Moov

Scaffolding Motion-Based, Paired Play Creation

By

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Abstract

Moov: Scaffolding Motion-Based, Paired Play Creation

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This project creates a motion-based play system that allows pairs of people to create their own play. It is an investigation in scaffolding an emergent play creation process. In it, players are placed in a minimal environment, given control over a digital body that emits movement-generated effects, and play emerges based on how players choose to express these effects in paired play. This paper describes the research and development that drove the creation of the system's underlying play model and architecture, as well as the results of user testing. A variety of research approaches were undertaken in the project, including readings, interviews, low/high-fidelity prototyping, system architectural design and coding. Relevant research was explored in the areas of play, open-ended play, emergent play, and digital performance. The core objectives of the research were to build the system and then validate its efficacy.

Keywords: Play, Open-ended Play, Emergent Play, Motion, Digital Body, Digital Performance

Dedications

I dedicate this project to my Primary and Secondary Thesis Advisors, Dr. Emma Westecott and Dr. Adam Tindale. Their wisdom, guidance, and tireless patience were critical in making this project come to fruition.

I also dedicate this project to my Father, James Albert Essex, for his tremendous emotional support.

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1 Introduction

1.1 Project Essence

1.1.1 Two Moving Bodies

This project was initiated by a vision I had of two bodies moving together sensually, exploring movement that was driven by their feelings. Through this, they were in tune with physical sensation and emotion, and they felt connected to their partner on an richly emotional level. They were aware of the energies they generated and exchanged with each other and their environment. Through this process, they achieved a new sense of togetherness – a deeper level of connection that was activated by movement, and existed almost subconsciously.

The vision was not sexual, but that of an experience in which awareness of the infinitudes of nuances in movement are heightened. This awareness extended to include the motions of the partner, understanding on a physical level how one partner affects the other. There were constant fluctuations in the leading and following of each other, both moving-feeling their way in emergent co-composition. I imagined the movement aesthetic to resemble some type of new age tai chi mixed with the dance form Contact Improvisation.

As a technologist, the next step after this inspiration was to imagine a digital system that would in some way facilitate and amplify the experience.

1.1.2 Play-Based Approach

I wanted to provide an experience that was less scripted. That is, rather than creating a system that required players to move in pre-defined forms of movement, I felt it should support movement that extended from user intention – something much more free-flowing. Users should be given the opportunity to explore moving together, and to see where it takes them. They should be able to experiment and to express with their bodies. They should be given opportunities to cause their partner to feel things - and they should be allowed to play.

I came to believe that what I wanted to build was a system that enabled movement-based partnered play. This play involves the co-creation of a shared performance between two people in front of a screen, interacting with each other via screen-based feedback.

1.1.3 "Our" Play: Co-operative Play Forming

It is a specific form of play that Moov scaffolds. I refer to this play as "our play". With "our play", I am referring to play that two people in a relationship create together. I give it the term "ours" because the play is defined by us. We define the rules. We define the objectives. Playing it creates a Huizingaian magic circle that is "ours", and it signifies the uniqueness of our relationship. Over the course of this project, I have examined a large collection of examples in developing the Moov system. Some are described below:

1) **Nose Kissing:** In a past relationship, my partner and I invented our own game of nose kissing. It began by exploring the sensation of slowly moving our noses across each other. It then evolved into gentle nose-sword play that achieved a rhythm that

was timed by shared sensation rather than communicated. Whenever either of us needed an emotional lift, we would play our nose kiss game, and it was instantly curative.

2) **Paired Clapping**: In this game, a mother and son combined their bodies to create a shared expression. Seated, with elbows on knees and forearms pointed upwards, the mother would tuck her left arm under her son's right arm. Then, using their interlocked arms, the pair would clap. The gesture was tender, loving, playful - and interconnected.
3) **Upside-Down Face**: The objective of this game was in provoking fun reactions in each other. My friend and I would lay down and perform ridiculous characters while facing each other with upside-down faces. It was abstract, crazier-the-better performative fun, that played on the mind and senses by distorting up from down. Further, it tended to start with one face, then evolved into the playing out of full character performances based on that face.
4) **Friends in Paris**: In this example, two female friends journeyed to foreign land, and were made to feel like second class citizens because they did not speak the native language. After repeated poor interactions with locals, the women developed their own game. They would approach a person and ask a question but use their native tongue instead of the local, and would perform a physical gesture that was not appropriate for the question, e.g. they would tap their watch when asking for directions. This created a sense of confusion and unease in the locals, which then empowered the women. Ultimately, what the game represented was a *celebration* of 'us' as different from you.

I consider "our play" to be special for several reasons. First, based on my own observations and from the data collected via this project, I believe that this play emerges

from and is specific to individual relationships. It occurs within the context of those relationships, thereby becoming markers of uniqueness, distinguishing the relationship from others and from the world at large. Second, I have observed that this play is used in relationships to strengthen bonds, signifying a special awareness of "us", and often functioning as a soothing agent/curative device. Third, as one of the friends from Paris told me, it creates lasting memories that are tied to emotional well-being. As she put it, "just remembering the game brings back all the same feelings that were there when we played."

1.1.4 Core Project Intention

At its core, the intended result of this research project is a system that enables movement-based play creation between two people. It is a different approach to the design of play systems. Instead of driving a particular play experience, the system scaffolds play creation in pairs of players. It provides players with a set tools that allows them to explore and define their own play. It is play forming versus play enactment.

It could be argued that all play is in effect play forming. Quoting Salen and Zimmerman, theorist Brian Upton states that "…play is an emergent property that arises from the game as a play[er] engages with the system" (2015, pg. 35). That is, when you and I engage in a game, our decisions, interactions, expressions, emotions, and movements collectively combine into a rich, fluctuating composition that can be seen as "our play". However, often "what" we are playing is pre-defined. The rules generally are already set, and we move within them in play.

What the Moov system is intended to provide is a framework in which two people define the "what" of their play. In it, players are given tools (their digital bodies), a set of visual effects generated by movement, and an environment. They are then given the freedom to explore the basic interaction opportunities of their tools, and through this co-exploration, they are free to co-operatively define their own play as they move together.

1.2 Why Technology?

A question that I have had to address in informal discussions regarding this project is, "why is technology appropriate in this context?" Or, "if people already create their own play in relationships, why do they need technology to serve the same purpose?" I have opted to address this question here because I believe it helps inform the system design. The reason for technology is that it offers a specific experiential lens – and this lens opens up play opportunities that are not openly available in non-digital play. Let me clarify this with a story.

Recently, I acquired a new mobile phone with a camera that offers a feature new to me, namely Selective Focus. The feature allows users to focus in on selected objects while de-focusing on other aspects in a scene. However, the feature has its limits. The selected object must be less than 50cm away from the lens, and if you zoom in too close, the feature fails to work. So, the operative range is somewhere between 10 and 50cm. The first time I used Selective Focus, it shocked me. I took a picture of a tiny toy car that has sat on my desk - seen by my naked eye - for over a year, but through this new lens, I saw colours, shadows, and nuances that I had never seen before. I was amazed. I continued exploring Selective

Focus with the car, tilting the camera (and my body) from a variety of angles, always seeing something new. I continued this exploration with an assortment of other objects, moving them into unordinary positions, casting different lights on them, and combining objects together.

This new technology lens sparked a new awareness, initiated exploration, and invoked play. It was not just a seeing experience - it was a moving-and-seeing-and-playing experience. It was an experience that affected my relationship with the world around me in a way that was not available through non-digital means. This project is intended to serve a similar purpose.

1.3 Project Vision

1.3.1 Long-Term Model

In the long-term, I envision this project as a play space that serves as a tool for relationships. Its core model, as illustrated in figure 1.1, is one in which two people in a relationship, driven by emotional and/or relational needs, dynamics, and motivations engage with the system. They explore the interactional opportunities, negotiate and form a type of play, follow that play through towards goals that serve their initial drives, and leave the space with an experience that affects their current relationship in the real. The system is engaged with as often as they desire, serving to activate new discoveries in their relationship, enable

improved communication, strengthen their bond, or express other emotional needs in their relationship.

The system, in the larger sense, is one that could be played by co-located partners or by players from a distance. Further, the artefacts, environment, and interaction opportunities could be customized to drive needs specific to different couplings. For instance, co-located partners in relationships with relational issues could engage in the system that has been customized by a therapist to support relationship counseling. Or, non-co-located parents with limited access to their children due to divorce or work obligations could engage with a system that is customized along with their children, enabling the parent to provide physical, emotionally supportive play.

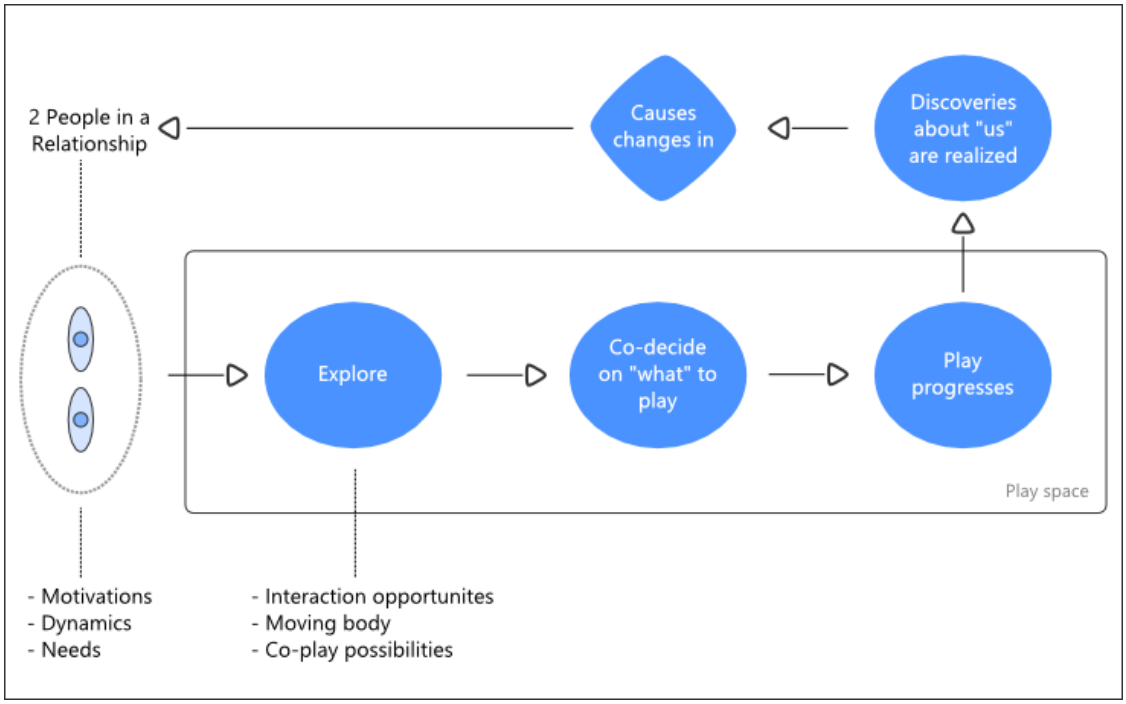

Figure 1: Long Term Core System Model

1.3.2 Current Scope

The long-term model, however, is far beyond the scope of this thesis project. In the short term, the project supports a simplified version of the long-term core system model. The current scope assumes no existing relationship between participants, and does not intend to function as a relationship tool. Its primary purpose is to demonstrate the validity and potential of the prototypes I have developed which support explorative, motion-based paired emergent play.

It supports play between two people with the basic interaction flow (Figure 1.2):

1) Exploration of interaction opportunities using the body
2) Co-operative play forming
3) Progression of the formed play

The final system in the current scope uses a Microsoft Kinect sensor to track player movement that is displayed on a digital screen. The physical play space is co-locational, being a rectangular floor space in front of the screen.

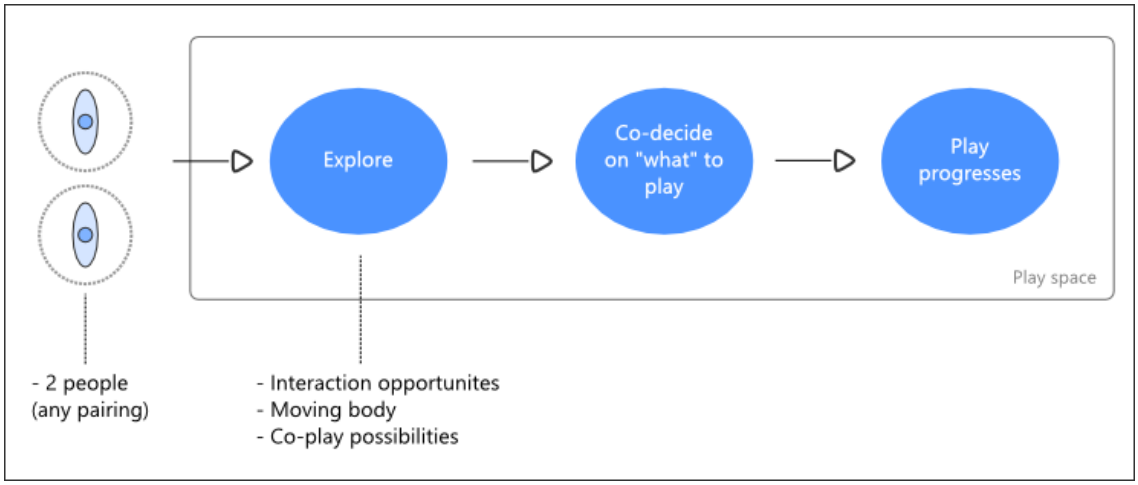

Figure 2: Current Scope Core Model

1.4 About Me

My background is largely in software development. I studied systems design and development in my undergraduate degree, then worked in industry in a number of development roles. In these, I have developed accounting and inventory systems, custom web solutions, independent video games, and mobile apps.

However, my passion is in developing technologies that connect and heal people. This project is a continuation and combination of several smaller projects within this theme that I developed during my graduate degree studies at OCAD University. Three of these are Furgs, Addict My Love, and Nanochakra.

Furgs are a pair of connected stuffed toys with sensors and vibration motors that allow two people located in different locations to cuddle and play fight. Users are able to do things like poke the belly or tug the ear of one of the toys and trigger vibrations in the respective body part of their partner's toy.

Addict My Love is an experimental video game that is intended to educate by experience the emotional cost of expending tangible and intangible resources in enabling addictive behaviours in loved ones. It employs the use of awkward mouse movements to provide physical feedback that reflect the emotional costs.

Nanochakra is a VR + Motion based game that allows players to channel energies and cast spells using gestures. It explores the relationship of the physical form with energies in an environment.

This project extends the connectivity in Furgs, the physical/experiential approach in Addict My Love, and the relationship of the physical form moving through and connecting to the energies within a digital play space in Nanochakra.

Image 1: Furgs (left), Nanochakra (right)

1.5 Purpose of Research

1.5.1 Project Purpose

The purpose of this project was the development of several digital prototypes that provide evidence of the core play model defined in section 1.3.2. The prototypes provide a movement-based, co-operative play space in which pairs of players explore paired interaction opportunities and play emerges.

Effectively, this project serves as a major step forward into a much larger line of inquiry. Its main purposes are to:

1. Develop and validate the initial stages of the play model
2. Provides insights into how this system can be extended

3. Define design characteristics of play and performance to support the design and development of these extended explorations
4. Provide a stable, well-architected core system that is highly extensible, supporting research led by rapid prototyping

1.5.2 Research Questions

At the top level, the main question this project sought to answer is: how could an interactive system and its space be designed such that it supported motion-based, exploratory play forming in pairs of participants?

Addressing this question required research to be conducted in the areas of:

1) **Play**: to extract some core characteristics of play to aid in designing the interaction opportunities in the space.
2) Open-Ended Play & Emergence: to extrapolate and build the desired emergent play[1] model
3) Digital Performance: to extract core principles in the design of digital bodies and relational experiences, such that the designs enhance exploratory, movement-based, sensorial play

The main question that this research addresses is: if two players are given respective digital bodies, and a set of effects that are produced by moving their digital bodies, will paired play creation emerge?

On the level of sensorial experience, questions the project addressed include: Which types of body representations best support empathetic relationship building with between

[1] The term "emergent play" is used throughout this text and refers to play creation.

player and representation? What design characteristics of motion-based interactive systems support sensorial physical play?

1.5.3 Importance of Research

From an academic perspective, this project contributes to the research community by extending research into play and open-ended play systems modeling and development. I believe the models presented herein offer a pathway for further academic research. The play model that it presents could be refined and/or extended either in the same general context or another.

On a social level, in the long-term, I hope that this project is of real value to people in relationships. It has the potential to stimulate play between two people that extends beyond their immediate experience with the system; that is, if they discover a new way of playing together, they may continue to play this way after they experience Moov.

2 Methodology

2.1 Overview

Moov's overall research methodology is Research-Oriented Design. The process tended to be more emergent than formally structured, with different methods being employed at the various stages of the development journey.

A large-front end of the process consisted of delving deeply into relevant literature, extracting relevant theory, sketching, brainstorming, and reflecting.

The tail-end of the process consisted of a series of rapid-prototyping sessions followed by user testing, and then continual refinements to the prototypes based on the testing.

The main goal of the research project was to demonstrate the efficacy of its models and system in enabling exploratory play forming between pairs of players. This goal was to illustrate both the potential for future work in the area and to provide a clear set of system design models that could be built upon in future projects.

The final output of this research project included a validated prototype and a set of development models. The models include design guidelines extracted and synthesized from previous scholarly works and relevant performance installations, and a set of system design models which were used in developing the prototype.

2.1.1 General Trajectory

In general, the pathway in fulfilling this project involved extrapolating a play process model and design characteristics that could be implemented digitally. The interrelated research and design components in the project included:

1) Defining a play model through scholarly research and low-fidelity prototyping. Low-fidelity prototypes included paper-based games
2) Converting the model into a system design model[2]
3) Implementing the model digitally via computer programming and design
4) Validating its efficacy through user testing
5) Documenting the model and results

2.2 Components

There were several key research components involved in the project:

2.2.1 Literature Review

Within the literature review, texts in the areas of play, open-ended play, emergent gameplay, interactive art, motion and representation, and performance were studied. The intention of this interdisciplinary study was to build up a play process model and extract key design characteristics to inform system design, interaction opportunities in the play space, and the design of on-screen player representations. Ways of making the play experience more relational were also explored.

[2] See Chapter 4.2

2.2.2 Contextual Review

Via a contextual review a selection of relevant art installations were examined. These aided in extending the play model and design characteristics that surfaced during the literature review. While Moov is not an art installation, theories related to the digital body and the digital space demonstrated in these works proved informative in my design decisions.

2.2.3 User Research

User research was performed via formal and informal interviews and a survey. This purpose of this research was to gain deeper insight into the types of play that people co-create with people in significant relationships. This questioning also looked to uncover their motivations, methods of communication, and the significance of co-created play to interviewees. Initially, the intention was to build an extensive database of play forms, group them, then design Moov to support the dominant forms of play. However, the project was later designed to scaffold the emergence of play forms rather than pre-design the system to support specific play. With that said, data collected in this research helped to further inform the designs built in the prior two sections.

2.2.4 Low-fidelity Prototyping

In this area of research, a series of low-fidelity prototypes were developed to validate the findings of initial research into open-ended play. A full description, purpose, design, and

results of the prototypes that were used is discussed in section 3.2.2.2. The prototypes validated initial research and informed further design decisions in the digital prototypes.

2.2.5 Digital Prototyping

The overall purpose of this section was to build the working play system. However, activities in this section were sub-divided into several main stages. These stages were repeated and/or revised several times throughout the process. The sub-activities included: abstract model building, system architectural design, programming, digital design, and play testing implementation and analysis. Note that the research activities described in the sections 2.2.1-2.2.4 above drove the digital prototyping phase(s).

3 Theoretical Background

3.1 Play

3.1.1 Characteristics of Play

In designing a system of emergent play, I began my research by first developing a deeper understanding of play theory. My initial intention was to develop a model of play that resembled a machine. The hope was that through reading from the works of major theorists, the process of play could be distilled into discrete, interworking components; play could be modeled to resemble an assembly line process. From this model, I believed components could be added or rearranged into a system that stimulated exploratory play forming, implemented as a digital experience.

Unfortunately, play does not lend itself to this sort of clean mechanization. So, instead, my approach shifted, drawing from research a set of characteristics of play that that functioned more as a framing mechanism. These characteristics served as a set of guiding principles, shaping the form of the system in a more abstract sense. The approach became more about trying to understand how to scaffold play experiences versus driving them via an engine.

The reason for this shift in approach was that play is messy. It "…is a notoriously difficult concept to define" (Flanagan, pg. 4). This difficulty can be attributed, in part, to its expansive

range of forms and the broad spectrum of rule sets (or lack thereof) that drive its moving shape.

As discussed at length by major theorists Huizinga (1950) and Caillois (1958), play occurs in a vast array of forms and functions across cultures. Play is so ubiquitous, that as Sutton-Smith states, "…almost anything can allow play to occur within its boundaries" (pg. 3). These boundaries can include extensive sets of 'laws' like in professional sports, or can be as loosely structured as "…picking which stick to use as a light saber" (Eberle, pg. 214).

Gaining a clear understanding of the motivations behind play is just as difficult as giving it a definition. Psychologist Karl Groos (1898) believed play to be driven by instinct as a means of training for future life functions like hunting. Csikszentmihalyi and Bennet (1971) describe play more as an alignment of a person's motivation and the affordances of the environment, which presents her with a clear pathway to escape from worry and boredom. Along the same lines, Huizinga asserted that we play for the experience of play itself (1950, pg. 3).

Fortunately, amongst the disagreement, ambiguity, and murkiness around play, theorist and game developer Brian Upton provides a definition that has had a major influence on my research project:

Play is free movement within a system of constraints. (2015, pg. 15).

The definition is effective because it is simple, yet encompasses the core characteristics of play. In developing a play system, it has helped greatly by highlighting the essential

elements. As Upton states, the definition is "…a simplification and an amplification" (2015, pg. 15) of Huizinga's. It describes the "…four elements that Huizinga believes are fundamental to play: rules, movement, freedom, and boundaries" (2015, pg. 14).

In designing my framing system for play, I found it necessary to unpack each of these four elements, and consider how they function as a system. While each of the elements interplay with each other when play is in effect, I believe the core element to be the rules of play.

3.1.2 Rules of Play (A System of Constraints)

The reason that rules are so central to play, and therefore to Moov, is that they are the characteristic that give it its form. Rules shape the experience of play. They circumscribe play from non-play, defining the boundaries of the play space, the operating procedures with and/or of the artefacts in the space, the play objectives, and the 'laws' of conduct in pursuing those objectives (Huizinga 1950, Caillois 1958).

Life is full of imperfections, ambiguity, unfairness, but play creates order (Huizinga, 1950, pg. 10). Play's organized structure creates a temporary second reality "…with which the player can cope in a predictable way" (Csikszentmihalyi & Bennet, 1971, pg. 49). It achieves this through simplification; in contrast to the confusion and chaos of the ordinary, play creates perceptual boundaries and limits moment to moment choice, allowing players to "…act with concentration and abandon' in the '…scaled-down world of the play form'" (Csikszentmihalyi & Bennet, 1971, pg. 54).

Rules can be written and formal, like the 226-page rule book of the National Hockey League. They can also be loose and flexible, open to interpretation as appropriate within a context. For example, in playing 'monster' with children, appropriate behaviour is to growl and act scary (Upton, 2015, pg. 17). Where the rules form governing laws in one instance of play, in play such as monster, the rules function more to frame or contextualize a type play experience, and are loose, adapting through player interaction to reflect the direction that play is taking them.

To better embody the function of rules in play, Upton provides useful reframing, referring to them instead as '*constraints*'. Whereas rules imply strictness and rigidity, 'constraints' leave room for ambiguity and interpretation. Also, constraints are more inclusive of the breadth of influential features of the play-world. As Upton states, "…anything that privileges one line of action over another is a constraint" (2015, pg. 18). This can include physical properties like the walls in a squash court that partition the space or the squares of the checkerboard that afford square-by-square movement. It can include laws of the universe like gravity and friction. It includes laws that govern conduct, permitting some actions while forbidding others. For example, in soccer all players are free to contact the ball with any part of their body, except their arms.

Most notably, in play the constraints are organized into a system that is structured to deliver a particular experience (Upton, 2015, pg. 15). This concept is vital to consider in the

design of play spaces and experiences. Design, in this realm, means defining and arranging a set of constraints to facilitate a desired play experience.

Each of the designed elements have the potential to influence players, and this capacity will be limited by players' understanding of them. So, in designing for play it is important to determine how are the rules communicated to players. Do they make sense? Do they simplify reality, creating an awareness of the play form available and how the player should interact with the play space?

Understanding that constraints shape the play experience, and that designing for play (usually) means arranging the constraints to enable a certain type of experience, posed one of the biggest design challenges in Moov. On one hand, the Moov experience needed to simplify reality so that moment-to-moment choice was limited, thereby providing freedom to the experience. On the other hand, the main intention of Moov was to provoke exploration and to enable players to form their own play. Therefore, what was being designed was not a system to enable a certain type of play but a system in which a set of interaction opportunities could be activated by different sets of players in different ways to facilitate their desired play experience.

A simplified example of this type of design might be a virtual ball-play room. Designing Moov was like designing the physical characteristics of a virtual room with virtual balls. The balls needed to have enough clarity – but potential variability - in the designs such that different types of play could emerge. Some people might play handball competitively, others

might juggle the balls back and forth trying to create interesting co-play patterns, others still might opt to hurl the balls at each other to train (in play) the reflexes of their partner. The key to Moov's success was balancing the design between clarity and ambiguity. The interaction opportunities needed to be clear enough to make sense to players, i.e. if I stomp my foot, my body emits a shape. But the rules of play – the "what can we do to/with each other" (while creating these shapes together) was left ambiguous to allow players to fill in the gaps and create their own rules of play.

In solving this design challenge, two specific solutions were employed. First, the number of ways the player could interact with the system were kept to a minimum – the number of stimuli that could be acted upon by user input were designed to be low, especially in the initial phases of interaction.

Secondly, the responses of the system to user input were designed to behave consistently in each interaction. This principle was applied directly to the user tracking/input system, meaning that if users moved their right hand forward, and this caused the right hand of their digital body to move forward, then this player-system response always behaved in the same manner. Therefore, clarity within Moov was achieved by giving players full control and predictability over their digital body.

And flexibility in the space for different types of play to be co-created the players was achieved by imposing no governing rules upon play. Players were made free to move, to co-create effects, and to play in creating these effects together in any way they (co)chose.

3.1.3 Play is Movement

The second main characteristic of play that affected the designs of Moov is that play is movement. This idea is central to Moov. The system is intended to stimulate depth of experience; it provides a journey - movement that is initiated, evolves, and then resolves.

As such, I identified several key properties of movement in play as they relate to Moov. First, play contains temporality and temporal boundaries; play has a beginning, middle, and an end (Huizinga, 1950, pg. 9). Second, play is progressive. As Upton describes, in play, there are constant transitions across play-world configurations - the pieces shift on the chessboard, the ball moves down field in soccer (2015, pg. 20). Within progression, play has momentum; current actions build on prior actions and open possibilities for future actions. "Play is action generating action" (Csikszentmihalyi & Bennet, 1971, pg. 45). Third, play is a totality in the physical sense. The moves in play are "…either mental or physical" (Upton, 2015, pg. 15). Each of these three properties of the movement of play are described below.

3.1.3.1 Temporality

Time, timing, and rhythm bear meaningful consideration within Moov. As Huizinga states, "…[play] is saturated with rhythm and harmony, the noblest gifts of aesthetic perception" (1950, pg. 7).

The progression of time, the regular ticking of the clock, imposes its own dynamics to play. Because play is limited by beginning and end, the constant forward movement of time creates tension and pace. So often in professional sports, the most exciting moments occur

within the last remaining seconds, like in hockey when the goalie is pulled to gain an extra attacker, leaving the net wide open.

Salazar Sutil (2015, pg. 90), in reference of the work of director Peter Greenaway, supports this idea that time introduces a natural dynamic, stating that progressions of numbers, [as in the tempo of the clock], create their own simple narrative. The sequence 1 2 3 4 5 6 7 8 9 10 is ''...a tale with a beginning, middle, and an end and a sense of progression''.

We often see this relationship to time used explicitly in games to push movement forward. It is used, like in the play clock in professional football and chess, to force the player to perform her next move with a sense of immediacy. Time is an ever-present motivator, magnifying action, driving motion, drumming multiple rhythms: the constant ticking of seconds, the 60-second stamp of the minute, your turn, my turn, your turn, and the sense of progression within.

Within Moov, a clock is not displayed to forward movement. However, wherever generative elements appear, they function with timed cycles of birth, growth, and death. In this way, a sense of forward momentum is constantly reinforced. This applies both to entities in the environment not directly tied to player representation and to the particles and movement residue that the player representation creates. The intention is to demonstrate predictability in the sequences of movement patterns the player can generate, thereby afforded a bridge between the moving player and time.

The design of predictability of movement patterns was included to afford play (in whatever form it occurs within Moov) with a sense of progression and momentum.

3.1.3.2 Progression & Momentum

As Huizinga states (1950, pg. 9), "…while [play] is in progress, all is movement, change, alternation, succession". This progress is achieved through a constant evolution of play's state in relation to the actions of the player(s). It is a process in which subsets of constraints on play become active and limit player choice. Player choice then causes a new subset of constraints to become active, others to become inactive, and so on until play concludes (Upton, 2015).

Consider that constraints fall into two categories: potential constraints and active constraints. Potential constraints are all the rules within the play-world that may at some point limit the actions of the players. Active constraints are the rules which limit player choice in the current moment. These active constraints indicate the current state of the play-world. When the player selects one choice in the current state, it will cause some of the constraints that were previously active to become inactive and a new set of previously potential constraints to become active. This constant, cyclical change is the basic framework of progression in play (Upton, 2015).

Part of what makes play fun is the momentum that is achieved in this interplay between game state and player decision. As Upton states (2015, pg. 26), "This reciprocal relationship between constraints and state creates a situation in which both our position within the overall

system and the immediate restrictions on our moment-to-moment actions are continually shifting and evolving."

Within Moov, no specific designs were implemented to support progressions in rule activations. The reason for this is because paired play has shown to "naturally" afford this structure. When we are in direct paired play within Moov, your actions limit what I can do next and my actions limit your choices. As we play together, paired current actions regulate the possible choices within our next movement.

Within this play, Moov enables fluctuations in leading and following, much like traditional dance. Players are free to follow a play direction that their player invites, or to strike out in another play direction, leading their partner down a new play path. Much of the fun in the process is derived in players mentally imagining and then playing out where play is taking them.

3.1.3.3 Mental Movement

The core of what makes relationship between active constraint and player decision exciting is not so much about what the player *can* do at any given moment, but what she *thinks she can do* at any given moment – and how she visualizes internally how the next series of moments will play out. This relates to the inner play inside the player's mind; it is about internally projecting a series of moves, anticipating how these moves will unfold within the play-space, and engaging through the play-space with those anticipations.

Upton draws clear distinction between the game as encountered and the game as understood. The game as encountered refers to all "…active constraints that influence the player's immediate actions – the rules that matter right now", and the game as understood refers to "…active constraints in the player's head - a mixture of internalize rules, invented strategies, and real-world knowledge" (2015, pg. 34). So often what that player is capable of performing is not what she believes she can perform.

Further, from that internal concept stems internal projections of series of moves. Upton refers to this as the 'horizon of intent' which he further describes as "…the set of all states that the player believes to be valid, attainable, and desirable in the near future" (2015, pg. 48). From this horizon, much of the joy of play is derived as the player exerts motions in the play space, watches her internal horizon play out, shifting it accordingly in reaching her goals. Huizinga refers generally to this, describing the tension that play is imparted when the player exerts the skills she believes she possesses within the rules of the game (1950, pg. 11).

In designing for play, Upton states that achieving intriguing horizons of intent as a difficult challenge. Like Csikszentmihalyi & Bennet (1971), Upton refers to play as occurring within the continuum of boredom versus confusion, and that these feelings are triggered by the complexity or difficulty of choices that the player faces moment by moment. Novice users can become overwhelmed by too much choice, while experts can become bored if the choices are not challenging enough (2015, pg. 53). Upton suggests that, generally, under constrained systems are a good solution to this problem. With fewer rules, novice players

tend to focus in on a few choices that make sense to them, while advanced players feel free to explore the many options available to them (2015, pg. 53).

This discussion on mental movement was important to Moov, but requires investigation beyond the scope of the current project. Ultimately, since Moov is intended to function as a tool that people use to explore, communicate, and expand relationship dynamics, the play space should support a richness of mental movement. In further work, structuring the interaction opportunities to support this movement, and then researching through testing with large sets of using will be required. However, the main design criteria in the current project was to give players freedom to play.

3.1.4 Play is Freedom

As discussed above, play creates a simplification of the world into a manageable "…slice of reality with which the player can cope in a predictable way, thereby losing himself in a pleasurable state of activity and consciousness" (Csikszentmihalyi & Bennet, 1971, pg. 49). Within this simplification, a player is freed; she is temporarily lifted from the complexities and difficulties of ordinary life.

Caillois suggests one reason as to why the rules of play afford freedom, namely that the player is free to make any choice available to her "…within the limits set by the rules" (1958, pg. 8). In real life, we are often bound by rules that afford no choice (or, at least, no playful choices). In play, we are free to choose, and by extension, I would argue, that since

those choices directly impact the state of the play space, we are afforded a sense of control. Our choices directly impact the state of the (play) environment – it can be empowering.

Huizinga suggests that we play because it feels good to play. He states that "…play casts a spell over us" (1950, pg. 10). He argues that we play for play's sake. In contradiction to scholars like Groos (1898) that assert that play serves another useful life function like skills acquisition, Huizinga argues that nature could have given us another device to serve those purposes, but instead she gave us play, "…with its tension, its mirth, and its fun" (1950, pg. 3).

Even within his stance on the purpose-driven approach to play, Groos (1898) sites examples of animals that seem to play for the pleasure of play. For example, he relates an anecdote shared by scholar Hudson in which he witnessed a pair of crested screamers flying directly into lightning-filled clouds, seemingly for the thrill (1898, pg. 108). Similarly, Caillois (1958, pg. 25) describes how some birds will allow themselves to tumble in free-fall, but 'open their wings when they are only a few feet from the ground, thus giving the impression that they are going to be crushed'.

In designing Moov, beyond creating clear rule sets, a sense of freedom is imparted on the user in the high level of controllability of the digital player representations and in the effects that their moving body produces.

Within the structure of interaction opportunities at any given play state within Moov was designed to allow for multiple choice aiming to design Caillois' freedom through choice into the system.

Further, on a very basic but fundamental level, Moov was designed to feel good to play. Its efficacy needs to be validated in user testing, but the idea is core to its success. Although testing in this realm is limited within my project scope to qualitative observation, simply put, if players do not appear to be actively playing and enjoying the experience, it is not working.

3.1.5 From the Ordinary

This last characteristic of play emerged into my model after reflecting on the demarcation between play and non-play (real) that scholars like Huizinga (1950) and Caillois (1958) assert. My belief is that play and reality are deeply interwoven. One goal of Moov is to explore this co-dependency, looking to see how motivations assumed within the real insert themselves in play, and how play functions in altering or affecting relationships in the real.

Therefore, within the model of play that I have acquired, I have assumed a working definition of play that extends Upton's:

Play is free movement, *from the ordinary*, within a system of constraints.

It seems quite clear that there are very real differences between the activities of play and non-play. Most of the characteristics of play described in the sections above put play in a realm that does not resemble the realities of everyday life. So, Caillois' statement that play is a 'separate occupation' holds; however, the other half of that statement, that play is "…isolated from the rest of life" (1958, pg. 6) fails to fully encapsulate the real-play relationship.

Leading scholars have highlighted the difference between real and play through the assertion that play is unproductive and results in no material gain (Caillois, 1958, pg. 10). The argument is unconvincing, given that the outcome of play seems at times to be tied very deeply to inner needs of some players.

As John Vanderhoef (2013) illustrates in his discussion of the conflict in the games industry, spearheaded by hardcore gamers against the casual games market, games have the capacity to meet very real emotional needs. In his discussion, he suggests that hardcore games, e.g. high definition first person shooters, appeal to a 'fragile masculinity'. They are a mechanism through which disenfranchised males, that lack personal power in the real, can feel empowered. The threat that casual games represents, to them, is both a feminisation of gaming proper and a threat that shifting market trends will take away their games – their power. The link between the real and play is palpable – the casual-hardcore game war has become militant, including threats of death.

On a personal level, play has long served a higher purpose in my life. I will never forget (and my family will not allow me to forget) that as a young boy, my soccer team lost the final game of the season. Moments after I received my runner-up trophy, I smashed it on the ground. For me, it was not just a game, soccer reflected who I was as a person. Second best on the season meant that I was a second-best person.

For Moov in the long-term, the real-play relationship is an important quality of play. The higher-order goals of the space are to enable exploration and discovery between two

people; Moov's intention is to use play to open pathways for meaningful exchanges in people's real-life relationships. Its intention is to open communication (through play and movement dialogue) that affects their real-life relationship. Further, in enabling this process, players should be able to bring their own inner motivations to light through movement. If they want to protect to say I love you, Moov should allow them. If they want to shake up their partner's perspectives, Moov should allow them.

This final characteristic of the play-space requires considerable development, testing, and refinement, to see if it works, and if so, to make it better. This is a long process, and therefore was only explored to a small degree in the short timeframe of the current project. Evidence from prototyping phase 4 showed clear evidence that the structure of the Moov play space already supports a stretching of play beyond play that could occur in non-digital contexts. Much more study is required. However, current Moov designs have proven effective in supporting the creation of new types of (emergent) play between players in real-life relationships.

3.2 Co-operative Play Formation & Emergence

3.2.1 Introduction

The purpose of the research in this section is to inform my model of emergent play, one in which players explore the interaction opportunities of the space, and as a result form their own play. The structure of the model is rooted in several research projects conducted

by other researchers in open-ended play, and was extended based on my organic prototyping exercises and the results of interviews and surveys.

The approach to this research was more intentional in focus that the general play characteristics extracted from my analysis of play. This was done so that my emergent play model could serve as more of a systems design document from which Moov designs and code logic could be structured.

Note, that the model I built is not intended to serve as a definitive guide to building similar (emergent) play forming systems. It is only one model that was built specifically for the Moov system. Further, the research results described below are also not intended as a definitive guide to developing similar systems. A work of this nature is beyond the scope of this text.

Further, within the research below, I refer to mechanics of emergence, speaking to ideas of emergent gameplay presented by several game theorists. These theorists examine rule sets that employ dynamics similar to that in flocking birds. In these dynamics, interrelated rules associated with interconnected elements produce fluctuations and constant emergence of wide-ranging patterns. These dynamics are different than the type of emergence supported in Moov.

Core to the current Moov system is a model that allows exploratory play co-forming. The emergence that Moov is designed to activate is one in which the goals and rules of play

are co-created by the players as they interact with each other in the play space. In this form of emergent play, players are co-operatively designing new play.

The discussions on bird flocking-like rule systems are still relevant to this discussion though because their dynamic rule structures function as regulators on play forms. Within Moov, regulation of movement is *co*-regulated between two players in motion together. Further, Moov play still bears similarity to the play of flocking birds; Moov play moves along co-regulated pathways, then tears of into new play forms, with partners taking turns in leading-by-following like groups of starlings in flight.

On a very basic level, however, Moov as a system of emergence of play relates to the basic definition of emergence in Oxford Dictionary (2017): "the process of becoming visible" and "the process of coming into existence".

The remainder of this section is devoted to building the Moov emergent play model. In this pursuit, I draw from formal studies in open-ended play, organic prototyping, interviews, personal experience, and emergent gameplay theory.

3.2.2 Relevant Research

3.2.2.1 Studies in Open-Ended Play

The Moov model of emergent play[3] was rooted in a basic model of open-ended play extracted from several research papers on the subject. Play that is open-ended provides

[3] See section 4.1

freedom for users to define their own play because they are free to explore and to create their own goals and rules (Rijnbout et al., 2015). Emergence becomes visible in the form of game creation. In the research studies that I examined, players created new games via a process of interacting with each other and a set of artefacts in the play space, co-interpreting the intended use of the artefacts and co-defining the rules of the game. These studies were useful in the development of Moov because they further informed the process of play formation that I assumed into my model. They also affected Moov's rule designs, illustrating how ambiguity in the interaction opportunities and play-space artefacts enable exploration, discovery, and a sense of joy found in exploratory play.

In research by Rjinbout et al. (2015), Mathews et al. (2008), and de Valk (2012), open-ended play of children with a series of interactive tiles was studied. Children were put in a room with a series of tiles/steps, given little or no instruction, and their play was observed. No formal rules were assigned to players. The only formal rules in the play space were the interactional rules of the individual tiles, e.g. they lit when stepped on. From these simple elements and conditions, a wide range of games emerged.

The tiles themselves were flat, single-foot sized, and stepping on them activated their respective coloured LED lights. The studies varied in the amount of interconnection and interactions of the individual tiles. This ranged from no interconnection between tiles (Mathews et al., 2008) to a preprogrammed series of interconnections in which activating a red tile randomly activated another tile to a red colour (de Valk, 2012).

Despite these differences, the process of exploratory play formation was the same across the studies. Children first played with the tiles to see what they could do, e.g. stepped on all the tiles and discovered that doing so lit a blue light for some and red for others (de Valk, 2012). They then arranged the tiles, agreed upon a set of play rules and objectives, and played together, e.g. Line Race (Mathews et al., 2008) or a Twister-like game (Rijnbout et al., 2015). Further, they often invented new rules as play progressed. For instance, in the Line Race game, after seeing that a runner did not successfully change the colour of each step after running the line, players introduced a new rule that stated that a previous player had to successfully step on all tiles before their next teammate could run the race (Mathews et al., 2008).

Linda de Valk (2012) provides a general model of the process, i.e. the stages of exploratory play forming: invitation, exploration, and immersion. However, based on the work of Costello and Edmonds (2009), in which exploration is described as occurring in both the discovery of what game artefacts can do and in what I/we can do with the artefacts, I believe the exploration stage can be further subcategorized. The stages in greater detail are [items in block quotes added by me]:

1) **Invitation**: potential player is attracted to a design [or asked to play a game a certain way by another player].
2) **Exploration**: player starts to interact with the design [artefacts and rules] of the game to come to an understanding of their meaning.

3) **Evolution**: player[s] defines the rules and objectives of a game based on their interactions in the exploration phase. [Often involves negotiating and co-creating with other players].
4) **Immersion**: player[s] play with the game. [This phase and the evolution phase can occur concurrently or consecutively, with continued evolution occurring during/because of play. Evolution and immersion together give the play space a kinetic energy, in which play is constantly unfolding and adapting].

In addition to providing a model for the play process structured in Moov, the rules in the above studies contained several characteristics that were beneficial in the rule designs of Moov:

Hidden: Because the rules of the play-world artefacts were not known in advance of play, players discovered them by interacting with the artefacts. Costello and Edmonds (2009) suggest that this type of design is one method of affording pleasurable experiences in players. For example, it provides opportunities to find pleasure in figuring something out, such as learning to hop on a tile to activate it, and to find pleasure in becoming proficient by practicing a skill, such as hopping tile-to-tile in a discernable rhythm.

Simple, Collective, Dynamic: The rules for each individual artefact were simple, i.e. when a tile is pressed, its light turns on. A similar, simple rule was applied every tile. In some of the studies, tiles were related to each other in that activating one tile affected changes in another tile. Important to note is that the tiles represented a collection of related artefacts in the space. This afforded an implied interconnection, hence, it made the rules dynamic, i.e. in

players' minds, what would the activation of one tile mean in relation to the other tiles? What type of causality chains would this create?

Ambiguous: Even though the simple interaction rules of the tiles were easily discoverable by interacting with them, there was a lot of ambiguity in *how* to play. For example, players were not given formal instruction on how to configure the tiles. They were not told how the tiles should be activated, e.g. stepping on them or punching them, one-at-a-time or four-at-a-time, use only one leg, spin the body in between jumps, take turns playing or play together, etc. This high level of ambiguity enabled players to "fill in the gaps" and create their own rules as they desired.

Interpreted: Given their hidden, interconnected, and ambiguous nature, the rules are the result of (co)interpretation. In Upton's model (2015), the rules constitute the 'game as understood'. This moves much of the actual play of the game inside the mind of players. The rules governing play are a set of internal constraints, defining both what a player *can* do and what she *should* do. This causes play to become exciting because of internal uncertainty and anticipation in relation to how the game will play out in the player's mind and how it plays out in real actuality, moment by moment.

Further, because rules are interpreted instead of explicitly dictated, players are free to add their own additional rules to enrich play (Rjinbout et al., 2015), e.g. in the Line Race game, where winning did not simply mean getting from A to B fastest, it also included having the fewest faults (Mathews et al., 2008).

Division of Labour: In de Valk's study (2012), open-ended designs resulted in situations where one player acted more as designer/inviter, 'pointing at lights during [the] invitation stage', and the other followed. In the study by Rjinbout et al. (2015), one child took on the role as the 'sleeping dragon' while the other two played in avoiding waking the dragon. This division of labour afforded in open-ended designs is important to Moov. By not pre-defining roles within the play space, open-ended designs allow for different roles to emerge such as a leader and a follower, common in paired dancing. The is especially important to Moov in the long-term since allowing role play to emerge in the space leaves room for partners to experiment with different relationship dynamics.

3.2.2.2 Low-fidelity Prototyping

After extracting a set of characteristics of play and building my own emergent play process model[4] from the above play studies, my next step was to expand upon and validate my findings through prototyping and user testing. To this end, I designed a series of low-fidelity, paper-based and non-digitally interactive prototypes and tested them will my colleagues.

Note that my intention in this exercise was to inform my own design models, not to conduct extensive validation testing, and therefore testing was conducted with only two groups of two participants, taken from my cohort of Digital Futures students at OCAD

[4] See section 4.1

University. Despite this limitation, the testing was successful in further developing my understanding of emergent play and contributed significantly to my model designs. A brief description of each prototype and its results follows:

Hop-OK-Go

The purpose of this exercise was to observe the communications between two players when faced with a game that had ambiguous instructions. To observe this effect more directly, a predefined game was presented to players, but the instructions on how to play were not made explicit.

In this game, players were instructed to follow a series of footfalls and a word. The footfalls were displayed as foot symbols in different configurations, in a side-by-side stack that represented a progression of movements for two people. Atop the stack a word such as 'shake' was displayed. Players were instructed to follow the steps forwards and then backwards. Note, they were not told when to start, how quickly to move, or assigned any tempo. They were not told when or how to shake. The ambiguous rules were verbally spoken to the players, and I sat back and observed the result.

Very quickly on, the exercise validated the basic exploratory play forming model I extracted in the research above. First, players interpreted what the rules meant, suggesting meaning and negotiating back and forth, until one player confirmed the agreed upon rules, i.e. they should move forward in unison, and then suggested to the other player that it was time to start (invitation stage). Next, they played the game, validating their interpretation with

each step, feeling out how effectively their co-interpretation seemed to work (exploration stage). Communication continued, and they discovered that verbally calling out 'hop, ok, go' served as a timer in-between each step. They initially shook after each step, but soon agreed that they would only shake at the half-way mark and at the end (evolution/additional rules stage).

After playing several "foot tracks", they had mastered their cooperative play and communication approach; confusion and uncertainty was replaced by a sense of accomplishment, evident in the relaxed gait that they presented and confident laughter (immersion stage). Also, their play validated one of the characteristics I suspected can result from co-operative play forming:

Ownership: the shared sense of authorship and claiming of possession of an emergent play form. When play concluded, the players proclaimed that, "that's the name of the game: Hop-Ok-Go!" It appeared to me that devices co-developed during play and/or the shared co-creation/co-negotiation of the game (as it was played by them) caused the players to claim authorship, stamping it with their own branding. The game had become *their* game; it was "our play". Key to this process was that the rules were ambiguous, thereby enabling room for players to create their own, and hence, claim ownership.

Pick and Perform

The next prototype was designed to see the effects of dynamic rules on behaviour. It was a performance game in which players had to pick two body part cards, a mood card, and a speed card, and then move their body as per what those cards implied to them. They were given no instructions other than select the cards from the deck and move their body, and to alternate between performing for then observing their performing partner.

Note that in this play, the rules functioned dynamically. Mood cards tended often to lend themselves to appropriate behaviours that both the speed and body part cards conflicted with. For instance, a 'sad' mood card would imply slow movements, perhaps with the head or hands. However, if a player selected 'fast' as the speed, 'feet' and 'hips' as the body parts, the conflicting messages created uncertainty and demanded a stretch in thinking. Further, although there was no timer, because players were stood in front of two spectators, there was an added time rule to perform.

The results of this study validated prior research on simple, dynamic rule sets, showing that they create richness in play. Granted, the study was small in scale and would need to be repeated from a much larger sample size. However, the study resulted in real richness in play. Players took to the task with vigour, richly expressing themselves with their bodies. None of the participants were trained performers, but all of them created energetic, rich expressions.

While further validation is required, it seemed that the dynamic rules contributed to the depth of the expressions. That is, their dynamic nature increased the emotional intensity of

the play experience, and this intensity resulted in richer emotional expressions. This illustrates another characteristic of co-operative play forming:

Energy: engaging in exploratory play forming tends to invoke an energy in players. Whether it is the dynamic rules playing out in the mind of the player, or engaging with the flow of emergence, or some other factor, it seems to simply feel good to connect with emergent play energy.

We cannot ask starlings why they enjoy swarming together, but I suspect that there is an energy that feels good to engage with; an energy that flows through the individual and the collective and back again. It seems to feel good to be a part of - but not in fully control of - play that is constantly shifting and emerging.

Create a Game

This final study combined the prior two, examining play in a context where the rules were both ambiguous and dynamic. In it, players were given the same cards as the Pick and Perform game and a stack of letter sized foot fall pages. They were given absolutely no instructions other than to use the elements and create a game.

The study appeared to fail initially, as it created a high level of confusion in the players. They really were not sure how to proceed. However, after some attempts, one player suggested a possible form, then the other, until finally they agreed on a game in which one player instructed the other on how to arrange the foot falls and generally move, and the other player acted as a performer, putting her own interpretation on the movement.

Again, this study needs further validation, however, it seemed to support the finding of Rjinbout et. al. (2012) that highly ambiguous artefacts afford a lot of room for players to create their own rules, and that this can result in a division of labour in game play. This finding was very influential on Moov, strongly demonstrating that explicit rules or in-game indicators as to how to play are not required. Players seem to find their own pathway into play, and do not need to be lead. At the same time, the study showed that too much ambiguity can be potentially stifling. While there is no numeric rule as to the number of rules that should be in play, or qualitatively how much ambiguity should be present, in my designs, I was aware that it was important to keep the number of rules small and avoid using ambiguity to the point of total confusion.

3.2.2.3 Interviews

Over the course of this project, many informal interviews were conducted with people for the purpose of trying to understand deeper the process of play creation in people in relationships. My aim was to try to extract a generalized process model from the disparate examples collected.

The approach bore very little fruit as it pointed to one of the main characteristics of emergent play in relationships. Namely, all interviewees described the play as absolutely vital in their relationships because it is something special that occurs just with a particular loved one. However, no interviewees were able to state when it started, how it started, or even how its starts when played today. Further, many participants weren't even aware that they

engaged in emergent play with their loved ones, and required prompting on my part to help them identify the play in their relationships.

What this finding illustrates is that the process seems ubiquitous in relationships, but is so deeply interwoven into the fabric of relationships that it is hard to even identify. Since the study did not reveal anything to the process of emergent play in relationships, it did not inform the Moov model of emergent play. Despite the limitations of the study, it did provide further evidence of the potential in adapting Moov into a tool in relationships – I am on the right track with this project.

Further, the interviews contributed more characteristics for designs that support emergent play.

Trust/Shared Control: often in cooperative play forming, the actions of one player depend on the actions of the other; it takes one or more people to play properly. Together, they compose play. This requires giving up some control of your actions to your partner. There is a reliance on each other, a dependency. This characteristic was employed heavily in Moov in that its space involves a co-expressivity, with the composition of the play-space resulting from paired interactions in players.

Surprise: This story illustrated the importance of surprise in emergent play. The unexpected – especially in the form of expression - appears to catalyze impulses for exploration of a play form. This key characteristic influenced the player representation designs of Moov in that they enabled the player form to be stretched out/contorted/blended in ways that players

would rarely see in everyday life or in playing with other digital spaces. This was intended to trigger exploration, and excite responses in partner play – to activate emergent play.

3.2.2.1 Emergent Gameplay

As discussed above, research on emergent gameplay was studied to see how rule sets enable emergent play. Theorists interested in emergent gameplay align the structural characteristics of its rule systems from complexity science. As Adams and Dormans state, this science "concerns itself with vast, complex systems". Examples of these systems are: weather, bird flocks, stock markets, and traffic. These systems are complex in that they contain many parts, and while the individual parts are simple to understand and model, when the parts are put together, the system displays surprising and unpredictable behaviours. (Adams & Dormans, 2012, pg. 45-47).

Games like chess illustrate this concept. For example, it is easy to visualize that "pawns can only move forward one square at a time" or knights moving like "the shape of an L" (Chess.com, 2017), but, by just examining the rules, it is near impossible to predict the configuration of the board after two players have each taken twenty turns moving their sixteen pieces on the board.

Nature displays the most important characteristic of rules in emergent systems: "it is the product of interconnections and interaction" (McDonald & Weir, 2006, pg. 2), "complexity is created by many connections and interactions *between* the rules" (Adams & Dormans, 2012, pg. 37). For example, as Fromm shows (2005, pg. 2) in discussing bird flocking, the governor

of an individual's movement is a mixture of two rules: 1) stay close to the group, but 2) don't get too close to your neighbours.

When these two interacting rules are applied to every member of the group, the result is a collective form that is constantly shifting, undulating, consolidating and dissipating unpredictably. This is achieved because not only do two rules drive the individual, they drive the group which in turn drives the individual. As an individual moves her body based on her proximity to all those around her, her moves then affect the movement decisions of all those around her, and this momentum of choice then cycles back to the individual, shifting what the rules mean to her in the next moment. Individual choice is both a causality chain that propagates through the group, and the result of the chain of causality. This chain causes the rules to become dynamic.

The same type of dynamic interplay of the rules occurs in games of emergence. Consider again chess. Each piece has a basic set of movement rules that govern how many spaces it can move in a single turn, such as the "one square forward" rule for pawns. However, each piece has a strategic rule associated with it as well. "Pieces are generally moved into positions where they can capture other pieces… defend their own pieces… or control important squares in the game" (Chess.com, 2017). The decision to move an individual piece is a choice made of the dynamics of what the piece can do (movement rule) and how its movement will affect in the potential for all other pieces in terms of defensive or attacking capabilities. These choices affect not only the player's choice, but the choices of the opponent

– and vice versa. As with the flock, all pieces in the composition are related to each other. The individual's choice is both driven by and drives collective choices, it both contributes to and is affected by the overall composition. It is this dynamic that gives games of emergence their unpredictability, variation, and energy.

In games studies, games of emergence are often differentiated from games of progression by the way the rule sets are structured. In games of progression, typically one-off challenges are presented in a long succession throughout the game. This results in a very large set of rules, with high predictability in how the game will progress (Juul, 2002).

In games of emergence, simple rules lead to complex gameplay. In fact, "sometimes it is more effective to reduce the number of rules to create a system that displays truly interesting and emergent gameplay" (Adams & Dormans, 2012, pg. 45). However, as Adams & Dormans point out (2012, pg. 49-50), there must be enough activity and interconnections between the rules and parts of the system for emergence to occur. Further, emergence "occurs only after a system is put into motion" (Adams & Dormans, 2012, pg. 43).

As this relates to Moov, during the literature review, it seemed clear that a system of rules that supports emergence was a better approach than a system of progression. A progressive experience *has always been* a goal of Moov; however, as the models of bird flocking and chess show, emergent systems enable their own progression via interconnected causality, and this progression is full of dynamic flows and intriguing unpredictability. It was therefore believed that rules needed to be designed to achieve the same effect.

However, during active prototyping, emergent play was demonstrated in a space that had *no* specific rules of play. Emergence of play occurred as people co-discovered what their moving bodies could co-generate in the space. The rules of play emerged (and evolved) in this process. Further, as discussed in the introduction to this section, this type of emergent play had similarities to flocking birds, in that co-movement functioned as the regulator/governor of the play form in the space. System-dictated rules proved to *not* be a requirement for emergent play. In Moov, leaving all rules out of the designs (except for system logic), allowing people to co-discover and negotiate the potential for any type of play proved the pathway for emergent play. It was an act of emerging co-performance.

3.3 Digital Performance

3.3.1 Objectives of Research

While the purpose of research into play was in developing Moov's play model, the intention of research into performance was to locate relevant theories and design principles that would support a sensorial, explorative play experience between two people. Moov is a play space, not a performance installation; however, in designing its aesthetic, I looked to digital-mediated performance to help inform the designs of the body and the interaction opportunities afforded to co-players. Moov is intended to be a pre-cognitive experience, one in which player actions are in flux, reacting to and led by unspoken intention in co-play, discoveries made as the experience unfolds, and the by the emotions and sensations that this

moving co-play invokes. It is a non-pre-scripted, evolving experience, enabling a flowing dialogue between two people.

At its core, Moov utilises only a small set of principles taken from what is a vast body of scholarly and practitioner-based works in the areas of digital-mediated performance and kinesthetic interaction. Discussing all this research is well beyond the scope of this text.

For example, two sections of my readings included Dixon's (2007) 650+ page volume which traces the history of digital media in performance and installations, and Sutil's (2015) comprehensive study of motion and representation. Any section of either of these texts could serve as a starting point for innumerable discussions. Therefore, the intention of my research was not to summarize the history of digital performance or build any comparative arguments; instead, my focus centred on extracting several key concepts that would aid in driving my designs. The first of these principles centred on designs of the digital body.

3.3.2 The Digital Body

The point of access and the mechanism that drives play within Moov are two digital bodies that reflect user movement in front of the system. In fact, Moov is essentially just a space in which two people control their respective digital double. Two people, moving their digital bodies together in the space, thereby generating digital responses which trigger further co-movements, is the both source and the result of the entire play system (see Section 4.1). From the players' perspective, it is process of relating to, and through, two moving

digital bodies. As such, the design of the body proved to be the most critical factor in the system's success. Its design needed to enable relationship building between the self and an individual digital double. Further, to enhance the aesthetic feel in controlling the double, the design needed to highlight the nuances, energies, and potentials in moving the digital body. I will start by discussing this central figure, the digital double.

3.3.2.1 The Digital Double

In simple terms, "Digital Double" refers to a digital representation of a person on a screen of which she is in control. Within Moov, the term refers to a controllable full-body representation of self. In simple terms, the digital double represents a mirroring of an individual's movement. That is, the basic functionality is that while facing a digital display, the user sees a representation of herself that mirrors her movements. Beyond this basic dynamic, I have discovered through readings and user-tested prototypes, that the digital double relationship is far richer than this basic model describes.

My understanding of the digital double was informed first by the theories described by Steven Dixon (2007, pg. 241-270). Dixon's ideas stem from the belief that the digital double is more than a reflection; it is a fully embodied, separate, yet deep-linked extension of (normally) unseen components of self. He states that "[he does] not believe the performing virtual body is either less authentic than the live, nor is it disembodied from the performer" (2007, pg. 215). Further, he believes that we "cognitively and empathetically perceive the performing virtual *human* body (as opposed to a computer simulated body) as always already

embodied material flesh" (2007, pg. 215). This central belief, in theory – and in validation through prototyping[5] - is the main driver of Moov's experience.

The phenomenon should not be understated. At work is a dynamic in which an individual perceives her digital double to be a separate but connected version of self, a "living" extension of self to which she is intimately connected to in both thinking and in feeling. I personally experienced this powerful relationship within the senses of my own body. During a testing session, my play partner virtually touched my digital double with his double, and this triggered a *physical,* sensorial response in my real body. Watching my virtual body react to being touched caused my real body to feel touched[6]. The revelation was infinitely intriguing.

Equally intriguing to note is that the digital double to which I related empathetically is not understood by me to be a copy of me in digital form. It is an extension of me - hidden, alternate parts of me that are not necessarily visible components of my self in the realm of ordinary, daily life. Yet with the digital double, these hidden parts are given an avenue through which to reveal themselves, and we relate to them on an emotional/aesthetic level.

Dixon aligns the concept of the digital double on a psychological and philosophical level with theories by Freud and Lacan. In Lacan's mirror stage theory, people are said to be lured by narcissism towards a more powerful, whole, yet phantasmal projection of ourselves in the mirror. In so doing, identity is falsely constructed; in creating an internalized union

[5] See prototyping phase 4, Findings
[6] See prototyping phase 4, Findings

with this our (better self) projection our real, fragmented selves are repressed (Dixon, 2007, pg. 242). Freud's concept of the uncanny suggests an emergence of a darker self. Per Dixon (2007, pg. 242), "…when repressive barriers to the subconscious are pricked or come down, the uncanny may emerge to create a double reality".

Dixon also traces the relationships we establish with our digital double to theatre in which "'consciousness of doubleness' is intrinsic to performance" (2007, pg. 241), and to ancient performative traditions. These are rich points for further discussion beyond the scope of this text. However, this project has proven that there is more at work in controlling a digital double than the mere manipulation of a ragdoll digital reflection. In this project, Dixon's typologies (2007, pg. 244) drove the designs of Moov's player representations, and in turn, testing these designs provided evidence of the above theories.

Dixon states that we form at least one, or more, of four types of relationships with our digital double: 1) the reflection, 2) the alter-ego, 3) spiritual emanation, 4) the manipulable mannequin. The influence of each type on Moov's designs are discussed below.

Double as Reflection: In simple terms, treating the double as a reflection relates in a larger sense to the growing relationship we have with technology as a tool to manipulate our presentation of self to the world. Dixon (2007, pg. 246) refers to a new "technological vanity", a growing faith we have in the "transformational power of computer technology – the power of the virtual *over* the real". With our digital double, we "gaze into, and back at, our new digital selves".

I have discovered that to successfully scaffold relationship building with our double requires that we are unable to see parts of our self that we do not want to see. This was shown to be very true during prototyping phase 4[7].

The demonstrated principle is that as soon as our digital reflection reveals details of our real self that we do not like, our internal response is to retract emotionally instead of forming a connection with our double. In designing the double, less is more.

Double as Alter-Ego: In this relationship, the digital double represents darker versions of self. It relates to Holzer's notion that within us are two versions of self, the light and the dark (Dixon, 2007, pg. 250). As in Freud's uncanny, the double as alter-ego represents a relational experience in which our darker sides are given room to emerge.

My prototyping explorations in this theme did not provide direct evidence of a darker self[8], but they did show evidence that play through digital doubles does provide room for behaviours that were previously non-present in real-life dynamics to emerge. That is, while not necessarily dark, play with doubles in Moov has shown that effective doubling either lowers inhibitions or provides a context in which non-standard behaviours tend to emerge, providing room for alternate "egos" to play.

Double as Spiritual Emanation: This relationship with the double is tied to the relationship of performers in ancient rites in which "the performer has been seen as a communicator with or

[7] See prototyping phase 4, Findings
[8] See prototyping phase 4, Findings

conduit to higher spiritual forces" (Dixon, 2007, pg. 254). Digital doubles of this form represent "emanations or incarnations of the body relate[d] to notions of ghosts, astral bodies, out-of-body experiences, and soul projection (Dixon, 2007, pg. 254). I believe there is a lot of potential for intimate play within this representation. The idea of associating with a double that is a spirit and then playing with a partner in her spirit form is fascinating. Co-play on a spiritual level could prove rich.

Current play tested prototypes do not include elements that represented spiritual characteristics, so I cannot speak to what constitutes effective designs in this context. However, in newly developed prototypes I have treated individual body parts as moving particles, and afforded interaction opportunities in which players can cast particle energy forms and affect the representation of partner particle forms through virtual touch. In developing these prototypes, my personal reactions to my particle-based double felt more sensorial than other representations.

Significantly, the more time spent developing and experiencing these doubles as they emerge has triggered changes in my perceptions. Namely, when looking at paper sketches, my mind immediately recalls my particle double and I can feel the still sketch moving.

Given Moov's intention to afford sensorial, explorative play, I believe that in the long-term continuing to explore the double-as-spirit will produce significant results in players.

Double as Manipulable Mannequin: This last double relationship is rooted in the idea of controlling an avatar, a term derived from Hindu scriptures describing the "…bodily

incarnation of deities" (Dixon, 2007, 259). It is also rooted in the puppet theatre, which "is in its core a theatre of more than one level of narration" (Dixon, 2007, 268).

Current play-tested prototypes revealed that treating the double as a controllable puppet is the core mechanism to establishing relationships with the double. In all cases, the first thing that players did with their double was explore how moving their body results in control of the movement of their double. It is the core device that forms the association of the double as an extension of self – the chief avenue towards relationship building.

I cannot overstate the importance of this relationship. Prototype testing revealed that effective designs of the double as a puppet are a gateway to emergent play[9]. Keys to these designs are that digital limb positions and angles accurately reflect actual player physical limb positions and angles; moreover, that the digital double responds fluidly to player movement. In addition to fluid responsiveness, evidence from my prototype testing has shown that designs that clearly demonstrate control over motion in *each individual* body part are more successful.

As a tested design guideline, representations of doubles that clearly and fluidly demonstrate individual moving body parts, that capture the essence of our unique moving physical form are best. The most important factor is the effectively representing the motion of the body.

[9] See prototyping phase 4, Findings

3.3.2.2 The Moving Body

Two main postulates forwarded by Nathaniel Stern and Brian Massumi influenced the designs of the moving players in Moov. The first, is that seeing is a participatory event. "Seeing… [is] folding in the past, present, and possible futures of our actions… We see what we do not see, and we imagine what we do not see, and both are part of vision" (Stern, 2013, pg. 25). Further, Stern believes that "vision is… multisensory… a small and indivisible part of sensation as a whole" (2013, pg. 26). As Dixon states (2016, pg. 216), "seeing is feeling."

The second postulate is that the body is always moving, always emergent, always becoming (Stern 2013, pg. 53-58). Quoting Massumi, Stern points to the idea that "the body is in a state of invention… retaining and combining past movements" (2013, pg. 54).

These main postulates directed my thinking towards designing representations of that body that demonstrated what Stern (2013, pg. 56) refers to as the body's *incipience*. That is, representing both past and present movements at the same time. Initially, I had intended to implement this type of aesthetic in a manner similar to Sutil, Melo, and Scialom's *Labanimations* (Sutil, 2015, pg. 84). In this piece, as a performer moves, the camera displays a smearing of the body in between each of its positions, almost like infinite, fluid stop frames, or 3-dimensional long-exposure photography, like Anton Giulio Bragaglia's photodynamism experiments that "show how objects are inevitably transformed in movement" (Sutil, 2015, pg. 83).

Incipience of the moving body is highlighted in these examples through active retrospection. As an observer watches the trace marks that the body creates as it moves, she begins to anticipate which new marks the body will create. The relationship between past, present, and future body actively merge into a relationship with the body that is always becoming.

Despite my interest in designing similar bodies in movement, I stumbled by accident into a design that also blended the display of past and current movements. In this design, whole body representations of players' past movements are left on screen alongside the currently moving body. The design has proven highly successful. Prototype evidence has shown that highlighting the imprint the body marks while moving in play triggers an emotional reaction in players, and this mechanism is an effective tool in enhancing the emotional-sensorial experience of Moov.

Highlighting the inner motion within motion has also influenced current designs of the player representation. In the current particle-based approach, individual limbs are composed of collections of particles that constantly move and rotate to reflect light. It is a sparkling energy, intended to further drive the aesthetic feeling associated to playing with digital doubles, akin to creating an heightened awareness of the blood flowing through our vessels.

In addition to Stern and Massumi, the work of Paul Sermon and Susan Kozel heavily influenced this design decision. Their piece, *Telematic Dreaming*, staged a virtual intimate performance between Kozel and visitors to an art gallery. In it, participants interacted with

Kozel's moving image projected onto a bed in one room, while Kozel interacted with participants' bodies projected onto a bed in another room. In this piece, Kozel attested that moving images – not static ones – were what gave the piece its vitality. She states that "what preserves the distinction between materiality and immateriality in the technology is movement: as moving beings people take on an alternative materiality". At one stage, she was gifted a rose from a virtual lover, but found that it conveyed little meaning to her, while having virtual sex with this partner, involving making shapes with their bodies and "rolling through one another" was "undeniably real" (Dixon, 2007, pg. 216-220).

As in the critical importance of amplifying individual body part movement discussed in digital doubles, the key to a kinesthetic, explorative play experience is in heightening player awareness of movement. It is the mechanic that affords a relational experience.

3.3.3 Relational Media

Research in this section directly drove the designs of system responses to user input. This is directly linked to, but is a separate component from the digital double design. Namely, this section informed the general characteristics of the effects that players are able to produce in play. For example, in an early prototype, players cast interconnected dot shapes that expand according to their own internal timing. In current designs, players can virtually touch their partner, causing touched particles to change colour, but then fade back to their original colour according to a clock that is separate from player interactional input. The effects are

included to enable play, but are also intended to enhance a moving-feeling aesthetic within Moov.

These designs, ideologically speaking, borrow from the discussions of Nathaniel Stern (2013) regarding relational versus interactive media and Brigid Costello's (2014) views that affective kinesthetic digital spaces are the result of two energetic systems interplaying with each other.

Stern draws a line between what he terms "relational" media versus interactive. In interactive media, the dialogue between user and machine tends to operate linearly. That is, I press a button, the machine responds, I press another button, and so on. Cause and effect are tightly mapped. Stern quotes Massumi, stating that the relationship "is merely a going back and forth between actions, largely reduced to instrumental function… Here technology foregrounds only what is possible in its limited system, not the broad experience of moreness and potential" (Stern, 2013, pg. 63).

In relational media, the relationship is more one of an emerging of experience with technology. Its aim is to shift the perspective away from what the technology can do, towards what a body can do. The media should "emphasize qualities of movement and emergence with technology, rather than technology itself" (Stern, 2013, pg. 64).

Within Moov, this overall ideology drove the design of digital bodies. They were given high expressive capacity due to their fluid responsiveness, thereby demonstrating subtleties in the moving body. Further, the designs explored an interactional model that clearly shows

the cause-and-effect relationship of user movement, but the effect component has its own artificial life, emerging beyond the control of user input.

Brigid Costello refers to this type of relationship as an interplay between two energetic systems. In her work, Elysian Fields, the "interaction between body and world emphasises the energetic nature and rhythmic character of [the] encounter… both energetic systems have the potential to affect the rhythms of the other" (2014, pg. 258).

In Moov, the intention is not to facilitate meaningful relations between self and an energetic environment. Instead, it facilitates meaningful relations between two human bodies. However, the designs of the moving effects draw from Costello's work. For example, in her Elysian Fields installation, blades of grass sway in the wind. When people approach the screen, their steps imprint on the grass, squishing it. When they step away, the grass does not immediately spring back into place, it grows back according to its own rhythm and then resumes swaying alongside neighbouring grass strands.

In this system, a person is an energy system with the potential to affect the rhythm of the other energy system that is the environment. In response, visitors to her installation "said they felt a pleasurable tension between having direct immediate control and feeling like the work had a life of its own… [others] enjoyed experiencing the vitality of the work" (Costello, 2014, pg. 258).

What this work speaks to is a model of interactivity that balances causality and control. Quoting S. Penny, Costello states (2014, pg. 258), "the persuasiveness of interactivity [in this

model] … is in the fact that bodily behaviour is intertwined with the formations of representations". Furthermore, there is pleasure found in seeing that while one is the cause of responses in the system, she is not in full control of the process.

Within Moov's initial phase 4 prototypes, evidence was found that play within this dynamic can result in sensorial experience and even very simple play mechanics can result in ongoing play. In the prototype in which players cast emerging, interconnect dot shapes, players reported feeling "light", "soft", and "free". They also engaged in shape casting for sessions lasting longer than 15 minutes.

In this interaction, dot creation is triggered by player movement and the direction and speed of individual dots are defined by player movement prior to the cast. However, although it is apparent that one's input triggers the shape, the complexity of the shapes interconnected behaviours and their varying speeds make it impossible to ever figure out how to fully control the shapes emerging form. This results in a thinking that is never fully complete, and at the same time, the emergence of the shapes has an alluring, hypnotic effect on the player. She is the cause, but is not in full control of movement as it emerges.

These same mechanics have been implemented in the most recent Moov prototypes, but play has been extended, centering on play between two people. In it, I cause things to happen to my partner, but I am not in control of the entire process. My experience is affected by her actions that are affected by my actions. It is the source of Moov's play. It is an

exploring and following of back and forth causality inputs of two people, engaging with an emerging, unfolding of experience.

3.3.4 Body Language

The final component of research into performance relates to the language of the body. This research further influenced the designs of interaction opportunities in the system.

Discussions on the language of the body are extensive, as Salazar Sutil's extensive work illustrates, and are therefore beyond the scope of this project. However, the discussion is relevant in that different treatments of the body as a meaning-making device influenced this project throughout its various stages. In the end, what influenced Moov the most was Sutil's arguments against using body representation systems which attempt to structure it according to an ordered logic. He states, "we move in thought and body, in software and hardware, and therefore the language machines we can come up with must generate new possibilities of movement… We cannot accept systems that only represent the intellection content of movement" (Sutil, 2015, pg. 4).

This is in fundamental opposition to the work of Rudolph Laban and authorities on his work like Ann Hutchinson Guest that treat the language of the body as a system of "alphabetizing" movement, reducing it to component forms that can be arranged into meaningful sentences. The assumption underlying this work is that dance is a language that is composed of basic components of body "talk". In it, nouns are body parts, and verbs are movements of these parts. Laban's system, employed in part to enable documenting

choreography so that it can be reproduced, reduces movement into repeatable basic forms. Dances (collections of movement dialogue) are built up by assembling successions of basic form structures (Hutchinson Guest, 2005, pg. 14-38).

In the system, movement "notes" are inscribed into a score, like notes on a musical stave. This approach to encoding basic movement building blocks so they can be decoded and reassembled by a "reader" in learning how perform a dance has been prolific. Its influence can even be seen directly in modern dance video games like Just Dance in which a stave notation drives player interaction. In this game, inside the stave is displayed basic movement positions that scroll by, and the player must frenetically arrange her body into those structures to successfully dance.

This approach is on the opposite spectrum of the type of movement experience that Moov was designed to facilitate. Its system does not attempt to force the player to conform to any pre-defined physical forms. In fact, it is meant to promote the exploration – and increase player awareness in – free flowing movement. Further, meaning is not derived by learning a language and using it to effectively communicate. Players are given a tool - their digital body, a reactive environment in which to explore, and are free to manifest their own understanding of the experience through play with their partner.

4 The Moov Framework

4.1 The Moov Play Model

4.1.1 Core Play Model

At its core, play within Moov emerges from three core components: 1) two bodies, represented as digital doubles, 2) performing movements, 3) which generate effects. The system does not directly prompt players or stimulate any actions. It does not stage any form of puzzles or challenges. Play emerges through the choices players make in response to the effects that their co-moving bodies generate.

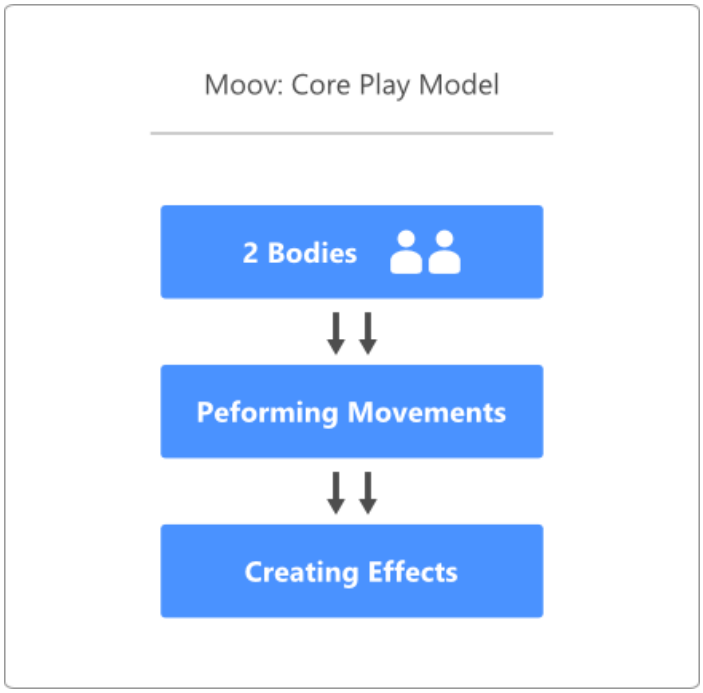

Figure 3: Moov Core Play Model

4.1.2 Play Stages

In general, play with Moov occurs in 4 main phases, divided further into a total of 5 stages. Stage one tends to involve little paired play, and is centered more on individual players exploring and forming a relationship (an empathetic association) with their digital double. Stages 2-4 are paired play stages. Note that these stages are not cleanly divided in effect, but are separated here for simplicity. Note too that within a single extended play session, smaller play cycles tend to emerge, and the stages repeat in a loop. The Primary Play Flow model in section 4.1.3 illustrates this cyclical looping.

The final stage in the Moov play model refers to play that is no longer focussed directly on the play space. In my observations, this type of play involves either: passive engagement with the system, or, play that continues beyond engagement with the system, but is similar in tone to active play within Moov. It seems to reflect further playing out of the play that occurred within Moov.

Note that the Moov play model below was informed by the open-ended play stage model discussed in section 3.2.2.1, but was defined based on play testing session with Moov prototypes.

Moov Play Model		
Phase	Stage	Description
Pre-Play	Coupling	Forming relationship with digital double through body movements
Primary Play	Exploration	Moving the body around the space, testing effect creation (both individually and in tandem with partner)
	Invitation	One player gestures to the other, inviting the partner into a type of play.
	Evolution	Once a play type is agreed upon, players play it out.
Secondary Play	Resonance	Players continue to engage with the system, but this engagement is less focussed.
Post-Play		After disengaging with Moov entirely, players continue to play with jokes, gestures, teasing, etc.

Table 1: Moov Play Model (Moov Play Stages)

4.1.3 Primary Play Flow

The primary play phase identified above tends to follow a circular flow as shown below. After exploration, one player tends to invite the other to play in a particular way. If there is hesitation, the invitation tends to be repeated. If declined, paired play tends to lag until either play decides to invite her partner in a different type of play. If accepted, a run of a particular type of play emerges. As it plays out, players tend to alternate between leading or following the partner. Once played out, players either start the process over, inviting new play types, or active play stops.

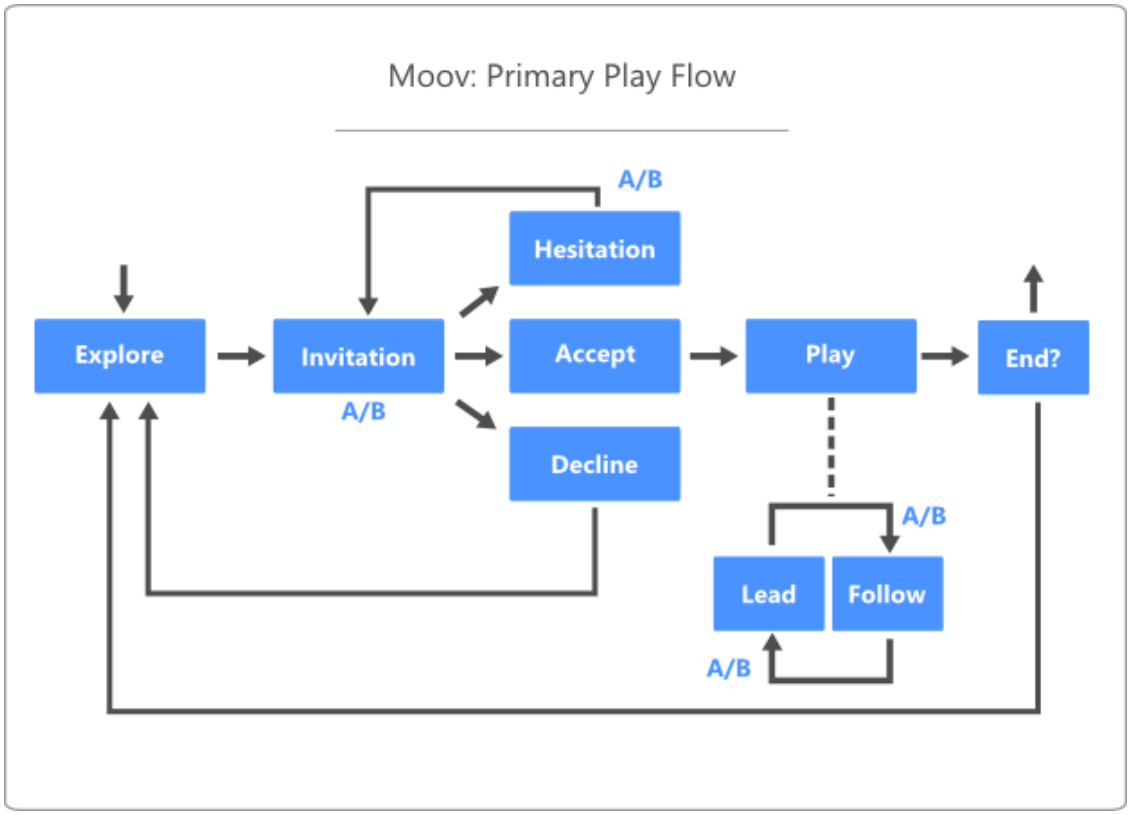

Figure 5: Moov Primary Play Flow Model

4.2 System Architecture

To support rapid prototyping, and to provide an extensible framework which would support future projects, a great deal of effort was devoted to the design of the system architecture. The goal was an architecture in which each of the components, in each of the subsystems, could be swapped out for new components, without having to rebuild or provide new interface layers to related components. For instance, new player representations can be defined with a few lines of code, and substituted for existing representations, without having to touch any other code like the data model or its controllers. As a metaphor, the design resembles building blocks. In it, multiple blocks, each serving a unique function, fit together seamlessly with related blocks to produce multiple variations of structures.

This architectural approach has several advantages. In all development efforts, if affords considerable time and effort savings because individual components can be optimized, extended, or substituted without having to devote any time to modify related components to function with the changed ones. Going forward, because the components of the system are not tightly interwoven, it enables the core components to be recombined and extended into new functionality in future projects.

During prototyping, it enabled quick testing of the effects of combining different representations, monitors, and effects on users. For example, the efficacy of the dot shape effect, triggered by a leg extension monitor using a manila or particle body could be tested. By selecting one radio button, an arm extension monitor is swapped, and with another radio

button, a particle effect is swapped for the dot shape. Not only did the architecture allow me to focus on building one system subset at a time, like spending a week on building variations in player representations, it also enabled fast prototype testing sessions with players.

4.2.1 Design Pattern

Moov uses a hybrid MVC and Object-Oriented design pattern. Blending characteristics from both enabled: (a) separation of the data layer from the view layer so that it a stable data set could be easily accessed by subsystems such as player representations and body trackers, (b) a component-based architecture which supported the building-block approach described above.

Separation of the data layer is provided by the MVC pattern. MVC separates a system into three core layers:

- **Model** (data layer)
- **Controller** (interface layer): in Moov, controllers convert Kinect data into a Moov-model data definition, while other controllers read this data and update body views
- **View** (representation layer): In Moov, these are the player body representations

Separation of the data layer from the view layer affords flexibility in the implementation of those subsystems with regards to the data, and also provides a data layer that always represents raw, Moov-model data; it is not diluted in any way by other layers and contains consistent data irrespective of other layer implementations.

From the Object-Oriented pattern, the rule of encapsulation of data within classes was abandoned to support MVC. However, several other core OO principles were strictly enforced:

- **Single purpose**: every class is responsible for an individual purpose
- **Loose coupling**: individual components were designed to serve their single purpose without requiring knowledge of related classes.
- **Abstraction & Polymorphism**: in a number of layers, a base abstract class was extended so that classes can instantiate and communicate with the base object without requiring any knowledge of the implementations within classes that extend the base.

These principles support extensibility in current and future designs. For example, a manila Body View or a Particle Body View can be instantiated by a Body object with a standard constructor, and the Body can update the either View with an UpdateView() method call. No changes to the Body are ever required to make this work. As long as a Body View extends the base abstract Body View class, the View can be operated upon by the Body with no additional coding.

4.2.2 System Overview

At its core, the Moov system consists of six major subsystems:

1. **Skeletal Tracking**: connects to Kinect sensor, reads skeletal data, converts it to Moov model-ready data, inserts the data into the model

2. **Data Model**: stores frames of body data, provides interface for body, tracking, and recorder systems from which to read body data.
3. **Body Representation**: converts data model body data into moving body representations.
4. **Tracking Management**: tracks paired and individual body movements, positionality, speeds, and initiates effect
5. **Effects Management**: produces effects external to and within player bodies.
6. **Recording System**: (when enabled) provides recording services, enabling long-term storage of body data that can also be replayed.

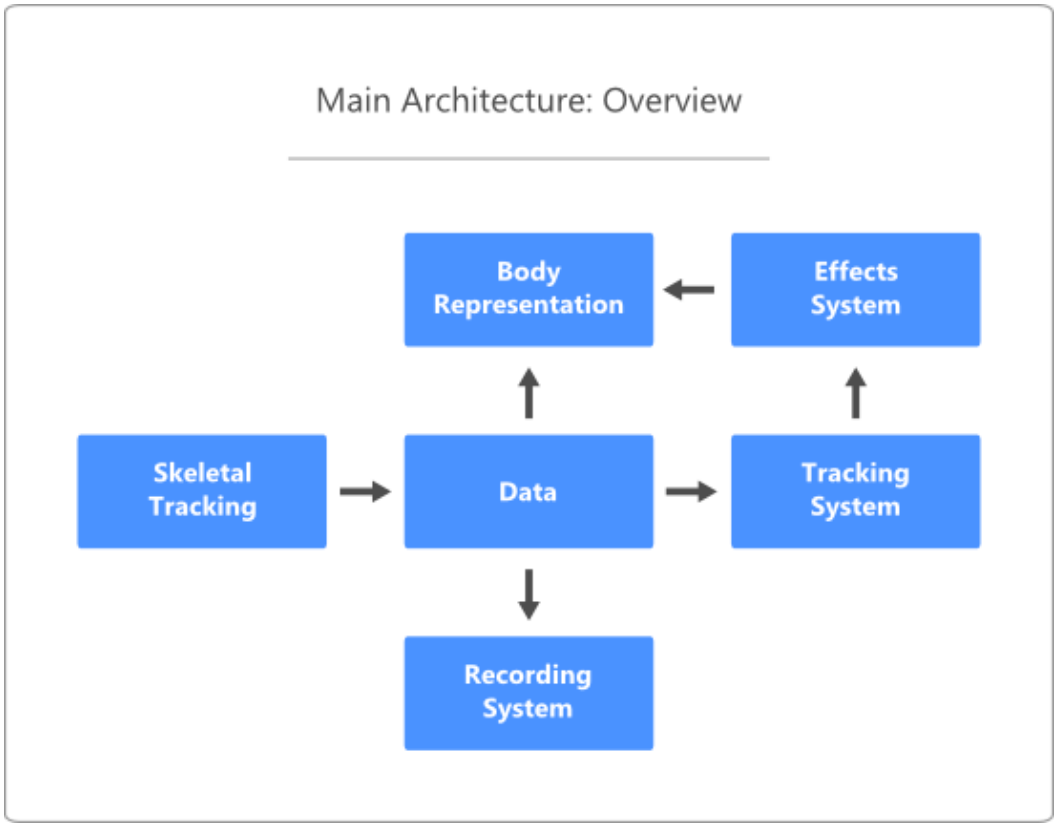

Figure 5: Moov Main Architecture Overview

4.2.3 Class Structure & Communications

Although there are additional components than those listed, the diagram below provides an overview of the basic class structure and workflow. For brevity, I have not described the details of each class, however, the basic workflow is as listed below. Note, the Bodies Manager and Paired Player Monitor are singletons and handle multiple bodies. Body, Body Monitor, and Effects Managers are duplicated; each human body detected instantiates each of these classes for an individual body's representation and effect production.

Setup

1. Bodies Manager and Paired Player Monitor instantiated
2. From Bodies Manager, Kinect sensor is opened, and a skeletal tracking reader is opened

Every Clock Cycle: Body Layer

1. [IF] new body detected, instantiate a Body object and assign it to the Paired player monitor

[For each Body]

2. Acquire latest frame of body data, delegate to Controller
3. Controller converts data to Moov-model frame, pushes into the Data Model
4. View Controller retrieves a frame from Data Model, updates Body View

Every Clock Cycle: Monitor & Effects Layer

[For each Body]

1. Body Tracker reads from the Data Model and reports to the Body Monitor
2. [IF] Body Monitor detects a trigger, i.e. it discovers the body has performed an action that causes an effect, report this to the Effects Manager and/or to the Paired Player Monitor. Note: some effects are caused by individual movements, while others require paired player movement. Both systems can communicate to the Effects Manager.
3. Effects Manager fires new effects (if one was requested), updates any existing effects, cleans up timed-out effects from the scene

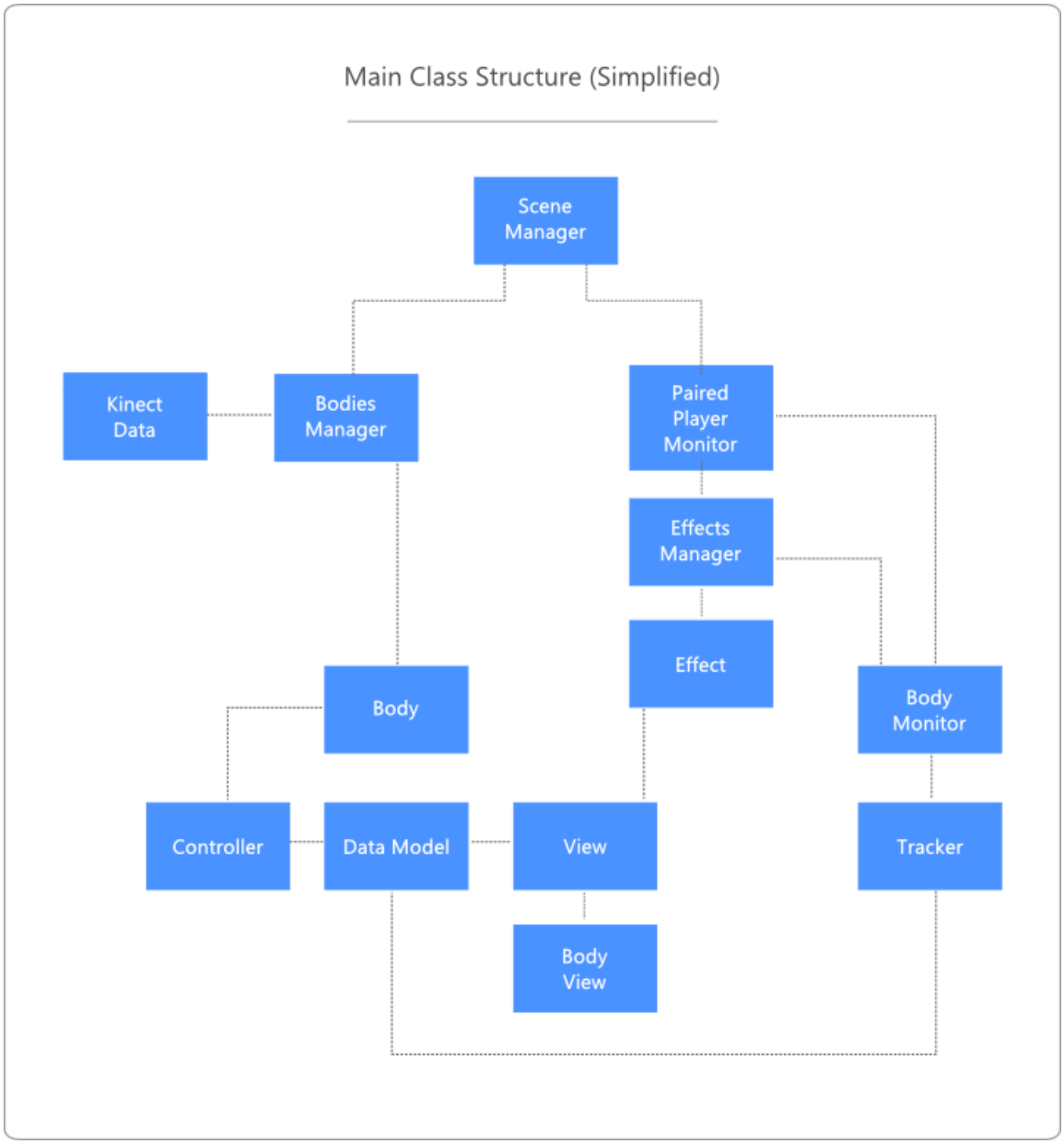

Figure 6: Moov Class Structure Overview

4.2.4 Recording System

A very useful feature within the Moov system is its recording and playback system. With it, player movements can be recorded to an external file. This data can then be reopened and used to recreate a moving player in real-time. It effectively allows for a moving "ghost" player to be displayed next to a live human player, in real-time.

What is most notable about this system is that once data is retrieved from the text file, it is fed back into a data model. This data model is then assigned to the Paired Player Monitor, allowing the ghost body to be tracked as if it were a live human body. From a development perspective, it was an essential feature because it allowed me to build and test paired movement tracking/effects without having to have another person next to me with which to test.

The feature may also prove of great benefit to future implementations of Moov, enabling players to record and playback their sessions and/or blend historical play sessions with a current session. As discussed in the prototyping phase 4/5 discussion, players expressed a real affinity for seeing their past movements blend in with their current movements, so this feature could be of real value to players in future implementations.

5 Prototyping & User Testing

5.1 The Development Journey

The pathway in achieving Moov's current designs and arriving at the project's most important findings was a circuitous, invigorating journey. I attribute this winding road largely to the sheer depth of the theory bases which my researched touched upon, and the resulting lines of inquiry the research activated within me. If the accepted form for submission of a thesis document were stacks of 8.5 X 11" brainstorming sheets, design sketches, furiously scribbled notes which describe interconnections and further lines of inquiry, I believe I could submit several.

Play theory is rich, ubiquitous, and messy, but also so richly powerful. Early on during my initial low-fi prototyping sessions, play demonstrated its curative power. Spurred on by this discovery, I spent much time studying its dynamics, deeply absorbing its key concepts from theorists like Caillois and Huizinga, then carefully examining the conceptual frameworks Brian Upton describes, in doing so attempting to really understand the processes and mechanics of effective play systems.

Open-ended, "emergent" play studies and writings in the academy seem to be at their early stages, but, for me, are infinitely fascinating, offering a lifetime of potential study. Play that is unique, specific to paired players in relationships, and that seems to emerge organically through mutual explorative interactions, seems interwoven into the fabric of intimate

relationships, but at that same time avoids ontologies. Where does it come from? How does it start? What occurs in the minds of its players? Through reflection, there were times when I believed emergent play to be a specific form of play – namely, play that is in the process of being defined. Then I believed it to be the result of dynamic, interconnected rules. Then I came to see that all play itself is emergent. This single line of inquiry could have proven sufficient as the basis of a thesis project. However, I knew that what I was creating was a space for two moving bodies, and this activated inquiry into performance theory.

Digital mediated performance has a long history, includes an enormity of theory and philosophy, and has produced a huge breadth of projects and installations – any piece of this body of work could catalyze rich thesis-level research. For example, Salazar Sutil's work with the body and representation, rooted in a history that extends as far back as Plato, is gripping, and led my passions down the path of wanting to use digital representations and experiences to build healthier reflections of the moving self.

In short, while my main research questions were always most important to me, in building the theoretical framework to support Moov, I found myself embarking upon, and spending time within, many different intellectual pursuits. Fortunately, in the latter stages of this project, I was able to build the prototypes which answered my key initial questions, namely, that it is possible to build a system which scaffolds paired emergent play.

While the prototypes of most significance to this project were achieved in the final development cycle, preceding the final cycle were three distinct development phases. A

description of development activities and resulting findings in each stage are discussed below.

5.2 Prototype Phases

5.2.1 Phase 1

The initial prototyping phase served as an exploration in the Microsoft Kinect SDK and reflected some of my initial understandings of emergent play. These were driven by my readings into open-ended play described in section 3.2.2.1 and in the results of the low-fi prototyping exercises I performed. The key design principle that I was looking to explore was that ambiguous instructions could drive emergent behaviours. Secondly, I hoped to examine the aesthetic of interacting with swarming – and this aesthetic enhancing the energy of the play space.

These swarms were intended to serve as stimulus agents in player movements. That is, they were designed to swarm towards player body part to provoke retreating movements and swarm away from the player in response to attacking movements. The intended effect was to enable players to engage with the random flowing and emergence that occurs in starling swarms in nature.

To support the basic logic of the swarms, I implemented a particle swarm algorithm similar to the one described by Kennedy and Eberhart (1995). This algorithm, simple in nature, dictates to individual particles that within every update call (approximately 60 times per second) they should move towards the particle that is closest to an imaginary point. I

extended their algorithm to randomly move the imaginary point around within three dimensions to prevent clustering near any given point for extended periods.

As this swarming related to the play phases, the system was structured such that:

1) Before a player has approached the screen, move a swarm of particles around the screen à la a bird swarm. The effect was intended to invite players to approach the system, and at the same time, imply the aesthetic of interaction the system affords.
2) Once the player moves to the screen and is detected by the motion sensor, burst a series of glowing particles that are arranged to represent the player's body on screen. This was meant to activate the player; it was intended to make her aware that this is a physical interaction space, and that her body is connected to the scene.
3) After initial activation, the player's particle representation fades. I wanted to indicate from the onset that to connect to the swarm and its energy, players had to continue to move their bodies. By making them effectively disappear, I hoped they would realize quickly that they needed to continually move and engage.
4) After a short period, a series of particles of different colours were introduced that moved in a direction. They were meant to guide movement. For example, a set of particles would move up-left to encourage the player to move their body up-left. If they complied, particles were emitted from the player's body, and these particles, once generated, started chasing the swarm.

The intended process in interacting with the system was to activate awareness on how to interact, to guide movement, and to promote the feeling of engaging back-and-forth with the energies of a flowing swarm.

Findings from Phase 1

By in large, the initial prototype did not achieve any form of desired results when players viewed it. In retrospect, the most critical error on my part was in *only* allowing people to view the system – not interact with it. I have since learned that feedback of any form proves far more informative that my own internal design decisions (and wrestles).

However, at the time, I believed that the system failed because it lacked any relatable design metaphors. Most problematic was that the system was not instructive to players – it simply did not make any sense to them.

My conclusion for this first phase was that I had misapplied the use of ambiguity in the design. The particles representing the player made little sense to them. Most importantly, the use of swarm particles to stimulate movement, conveyed little meaning.

They were supposed to instruct the user on the directionality of movement, but were left abstract enough to allow the player to interpret which body part (or parts) to move. However, in this all this abstraction, all phases of the system were lost on my audience.

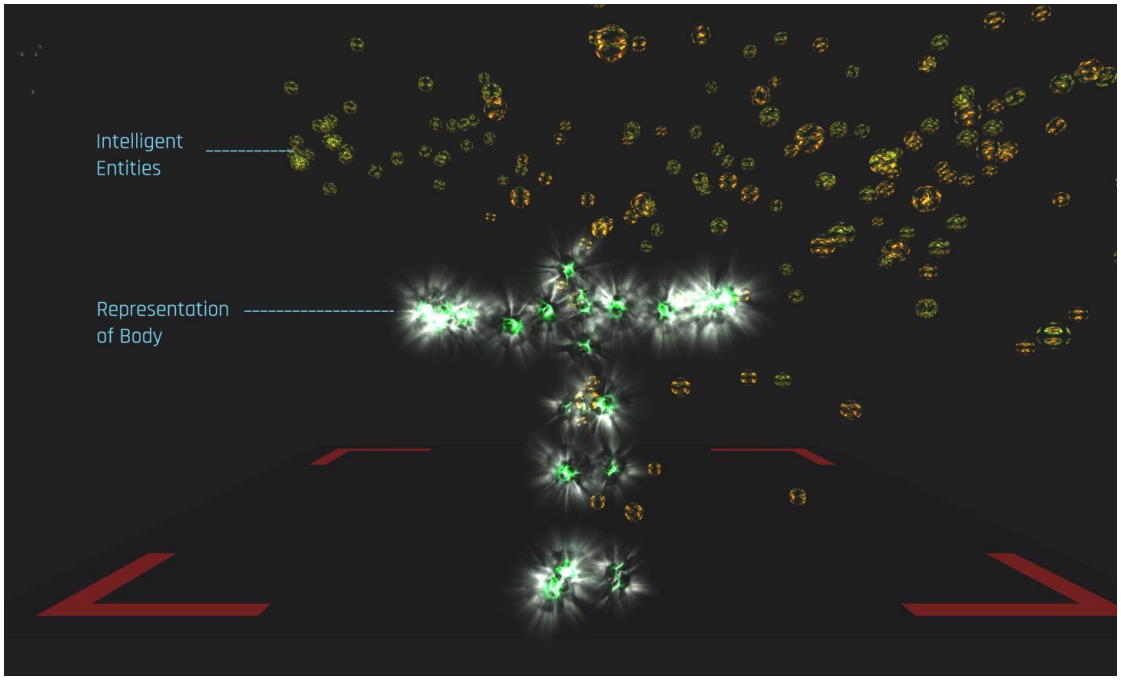

Image 2: Digital Prototype 1

5.2.2 Phase 2

The design in phase 2 was driven largely by the influence that Sutil's work on body language had on me. My intention was to build a system which used a basic form building approach like Rudolph Laban, but rather than "teaching" people how to talk with their bodies by acquiring a pre-defined set of body nouns, the system was intended to allow people to build a new physical vocabulary that was unique to them. Ultimately, it was intended to stretch them to expand their own unique body-vocabulary, and see the beauty of in themselves moving/communicating this body speak. Emergence in this case, was thought to be the appearance of a body with new expressive capacities.

To support this expansion of form, a set of stimulus dummies were built that reacted to player movement. That is, after one expression, the dummies would pop up and suggest

another body movement that could extend from the player's last. As the play session continued, the stimuli would suggest new forms of greater complexity. Using this device, it was thought that players could build their vocabulary based on their own choices (which of the two agents to follow), and that this vocabulary would grow in complexity as more complex movements are introduced.

Findings from Phase 2

Informal testing during this phase was far more promising than in phase one. Representation of the player characters seemed most successful. Players seemed to immediately relate to the solid forms. Several people engaged with the system for several minutes, and each laughed and moved their bodies with excitement. Onlookers also appeared enthusiastic about the energy that the system conveyed. I concluded that solid forms for the players is a far better approach than an abstract one.

Feedback regarding the aesthetic was not as promising though. Several individuals plainly stated that they did not like the empty stage representation as well as the lighting used. The non-player solid forms seemed to stimulate a positive response to the aesthetic, but in all cases (including my own testing) indicated that as aides in initiating system driven movement, they did not work at all. By my own conclusion, I believe this is because they require people to perform extraneous reasoning internally.

Moov, at the time, was intended to enable an outward flow of movement from people that felt natural. Having them mentally process the meaning of symbols on screen each and every step simply did not seem to work.

Further, after this phase was complete, it became apparent that my direction with the project was somewhat off course. For several months, my focus has centred on what seemed an elusive problem: how to instruct appropriate behaviour while leaving enough room for players to interpret those instructions in a manner that felt 'right' for them. It was a perplexing dilemma. I hoped to structure a system that was layered with 'emergent progression'; that is, I hoped to stimulate basic movements, forming a core a person's unique 'physical vocabulary', then provoke that vocabulary to build on itself. The intended result was newly acquired movement form in the user that was highly personalized to her, and that grew from her own basic movements.

While there may be merit in the approach, such as providing a platform for users to discover and view the beauty in their moving form, this type of system was not the original goal of Moov. Its main goal is to allow *two* people to create their own play.

Fortunately, all was not lost during this phase. Although considerable time had been misallocated, many of the backend system components developed during this phase were useful in the next phases.

5.2.3 Phase 3

The main activities in phase 3 were the careful remodeling and coding of the new system architecture. No prototype testing occurred in this phase. However, it was a fruitful endeavour from which I achieved a solid and extensible core system. Further, it produced the first digital double representation that was explored in phase 4.

5.2.4 Phase 4: Paired Emergent Play

Phase 4 was by far the most exhilarating and fruitful prototyping phase. It was the phase in which I personally came to understand the model I had imagined a year prior, and how to begin its implementation. It was the phase in which I was actually able to see evidence that the model resulted in emergent play between two people! Some of the results were expected, and therefore served to validate the general Moov emergent play model, while others were unexpected – but fascinating. The results led to the definition of the Primary Play Flow model above, providing a much more focused view into emergent play, and opened the door for future explorations.

Several prototypes were developed in this phase using the code framework developed in phase 3. There were two major investigations in the phase: (a) investigate the efficacy of different digital double designs, and explore the players' relationship with their digital double, (b) investigate whether giving people a small set of interaction opportunities in the play space will result in emergent play.

Descriptions of the prototypes in each investigation and test findings are provided below.

5.2.4.1 The Digital Double

Four digital double designs were implemented and tested in this phase: a manila mannequin, a body shell composed of particles, a body made of large bubbles, and a pixelated shadow. Their description and findings as to their efficacy in creating human-double relationships are below.

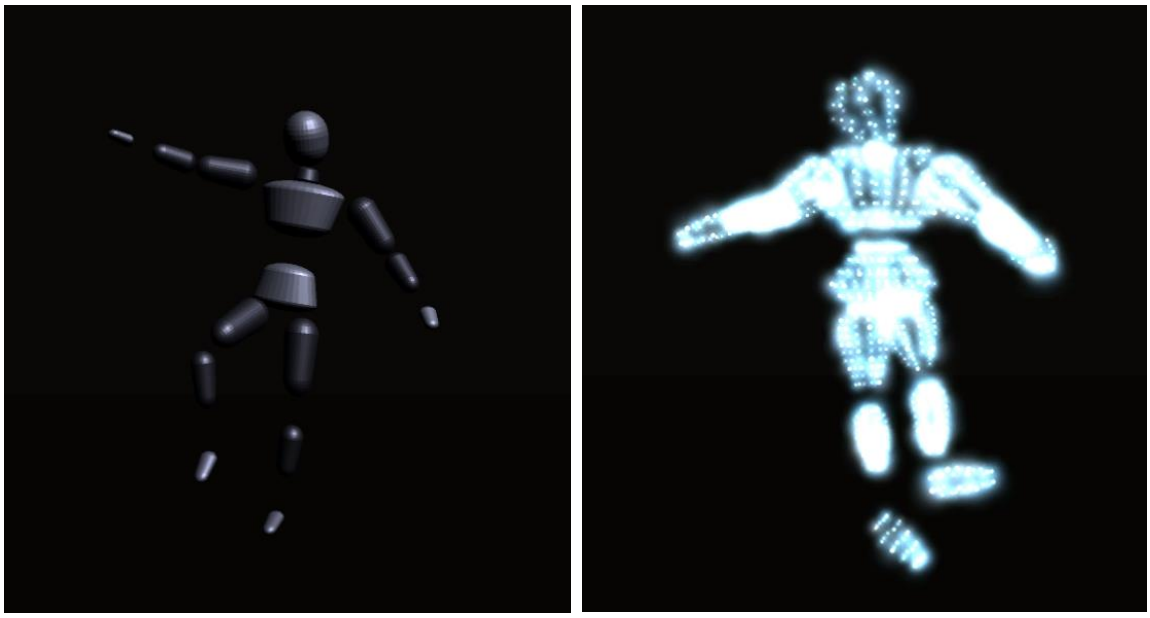

Image 3: Doubles 1 & 2 - manila mannequin and particle shell

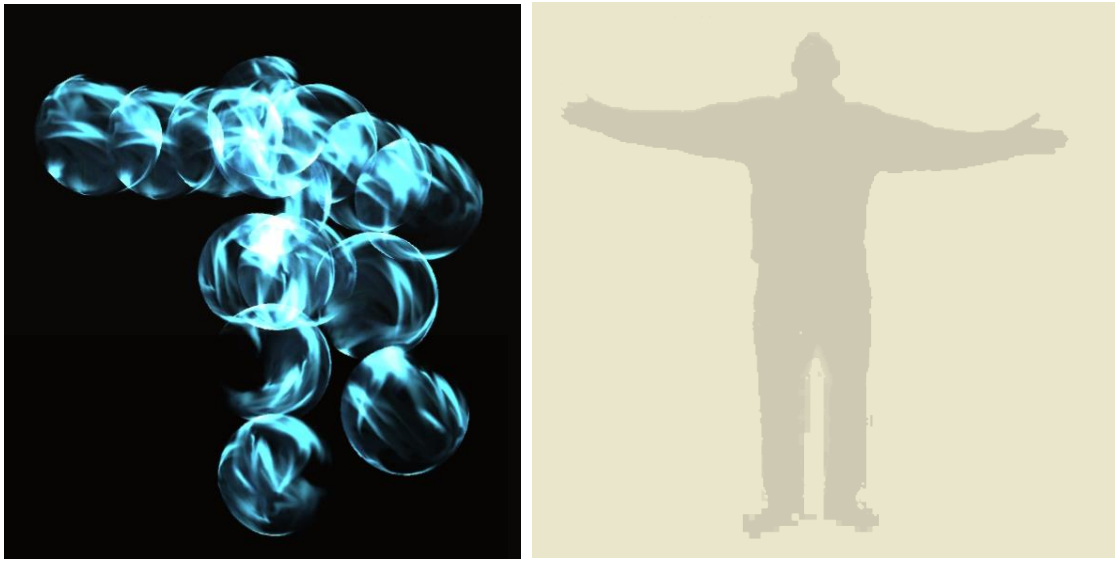

Image 4: Doubles 3 & 4 - body bubble and pixelated shadow

Manila Mannequin: this design was kept completely generic to see if players formed relationships with their double based on its posture and movement. The key principle was to see if people would form a significant relationship based solely on movement. Based on feedback from the player representation in phase 2, and from my readings in performance, individual body parts were designed to have significant space in between themselves and neighbouring body parts.

In terms of their efficacy as digital double in which players form a relationship, the manila mannequin was most successful. The key to this success, as expressed by all participants, was that the double reflected their posture, gait, scale, and because it reacted fluidly and responsively to their movements. Interestingly, none of the players felt as though the mannequins were lacking in expressive capacity, or failed to fully reflect the players, even

though the mannequins are just a generic model. These findings confirm my research suggesting that what people identify to most in their digital representation is their own movement.

Particle Shell: was made of sparkling particles to see if a more "dream-like" design would make the experience feel more sensorial.

Responses to the particle shell were not favourable. I cannot speak to whether sparkling effects affect the senses, because the relationship in this case seemed to break down quickly. All testers, within seconds of moving with the new double, described the system as slow and less responsive. However, I had previously tested the performance of the space with the shell against that of the mannequin – and the frame rate was identical! Several participants complained about the limb connection, stating they were too clunky. This confirmed my research in that it is vital to isolate individual body parts such that players can clearly see how their motion affects each of their body parts. You need to provide a relatable bridge between the self and the digital self. When you obscure away the nuances of movement, you break that bridge.

Body Bubbles: was made of large spheres resembling bubbles to see if a representation that was more playful and less literal (while still reflecting player movement) would cause players to form more of a playful relationship with their double.

Responses to the bubble representation were mixed. One player immediately liked it and indicated a desire to with the bubbles. It also appeared as if she had formed a

relationship with the double. Other participants, however, did not like the representation. This mixed result is actually a promising result. It suggests that the type of player representation immediately lends itself to a particular tone of play. It suggests than in future implementations, it would be fruitful to give people types of representations to choose from based on their play needs or type of partner. It would enable different types of play such as light, child-like play.

Particle Shadow: was designed to render a body which closely resembled the player silhouette. The design sought to investigate whether seeing too much of self in our double negatively affects the connection we form with our double. The shadow also emitted movement trails when the player moved. The trails were introduced to see if they enhanced awareness of movement in players.

Responses to the pixelated shadow were also mixed. People responded favourably to the movement trails, and expressed that they liked the "feel" of producing them. It also resulted in individual play. Most players experimented with the effect, looking at the types of "drawings" they could create with them. I believe that this type of effect should be explored further as a play mechanic and as a tool for sensorial play.

Despite this positive finding, the prototype revealed a critical design criterion: doubles should not reveal so players parts of the form that they do not like (the parts they feel ashamed of). One participant had a very negative experience, stating that the "realness" of the double made him suddenly very self-conscious, suddenly very aware of his choice of attire

on the day. I experienced insecurity of my own with this representation as it caused me to feel hyper-aware of the length of my nose. The intensity of our reactions strongly supports the idea that successful digital doubles are those that prevent us from seeing the parts of us that we do not like.

Double Five: A fifth prototype was developed to investigate reverse-mirroring with the double. Specifically, I wanted to see that if the double was rotated so the player faced its back, whether the empathetic connection to the double would change. In addition to rotating the double, the scaling relationship was altered such that approaching the sensor (the mirror) caused the player to get smaller and move into the space. Moving away from the sensor caused the player to get larger, as if exiting the space.

Image 5: Reverse Digital Double

The investigation was very worthwhile because it very clearly illustrated that to have users form meaningful connections with their doubles, they need to face them as if looking in the mirror. Repeat testing with a larger sample size would need to be conducted to state this finding conclusively. However, the intensity of negative responses of those tested in the study strongly suggests that the finding is accurate, or at least probable in most players. Testers used words like "*hate*", and "*so confusing*". Another tester disliked viewing the back of her head, and she seemed to feel mad that she no longer had a connection to her double. One participant said that it no longer felt like he was controlling himself (note the mention of "self" in terms of double). While another found the relationship of moving into the mirror to be totally confusing. The investigation proved worthwhile because it focussed the direction of future work back to the mirror relationship that appears so essential to digital doubling.

Other Findings from Digital Double Investigation

The digital double prototype testing revealed many findings as they relate to how different designs affect relationships with doubles. Surprisingly, in addition to providing insight into this relationship, the above prototypes also revealed some important findings related to emergent play and sensorial digital experience within Moov.

Touching Without Touch: I personally experienced an effect that was startling and could be very promising. Namely, when I saw my digital double being affected by virtual touch, my real body experienced physical sensations. I felt touched without actually being touched!

The effect merits considerable investigation. It has major implications for future implementations, especially within Moov - a system of sensorial emergent play. The finding also provides further evidence that what is at play in the human-double relationship is a high level of kinesthetic empathy.

Movement Residue: an unresolved bug in the system revealed an intriguing finding. With this bug, when the Kinect sensor lost body tracking for a particular body, whole body representations of players' past movements were left on screen alongside the currently moving body.

Testers loved this. They expressed real pleasure in seeing where their body had been. Some expressed an affinitive connection to their past movement representations, asking for screen shots of the body-riddled play space. Their response is evidence that highlighting the imprint the body marks while moving in play triggers an emotional reaction in players

Image 6: Movement Residue

Relationship Exploration: the digital double appears to stretch comfort levels in expressing behaviours that people would not necessarily feel comfortable expressing in the non-digital. This was made clear in *all* testing sessions. For example, due to the limitations of the Kinect, when joint positions are unreadable, the sensor infers these positions. Limbs that are mapped to this data twitch as a result. By accident, during testing one tester discovered that putting her foot in front of the other player caused the other foot of the other player's double to twitch. The discovery resulted in foot play.

Notable in this example was that the testers had a formal relationship prior to playing in Moov. They had met with each other often over the course of a year in a formal context, and had never engage in any of this (innocent but non-formal) play.

This is a very promising finding within the long-term scope of Moov which uses the system as a communication device within relationships. If the digital double enables a greater range of play and expression, then it could potentially be used by people within Moov to communicate at an expanded level with a play partner. It could stretch and expand dynamics in the relationship.

5.2.4.1 Basic Emergent, Sensorial Play

During the digital double prototype investigation, an additional prototype was developed and tested. Its purpose was to see if simply giving players a small set of effects which could be produced by moving their bodies would result in play creation. The prototype also applied time-based internal mechanics to the produced effects. This served to

investigate whether engaging with a system with a rhythm that differed from player rhythms could result in an enhanced kinesthetic experience, similar to the discussions to this effect in section 3.3.3 above.

The effect that people could produce were "dot shapes". After casting, a dot is emitted from each of the player's joint positions. Dots are interconnected with lines. The dots themselves move at a speed and direction that is an average of the speed and direction of the player joint from which they were emitted. Both the dots and the lines fade and shrink according to a pre-define clock cycle.

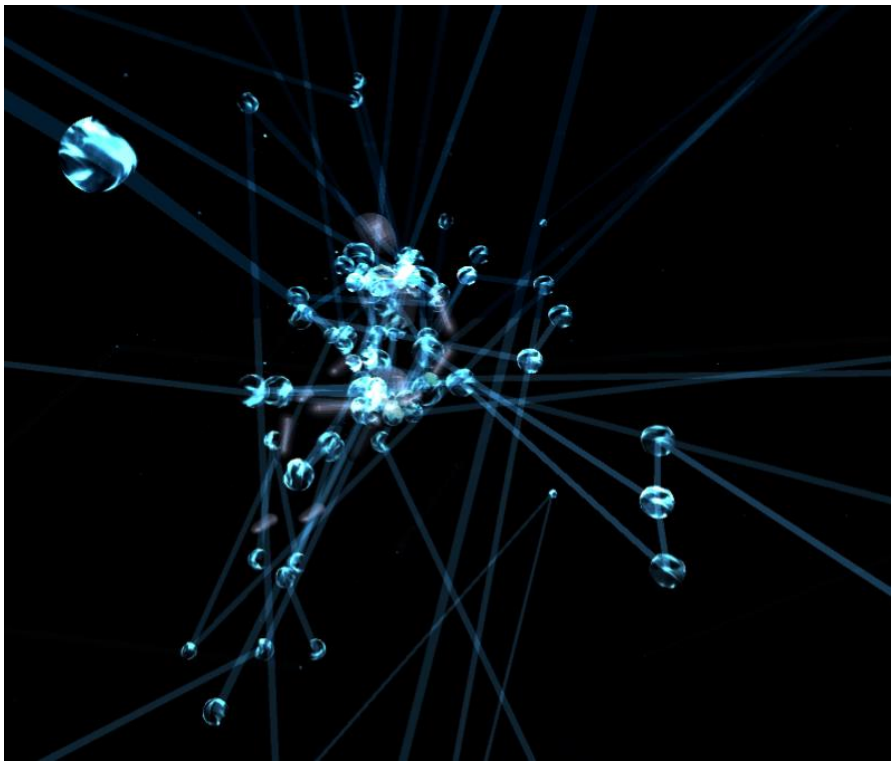

Image 7: Dot Shape Effect Casting

Findings from Dot Shape Prototype

The results of this prototype were very promising. Tested with multiple pairs, the prototype provided evidence that play within this dynamic (of a two-rhythm system) can result in kinesthetic experience. Players reported feeling calmed and soothed by the playing with the prototype. At times, they seemed transfixed by the interaction and by the emergence of the shapes.

Further, the prototype revealed that even very simple play mechanics can result in ongoing play. Importantly, it also revealed potential further exploration in treating the Moov space as having a primary play phase, in which players are actively engaged, and a secondary phase in which players are passively engaged. These phases emerged during testing. In the secondary phases, players sat together in front of the screen engaging in conversation, at times they would be drawn back into Moov, play for a while, then return to conversation. Moov seemed interwoven into the conversation space.

There is room for a lot of investigation in adapting Moov to support this type of passive-active play in future implementations. However, in the context of the current Moov implementations, this study strongly supported that treating effects with their own rhythms effectively enhances kinesthetic relations in the space.

5.2.5 Phase 5: Paired Emergent, Sensorial play

In the final phase, principles were combined from the preceding phases into a more robust set of prototypes. Most importantly, the prototypes were designed to allow play that is more specifically paired. This was achieved by introducing body effects that are activated by paired player movement. The prototypes also deepened the exploration into the kinesthetic experience of moving in the space.

The prototypes were produced immediately prior to my thesis defense and exhibition, and therefore have not been user tested as deeply as the prototypes in phase 4. However, informal testing revealed the that the prototypes do support a greater degree of paired play. They also activated a high level of interest in players, as evidence by excited responses such as leaping, laughing, and proclamations like, "I didn't want to stop!"

Brief descriptions of each prototype are described below.

Touch Play: as the name implies, this prototype explores play that relates around touching. It extends the virtual touching discovery made in the previous phase. By positioning body parts close to their partner's body, players transmit flows of particles from their body into their partner.

Two versions of this prototype were tested. The first enabled virtual touching only. The second extended the first. In it, when several parts of players' bodies overlap, the overlapped parts create particle bursts that flow from the body toward the front of the screen.

The mechanic enables play around causing changes to partner form and in co-creating shapes.

Both prototypes proved very successful. This first resulted in soft, tender, explorative play. The second resulted in a wide range of play, e.g. trying to make a partner's head explode, and a high level of interwoven bodies in play.

Both prototypes require more user testing but supported the efficacy of the Moov model of emergent play.

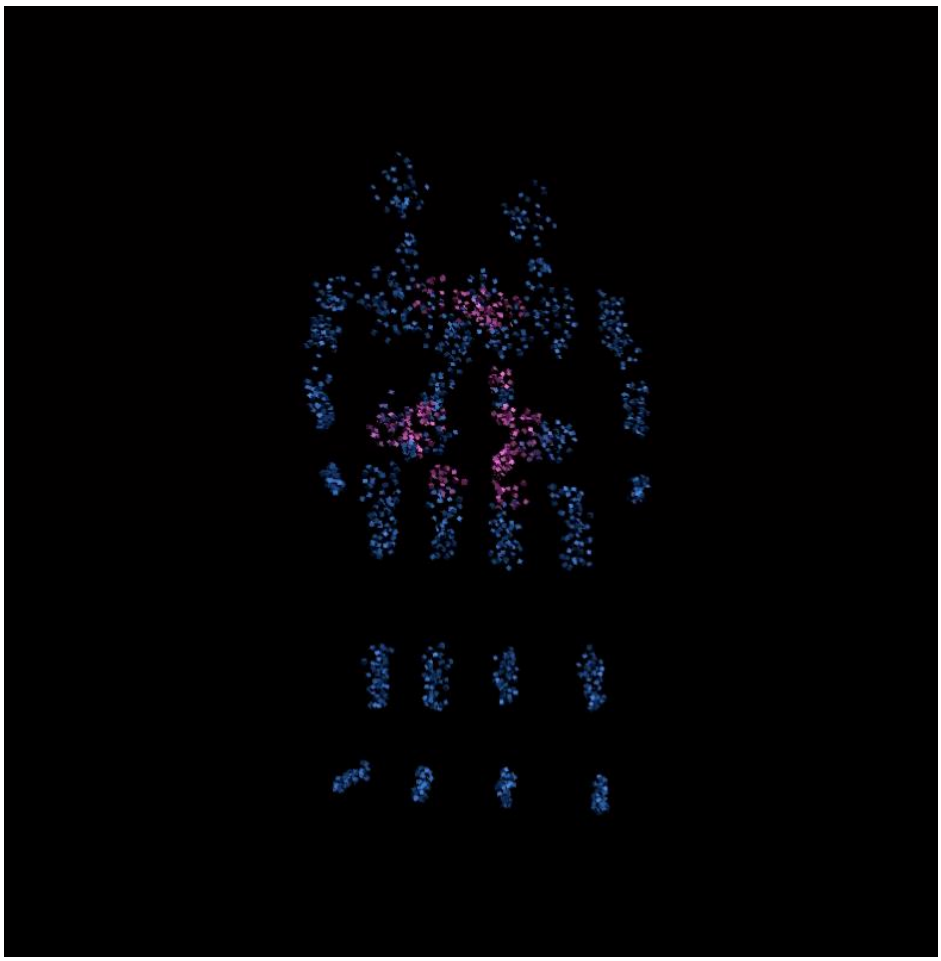

Image 8: Touch without touch

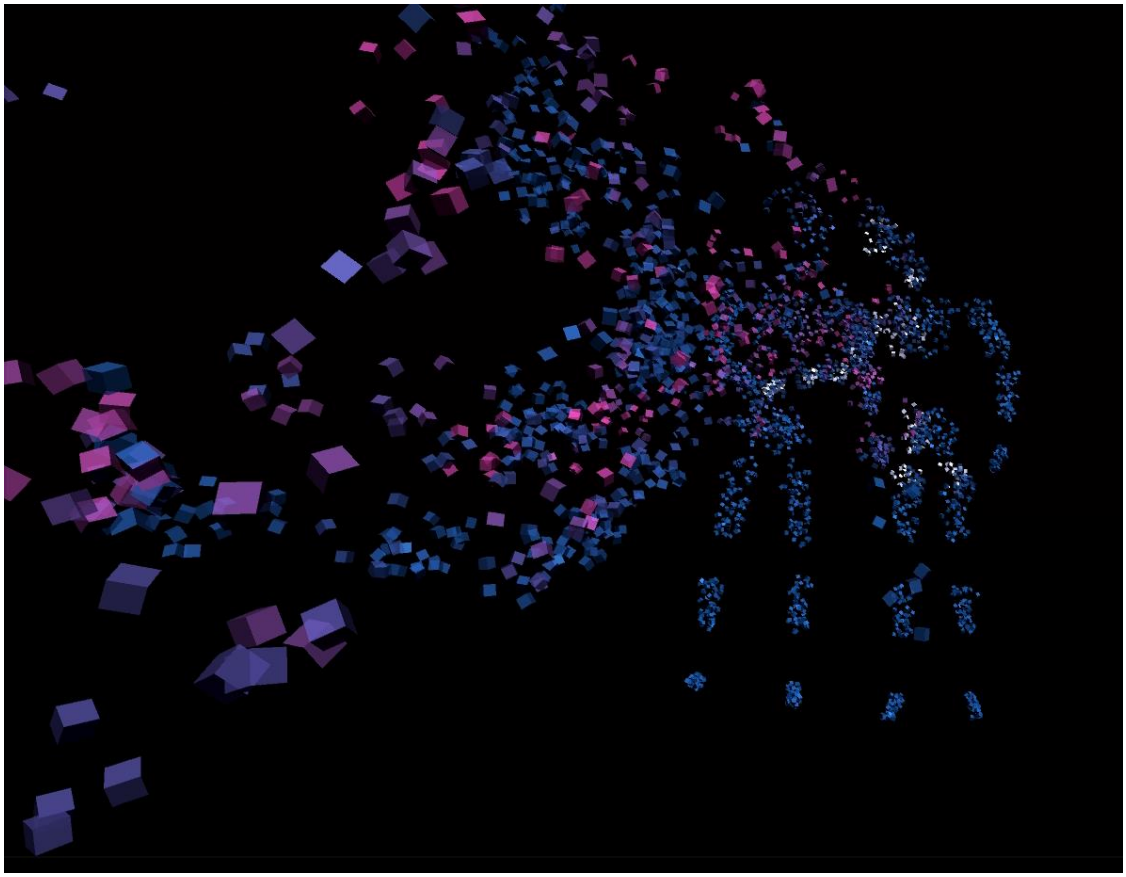

Image 9: Touching without touch – particle casting

Body Casting: in this prototype, players move then stop to cast off whole body "ghosts" of their bodies. These produced ghosts move per the rate of speed and direction of each of the player's body parts prior to casting. When the castings of one player collide with their partner's casting, the colours of the cast change to pink. Further, if a player's solid form makes contact with her partner's casted body, the casted body changes colour to blue.

The results of the prototype testing were very intriguing. Players showed evidence of a lot of stretching in form as they explored the possibilities of what their bodies could create. They also resulted in leading and following fluctuations in which one player started casting

one type of shape and the partner following by attempting to cast the same form. After playing out the play, player's made discoveries in the effects of overlap casting and play then shifted. The Moov emergent play model was clearly demonstrated.

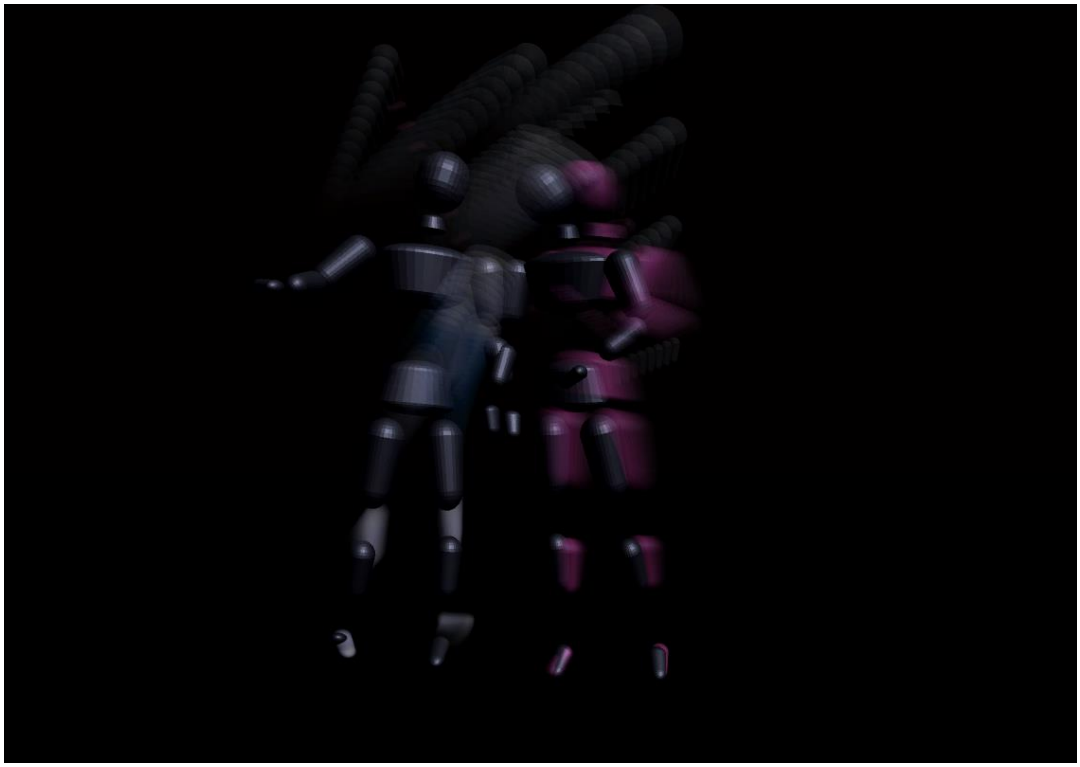

Image 10: Body Casting

Paired Dot Shape: in this prototype, the dot shape casting effect was extended such that shapes combine features of from both player bodies. It was designed to allow play in exploring, and kinesthetically feeling, the results of moving together with a partner.

Aesthetically, this prototype was most successful. All testers described the moving dot shapes as being beautiful. It was also highly successful in demonstrating leading/following emergent play with a high range of expression and exploration in players.

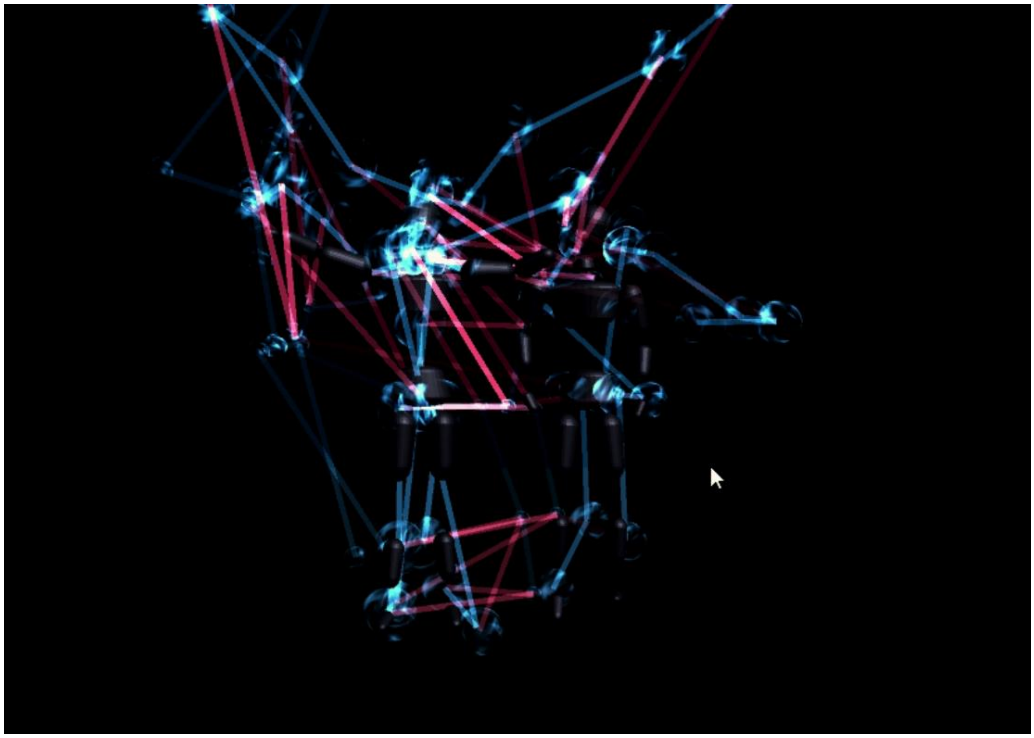

Image 11: Paired Dot Shape

6 Analysis

The nature of this project has involved continuous, sometimes frustrating, often exhilarating analysis. Play creation between two people is both thin but broad and elusive. It feels thin because subtle variations in the core elements in the play space seem to either make or break play. But it is broad in that it appears as an avenue in which the rich dynamics of relationships and human nature find room to drive play, and it is broad because it seems to become visible in a huge array of play forms.

It is elusive. Sometimes it starts, sometimes it does not. It can last for milliseconds only but imply so much in that flash, or play out for extended periods. It's incredibly rich material to study.

From a development perspective, the project was frustrating for a long time because so much software engineering is involved in structuring systems – building engines to serve their purpose with speed and efficiency – but allowing people to create play involves creating the space in which the players become the engineers. I searched relentlessly through readings and late-night brainstorm sessions to find the missing widgets in the machine that would allow me to structure an engine that would stimulate emergent play. In the end, what was required instead was to make a simple space with two bodies, simple body effects, and then to step back and let the players drive. It still feels slightly odd for me to say that, but evidence in this research project has shown that the approach works.

The bonding we create with our digital doubles appears equally as mysterious as the complexities of people in relationships in play. What makes it appear so mysterious, is that the bridge into the empathetic relationship between player and double appears to be movement. How is that so? We often see ourselves in mirrors and photographs, but how often to we see ourselves moving? How is it that we identify so intensely with our own movement that when we *see* it in the double, we *see* ourselves – so much so that we believe a digital representation to be an extension of us?! Is it just that when we engage with the double, we see it responding to us like a mirrored reflection? Perhaps.

How is it then that when I run Moov's playback system, using data extracted from an individual's movement, that individual can still distinguish her self from others? Motion seems to be a form of vision. The act of moving is seeing by doing, and the seeing is done with the body.

Further, I have noticed the strangest phenomenon in my physicality. When moving my arms as I describe Moov to people, I feel physical sensations in my body and I visually recall playing with Moov. It is whole-body perception recall.

The implications are big. Moov, by scaffolding emergent play between two people in relationships, has the potential to allow people to create play that is "ours". Since it is play that emerges from two people exploring together in a shared context, it is play that strengthens relationships, signifying them as different and special from all other relationships. Factoring in movement, if motion is vision that physically imprints on our being, then Moov

has the potential to allow for significant, shared play experiences that not are not only imprinted in our minds, and in our relationships - they are imprinted in our bodies.

The potential is exhilarating.

7 Conclusions

Reflecting on the long journey this project took, I feel like it was almost beyond the scope of a Master's-level thesis. It might best have been divided into two projects. The first would have been devoted to researching all the theoretical frameworks. The second would have been devoted solely to rapid prototyping.

I say this for several reasons. First, while a large portion of my readings added to my personal knowledge bank, and perhaps influenced this project in ways I cannot yet see, only a small portion ended up driving my designs. Secondly, the activities that proved the most informative overall were the prototyping and user play testing sessions. I would like to see where a year devoted solely to those activities would take Moov.

Within prototyping, I believe that while my testing revealed some potentially powerful results, I have really only scratched the surface. Evidence has shown that the emergent play model works. Two people, placed in a minimal digital environment and given some basic tools, will create play together. However, I have not nailed down so many of the surrounding questions, like: how does this happen? What motivates it? If you substituted X component in the model with Y, would it produce with certainty result Z? What Moov has represented at this stage is a large step forward into a much larger project. Given my passion for it, that's probably a good thing.

In terms of specific conclusions based on the results of the study, I have only a few. First, the digital double relationship that Dixon describes is very real. Two, the empathetic response that it activates in us is real too – and movement is the key. Three, paired play creation isn't something you design – you design to allow it to happen.

There is still so very much more to explore.

8 Future Work

In terms of the short-term horizon, I would like to turn Moov into a commercial project. I believe that once the prototypes have been fleshed out further, Moov can offer a unique approach to connective play. My biggest goal in this domain is to give this connectivity to a lot of people – to help them bond with each other in new ways, and also just to smile together. At minimum, to achieve a commercial project, the prototypes need to be tested with more users to determine which ones are most effective, and perhaps, creating additional prototypes. The envisioned product is one in which players can pick the type of representations and the types of effects they want to use, thereby choosing a particular theme of play creation, i.e. using the bubble representation to create dot shape play.

Going forward, I would like to extend the core system to offer customization and extensibility to end users. For example, I would like to offer people tools to customize player representations to enable them to express more of their "alter egos". Or, perhaps there are types of effects that players want to create with partners that are not present in the system. Since Moov is a system that allows people to create play together, continued work with end users is required to give them tools they need to create the play they want to create.

On the commercial level, I would like to investigate adapting Moov so that two non-co-located players could have a similar experience. For instance, I see potential in adapting

it so that parents that are separated from their children for various reasons can create play (with a touch/sensorial component) together.

On the purely research level, I would like to use Moov to investigate deeply motion-based play creation in relationships. Questions I would pursue include: what are the emotional needs and/or relationship dynamics driving the play (and the movements themselves); how is motion serving as a communication tool within the dynamic; how does the representation of two players in co-creative play affect their concepts of their relationship (short-term and long-term); what sort of physiological changes are occurring in the body during Moov play?

I would also like to further investigate our relationship with motion, specifically the dimension in which it imprints our physicality. Also, as in phase 4 explorations above, why do we feel such affection for our past movements? How does blending them with current movements affect our perceptions?

Furthermore, I believe there are potential therapeutic applications of Moov in the long-term. A few examples include: helping people in long-term relationships rediscover play; helping trauma sufferers imprint positivity into their bodies (or unlock the old); helping people with body issues learn to love their bodies through motion-play via the digital double.

Imagining the potential is incredibly exciting! But what I find so beautiful is the process at the core of it all - the thing that sparked the project from the very beginning - two bodies in motion, together, creating play.

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