-down, 2D game set in outer space. In *Prism Squad*, each player controls a colored spaceship, floating around a planet in space. This planet is your objective – your goal is to protect it from alien invaders.

In each stage of Prism Squad, enemies will fly towards the planet from off-screen. These enemies cannot hurt you, but they will damage the planet if they manage to collide with it. The green ring around the planet represents the planet's health; with each collision, this ring will begin to disappear. When the ring disappears completely, you lose.

You three can protect the planet by shooting down incoming enemies with your lasers. Each ship can fire a laser out from the nose of their ship by pressing the 'B' button on their controller [show the participants the 'B' button on the Wiimote.] Holding down 'B' will allow your ship to shoot continuously.

By now I'm sure you've noticed that there are three ships colored red, yellow and blue. Each player controls a different ship, and each ship shoots a different color of laser. The red ship shoots red lasers, the yellow ship shoots yellow lasers, and so on.

Now, take a look at the table of enemies [press spacebar to transition to the table of enemies]. You'll notice that there are four basic enemies. Meteors can be destroyed by any player, but the colored UFOs can only be destroyed by the laser of the appropriate color. That means that the red player is responsible for destroying the red UFOs, the blue player is responsible for the blue ones, and so on.

I'm sure you've noticed that there are even more enemies; orange, green, violet and even white UFOs. This is where the game gets tricky. In order to destroy these secondary enemies, the players must "blend colors". Have you ever painted before? Blending colors is a lot like mixing paints. Red and yellow combine to make orange, yellow and blue combine to make green, and so on. You can see all the possible color combinations on the sheet. When two players blend colors, each players' ship will begin to glow, and each player will begin to shoot lasers of the blended color. Through color-blending, players can take down these advanced enemies [press spacebar again to return to the demo program].

In order to blend colors, each player must hold down the 'A' button on their controller [show the participants the 'A' button] – each person who holds down 'A' is participating in the blend. So, if only one person holds down 'A', nothing happens – but if you and I both hold down 'A' simultaneously, then we're blending our colors. Then, if either of us lets go of 'A', nothing is happening anymore.

Does everyone understand how color-blending works? [Answer any questions at this point.]

Finally, I want to talk to you about moving; you'll notice that each spaceship has a corresponding crosshair. These crosshairs correspond to the position of each player's Wiimote; as you move your Wiimote, the crosshair will follow it onscreen. Each spaceship continuously follows its crosshair, travelling the shortest possible distance to get there. So, if you want to move your ship some place, all you have to do is point there!

Still, there are times when you won't want your ship to move. The "down" button on the D-pad is the ship's brake [show the participants the down button]. If you press and hold "down", your ship will immediately stop moving – although it will still rotate in place to orient itself to your cursor. When you release the down button, the ship will resume chasing the cursor.

The game is made up of a series of stages which get more and more difficult as the game goes on. Each stage has a set time limit; you advance through the game by protecting the planet until time runs out. If you fail a stage, you'll have the option to repeat it.

That's pretty much it. Does anyone have any questions before we begin? [Answer any questions at this point.]

From now on, I'm going to try to stay out of your way, and let you play. Please just try to have fun and act naturally. If you have any problems, please try your best to figure them out with your team, but if you get really stuck, I'll be here to help you."

[At this point, you should launch the game, and – if necessary – help the players to choose their colors. Beyond that, give the players free reign to experiment and find things out for themselves.]

Video Recording

If all of the players agreed to be recorded in their consent forms, start the video recording when the players begin to play. The video camera should be trained on the players, not the screen, and positioned in such a way as to capture all three players at once.

Ending Conditions

The game should proceed until one of two conditions is met: Either the players successfully complete the final stage (Earth) and win the game, or the players fail any stage three times consecutively.

After the Game

Once the participants have finished playing, stop the video recording, collect their Wiimotes, and distribute a questionnaire and writing utensil to each player. Ask each player to complete the questionnaires independently (to protect against any conformity biases) and honestly.

Make sure that each player correctly records his or her color on the questionnaire; this is crucial for matching the player to his or her logged score data.

Take the questionnaires from each player as they're completed. When all the participants have finished their questionnaires, it's time for a little group dialog; gather the participants together, and ask them if they have any questions. At this point, any of the experimenters present may choose to ask the participants questions of their own.

When everyone has run out of questions, give each participant their $10 payment, thank them for their time, and walk them to the door.

B.4 Post-Game Questionnaire

Your name: _____ Your in-game color: _____
Your gender: ☐ Male ☐ Female

Please answer the following questions as honestly as possible. Your feedback will help us to understand how players really feel about *Prism Squad: GO!*

1. **Overall, how would you describe your experience playing *Prism Squad: GO!*?**

Very unenjoyable			Neither enjoyable nor unenjoyable			Very enjoyable
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

2. **As a whole, how would you describe your team as they played *Prism Squad: GO!*?**

Very unenthusiastic			Neither enthusiastic nor unenthusiastic			Very enthusiastic
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

3. **As a whole, how would you describe your team as they played *Prism Squad: GO!*?**

Very Hostile			Neither supportive nor hostile			Very supportive
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

4. **As a whole, how would you describe your team as they played *Prism Squad: GO!*?**

Very quiet			Neither talkative nor quiet			Very talkative
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

5. **As a whole, how would you describe your team as they played *Prism Squad: GO!*?**

Very uncooperative			Neither cooperative nor uncooperative			Very cooperative
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

6. **Overall, how do you feel about your team's performance in *Prism Squad: GO!*?**

Very dissatisfied			Neither satisfied nor dissatisfied			Very satisfied
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

7. **How easy was it for you to remember *Prism Squad: GO!*'s color-combinations? (Red + Yellow = Orange, Yellow + Blue = Green, Blue + Red = Violet, etc.)**

Very difficult			Neither easy nor difficult			Very easy
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

8. **How difficult was it for you to combine colors with your partners in *Prism Squad: GO!*?**

Very difficult			Neither easy nor difficult			Very easy
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

9. **How would you feel about playing *Prism Squad: GO!* with complete strangers?**

Very uncomfortable			Neither comfortable nor uncomfortable			Very comfortable
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

10. **How would you feel about playing *Prism Squad: GO!* with friends of your own gender?**

Very uncomfortable			Neither comfortable nor uncomfortable			Very comfortable
•	•	•	•	•	•	•
-3	-2	-1	0	1	2	3

11. **What (if anything) did you most enjoy about *Prism Squad: GO!*?**

12. **What (if anything) frustrated you the most about *Prism Squad: GO!*?**

13. **If you were in charge of designing *Prism Squad: GO!* how would you change the game to make it better? What would you add to or remove from the game, and why?**

14. **Is there anything else you'd like to tell us about *Prism Squad: GO!*?**

Appendix C. Co-Author Permissions

This appendix contains signed permission from my past co-authors to reuse certain portions of our jointly-authored work in this thesis.

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I, Ehud Sharlin, give Cody Watts permission to use co-authored work from our papers listed below for chapters of his MSc thesis and to have this work microfilmed.

Co-authored work:

Watts, C., Sharlin, E., and Woytiuk, P. (2008). **Exploring Interpersonal Touch in Computer Games**. In Proceedings of the 2008 international Conference on Advances in Computer Entertainment Technology (Yokohama, Japan, December 03 - 05, 2008). ACE '08, vol. 352. ACM, New York, NY, 423-423.

Watts, C., Sharlin, E., and Woytiuk, P. (2009). **Matchmaker: Interpersonal Touch in Gaming**. In Proceedings of the 4th international Conference on E-Learning and Games: Learning By Playing. Game-Based Education System Design and Development (Banff, Alberta, Canada, August 09 - 11, 2009). M. Chang, R. Kuo, Kinshuk, G. Chen, and M. Hirose, Eds. Lecture Notes In Computer Science, vol. 5670. Springer-Verlag, Berlin, Heidelberg, 13-24.

Sincerely,

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I, Peter Woytiuk, give Cody Watts permission to use co-authored work from our papers listed below for chapters of his MSc thesis and to have this work microfilmed.

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Sincerely,

Peter Woytiuk

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