Digital + Physical: Rethinking the Playground

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Figure 1. Line drawing of Funky Bars (opposite)
Digital + Physical: Rethinking the Playground

Abstract

The increasing presence of digital play experiences has become an undeniable part of many children’s lives. These digital experiences have begun to rival traditional physical play. Even with the introduction of the Nintendo Wii digital and physical rarely cross paths. This masters thesis investigates the design of a play experience that embraces digital experience through the combination of handheld wireless technology and playground experiences. The combination of these elements aims to create a play experience that provides the physical and imaginative aspects of traditional play while utilizing the personal, communication, social, competitive, and graphical informational properties of wireless handheld devices. This thesis documents the research, conceptualization and final development of the Funky Bars and Whirly Bird playground pieces.

William Benjamin Montgomery Tew
Figure 2. Line drawing of Whirly Bird (opposite)
“Keep away from those who try to belittle your ambitions. Small people always do that, but the really great make you believe you can too become great.”

-Mark Twain

I dedicate this book to all my family, friends and teachers along the way. Without a doubt it would have been impossible to be where I am right now without a single one of them.

I love you all!
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In recent decades digital play has become a large part of children’s lives and in many ways has begun to rival traditional physical play experiences. According to documents issued by the United States Census Bureau (2008) household video game usage has increased from 65 hours per year per person in 2000 to 73 hours per year per person in 2005 and is projected to reach 86 hours by 2010. Additionally, household internet usage has increased from 100 hours per year in 2000 to 172 hours per year in 2005 with projections of 183 hours in 2010.

These digital experiences, in the form of video games and the internet, are increasing in variety and availability. The majority require little movement and lack any of the health benefits of traditional physical play.

Physical play requires little more than space and imagination, but struggles to compete with the endless varieties of pre-imagined video game scenarios that children can choose from.

It is the juxtaposition of these two types of experiences that underpins this investigation: How might Digital + Physical inform each other and create a playground experience that provides outdoor physical activity while still maintaining pace with the digital experiences children have become enjoy so much?
The variety of digital and physical play experiences are seemingly endless. This thesis has focused on a few areas of interest in the realms of digital and physical play.

There are numerous topics in the field of child psychology that relate to play and this investigation has focused on a specific few. The concepts of age specific play and types of play were the initial areas studied to gain an understanding of children on the playground.

This section covers the areas of physical and digital play that have been researched and how they began to influence the design process.
Digital + Physical: Rethinking the Playground

Physical and Digital Play

Since the introduction of the first video game the industry has grown into a 32.6 billion dollar industry that is projected to reach 65.9 billion dollars by 2011 (Maragos, 2006). Digital forms of entertainment and media have become a ubiquitous part of a child's life and serve as a large part of the way children receive information. For the purposes of this thesis there are three entities of particular interest: console based gaming, handheld based gaming and the internet.

Console based gaming requires an external screen and uses a handheld controller interface. These gaming experiences tend to be more social when playing games that allow for multiple players. They provide little reason for movement from the seated position and keep the child engaged with the screen a majority of the time. Although, recently Nintendo has introduced the Nintendo Wii (seen on the opposite page in figure 6), a console that utilizes motion detection in its controllers to allow for physical movement of the controller to be translated into movement or input within the game on the screen. Tactile and auditory feedback are provided on each controller, which relate directly to the actions on the screen. For example, during a tennis video game the player will swing the controller, much like a tennis racquet and the character will do the same, upon impact with the ball the controller will vibrate and make a sound to simulate hitting the ball. This form of game provides an aerobic and multi-sensory experience, but still relies on interaction with imagery on the screen.

Handheld gaming systems provide a more solitary form of digital entertainment, but in recent years Nintendo has taken advantage of short range wireless technology to create a handheld system that has much more social capabilities. The Nintendo DS seen above uses short range wireless technology to provide children the ability to communicate interact with each other over a wireless connection. A less obvious example of this technology is that children no longer pass notes in class but send each other messages on their Nintendo DS’s. Handheld gaming systems may allow for slightly more movement but it is usually related to the handheld’s inherent portability.

Figure 5. Image of Nintendo DS
The internet is seemingly infinite and provides numerous sources of information for children along with the ability to communicate with others from around the world. The internet provides social interaction between peers and for the exchange of information.

One example of literally thousands is http://kids.nationalgeographic.com. This web site serves as a supplement to the publication National Geographic Kids. It is a site with numerous sources of information on the natural world ranging from articles, videos, games, stories, photo’s etc. Children are also able to customize their own home page once registered. This allows the children to communicate through e-mail to their friends about what they have found on the web site. It is a great resource that is continually updated providing children with hours of entertainment and learning.

A resource like this has proven itself highly effective and is simply cannot be ignored. When considering the huge range of abilities of the three chosen entities It is the motion detection abilities of the Nintendo Wii, the wireless abilities of the Nintendo DS and the expansive information relaying abilities of the internet that are the most interesting and may mesh well with the development of a digital wireless play experience.
In order to effectively combine the digital and physical it was important to research how play evolves as children grow.

Methods of play change and develop as children grow. There are distinct differences in the types of play and it is important to address them. Children between the ages of 3-6 years are beginning to develop social skills and are developing these skills through group play. This grouping of children enjoys a more abstract form of play that involves their imagination and interaction with objects such as tables, benches and moveable objects. According to Carles Broto “From age 6 to 8 children gravitate toward activities which involve motion and action; activities that develop both organizational and physical skills.” Children in this group are drawn to activities that test their physical dexterity and enjoy activities such as climbing nets and other features that utilize their developing motor skills. From 8-10 years old children like to play in isolated groups with out interference from adults or younger children (Broto). “Structured games with objective play rules played in groups or teams tend to predominate this age.” (Broto, 2006, p.A-6). These varying interests on the playground require successful designs to incorporate features that entertain all age groups.

The structured nature of digital experiences and the type of play at that age suggests that the 8-10 age group would be the most appropriate.
Digital + Physical: Rethinking the Playground

3-6 Years
- Abstract play
- Imagination
- Interaction with objects

6-8 Years
- Motion and action
- Organizational skills
- Developing motor skills

8-10 Years
- Structured games
- Objective play rules
- Isolated from younger children

Figure 9. Sketches of children at play
Types of Play

There are many types of play and According to Tai, Haque, McLellan, & Knight (2006):

some play, such as games of make-believe and role play, investigative play such as exploration of nature, develops the mind of a child and expands the thought processes. Other play is more active, and directly effects a child’s development of motor skills and physical fitness. Yet another kind of play is the controlled and deliberate release of feeling, and expression of self, such as drawing a picture or making any unique and artistic object. Each type of play contributes to a child’s education. (p. 28)

This might suggest that children’s play can be put into rough categories of imaginative, explorative, physical, and creative. Additionally, social play and solitary play have their place on the playground. Social play involves chasing hiding, and role playing with other children while solitary play provides the child with time to themselves to reflect (Broto, 2006 p. A-7).

With all of these types of play in mind this thesis focused on physical play and social play. Physical play is the basis of all outdoor activity, while social will lend itself better to the capabilities of digital play.

Figure 10. Sketches of children participating in different types of play
Digital + Physical: Rethinking the Playground

Physical and Digital Play

Creative Play

Social Play

Physical Play
Figure 11. Image of one year's worth of sketching.
The concept development process as a whole is cyclical but for the purposes of this book it has been broken down into two phases. The initial phase covers the convergent part of the design process while the secondary phase becomes more divergent.

Phase one includes extensive concept development sketching along with experimental work with the concept of sketching in 3D. The concept development work in phase one served to lay the ground work for the interaction of the Digital + Physical.
The initial phase of concept generation was sparked by the use of a verb list and a grouping of people list. These words were derived through brainstorming about what activities children participate in on the playground. One or two verbs were chosen along with a grouping of people. This group of words was then the inspiration for the creation of a playground piece. Concept development explored the various ways that digital and physical play experiences could be combined or interact with each other. The majority of initial concepts were purely physical but as the drawings progressed the concepts began to utilize the abilities of short range wireless.

**Verb List**

run, jump, spin, climb, twist, twirl, shake, swing, bounce, slide, rock, push, roll, spin, hang, crawl, crouch, reach, bend, balance, grip, hug, step, hop, skip up, down, around, hide, seek, daydream.

alone, with one friend, versus one friend, with two friends, versus two friends, with three friends, versus three friends, with group, versus group, with parents, versus parents, with differently abled.
The spinning platform pillars allow children to create a play surface that changes as they rotate the platforms up and down the threaded towers.

Figure 12. Sketch of spinning platforms
The twist and swing is a multi-child activity that allows children to twist the center of the flexible swing upright and move friends around in an irregular swinging pattern.

Figure 13. Sketch of twist and swing
Large colorful hard plastic spheres are grouped to create a structure that children can climb on and around.

Figure 14. Sketch of climbing spheres
This two piece roto-molded polyethylene slide includes an integrated staircase, embedded rollers and a tunnel that passes under the slide platform. The embedded rollers provide an interesting tactile sensation when traveling down the slide.

Figure 15. Sketch of roller slide
The rock and hang provides children with the challenge of climbing across a net suspended above their heads. The challenge increases as the structure begins to rock with increasing activity from other children.
Children swing around the perimeter of this corkscrew-like structure and experience outward motion while moving towards the ground. It can be ridden both up and down the corkscrew.
The tangled slides give users an opportunity to slide together by beginning their journey down the slide at the same elevation but on separate slides.

Figure 18. Sketch of tangled slides
The rock and slide allows children to use leverage to adjust the angle on a slippery surface and rock their friends back and forth.

Figure 19. Sketch of rock and slide
The cane climbers allow users to adjust the light green steps and change the climbing surfaces between all of the canes. The tops of the canes have cross bars that users can hang from and use to climb between canes.

Figure 20. Sketch of cane climbers
Crawling paths allow children to climb all around and through a cylindrical structure.

Figure 21 Sketch of crawling paths
This monkey bar-like piece allows children to hang from an overhead structure and traverse it by using the moveable rings.

Figure 22. Sketch of Funky Bars
This second iteration works on a similar principle as the predecessor; but now includes notches for the rings. The structure has more notches than rings, allowing the children to change the climbing pattern.
The third iteration works similarly to the previous, but uses externally mounted components to create the notches for the rings.

Figure 24. Sketch of Funky Bars 3

hang, climb, alone (3)
This wireless playground is a simple scenario of how a child or group of children might interact with a handheld wireless device and a playground's surface.
This second iteration outlines how children might interact with a handheld wireless device, and some of the games that could be played.
The third iteration further outlines how a child might use the Nintendo DS handheld gaming system to interact with a more complex playground system.
The final iteration is a combination of the previous three that provides for a playground experience with interactive play opportunities on multiple surfaces.

Figure 28. Sketch of wireless playground 4
In addition to traditional 2-D sketching methods of concept development the use of “3-D sketching” was employed to explore the possibilities of the use of 3D fuse deposition modeling to create conceptual play environments that express kinetic or potential energy. This study hoped to use the tactile nature of 3D printed parts to create play structures while utilizing the geometric accuracy of the 3D printing process. Additionally, the study aimed to create physical structures that are not limited by the confines of mate relations of a computer modeling program.
Evolution 1

The initial evolution of the play structure was inspired by the theoretical orbits of electrons around atoms along with the clustering of protons in the nucleus of an atom. The spherical clusters are able to connect to the orbits in an infinite number of positions. The curved structural members create a feeling of movement as they flow through the connectors and each member curves in a different direction. The initial evolution contains both aspects of kinetic and potential energy. The sweeping curves imply movement while their upright arrangement implies the potential energy stored within a structure.
The connector used in Evolution 1 did not attach as effectively to the members as expected and this led to a change in form in the connector to better grip the structural members. The arrangement in the bottom image is a representation of the energy present in skipping a flat stone on water. The top right image configures the parts to represent the gain of potential energy through the compression of a spring. The top left image is derived from trailing vortices in airfoil shapes such as fans or wings. Despite its ability to be infinitely configured, structural issues in the connection points existed.
Evolution 3

The final evolution responded to the previous evolution’s structural issues at the connection point by increasing the contact surface area between mating parts. The new structural member utilizes a notched surface that allows for a better fit with the connector. Due to the constraints present in the notched surface new structural segments were introduced to increase the configuration possibilities. The new shapes were formulated to give a greater range of structural possibilities and allow for more expansive configurations. The new forms began to be more organic and complex, and give way to notions of plant structures.

Figure 34. Sketches of evolution 3
Figure 35. Images of evolution 3
The representation of forces in the final evolution begin to speak more to the complexities in nature. When viewed from the point of view of the inhabitant they seem kinetic and chaotic and when viewed from afar the rigidity of the structure is evident. One might begin to make analogies with a jungle where internal forces are constantly reacting, when viewed closely always moving and changing. When viewed from a distance its complex and immense nature emphasizes its permanence and strength.
Findings

The creation of these forms with the fuse deposition modeler was one of trial and error. The three forms shown above were ones that did not take well to the fuse deposition modeling process. The main criteria for the scale of the models was driven by the number of parts to be produced. The parts in the top right image had issues with the limited tolerances of the fuse deposition modeler. The connectors in the second image were too complex for the machine to print and resulted in an entire tray of failed models. The connectors in the third image went beyond the limits of the modeling capacity in terms of creating snap fit parts. Overall these experiences helped expose the limits of using a fuse deposition modeling machine at such a small scale.
Overall this was an informative study in discovering the limits of the fuse deposition modeling machine when creating scaled environments. The printing resolution of the machine does not allow for adequate performance when creating small scale snap-fit parts. The original intention was to use these pieces to create environments that were not limited by the constrictions of the 3D modeling software but the end result was that the capabilities of the fuse deposition modeler became the limiting factor. Design evolutions became more influence by the abilities of the machine rather than the impact of the designs themselves.

Figure 38. Image of 3D print parts
The previous research served to lay the groundwork for the Design Out Loud Research Study. This user research study was developed with assistance from Dr. Cornelia Brunner, Director of the Center for Children and Technology. With her assistance Design Out Loud was developed to connect with the 8-10 year old user group and determine their desires in playground play.
The activities children can engage in on a playground vary greatly and are seemingly endless. Design Out Loud aimed to discover what children like to do on the playground and what they wish they could do by asking them to design a playground of the future. Additionally, the children were introduced to design concepts that had begun to integrate wireless video gaming. In two separate studies a group of boys and a group of girls participated in a video-taped session where they were asked to create blue prints for the playground of the future and were presented playground equipment concepts.

Participants
The research subjects of this study consisted of 3 eight year old boys and 2 ten year old girls. All children attend a local elementary school.

Research Instrument
Design Out Loud was a two part study consisting of an initial drawing and interview session followed by a presentation of playground concepts and interview. Design Out Loud aimed to gain knowledge about the following aspects of children’s time on the playground.

(i) What children like to do on the playground.
(ii) What children wish they could do on the playground.
(iii) How children might interact with wireless handheld devices on the playground.

Figure 39. Image of children drawing during Design Out Loud
Design Out Loud

Instrument I

Design Out Loud began with a creative activity where the children were presented with the design brief seen on the right.

The children were encouraged to “Design Out Loud” by talking about what they were drawing. The following list of questions were used to incite conversation about their drawings and were again asked at the end of the study.

1. What is the name of your playground of the future?
2. What do you do on this playground?
3. What kind of activities are there on your playground?
4. What are the names of these activities?
5. How do these activities work?
6. What do you like best about this playground?
Part Concept Presentation Interview

1. Would you like to play on a playground like this?
2. What else might you like to do on a playground that works with your Nintendo DS?
3. Would you like to add anything to this design?

Figure 42. Concept sketch that was presented to children
Figure 43. Image of document used in Design Out Loud
Design Out Loud

Designs

The following section presents the participants’ designs and provides a piece of commentary from the participants regarding what they were designing, out loud. Included in each page are icons that represent activities, which were important to the participants. These icons and their significance are outlined below. The names of the children have been changed to protect their identity.

![Figure 44. Graphic of activities found in children’s drawings](image-url)
“You get to go on one of those things when you spin around in circles and it's kinda like a maze”

![Figure 45. George's playground of the future drawing](image)

**Weird Park**

“George”
8 years old
Local elementary school student
Design Method: rock back and forth, draw up an idea, run around room, repeat.

![Image of George's drawing](image)
Hall of Imagination

“Natalya”
10 years old
Local elementary school student
Design Method: diligent worker and enjoyed talking about her designs.

“Hall of imagination... It can be anything you imagine...like a hairy guy with a bunch of chocolate pudding...”
“well you just like climb up a ladder then you jump onto another ladder then you go up another ladder.”

Figure 47. Ethan’s Playground of the future drawing
Cactus Park

“Bianca”
10 years old
Local elementary school student
Design Method: Shy but had a great range of ideas for the playground of the future.

Figure 48. Bianca’s drawing of the playground of the future
“find a thing called a smash ball when you break it. You can have one of four powers it depends on your personality.”

Figure 49. Clark's drawing of the playground of the future

**My Park**

“Clark”  
10 years old  
Local elementary school student  
Design Method: diligent worker, provided much details of his designs which closely paralleled his favorite video games.
Instrument Use
The instruments were implemented in a private classroom at the school of Architecture. The subjects were separated by gender and tested as a group on separate occasions. This was done to ensure that the other party did not effect the data gathered from one group due to fear of judgement from the other. A parent of one of the children was present at each time of instrument use.

Analysis
Interviews were transcribed and video data was evaluated soon after the studies were conducted. The video data was viewed and attention was paid to the details of the children’s responses to the ongoing interview questions.

Findings
The areas of interest in children’s video game usage discussed earlier and their responses to those inquiries are described here. The specific relevance of each area is explained at the beginning of each section.

(i) What children like to do on the playground.
In order to obtain a general knowledge of children’s preferences in playground activities the drawing exercise and interview questions were kept simple to allow for the children to answer freely and to encourage creativity.

When examining the children’s drawings and considering how these could inform what children like to do on the playground there were two from the group that detailed the physical activities they prefer they to participate in currently. **Weird Park** provided insight into the way that subject liked to travel around the playground. Its maze like quality suggest that the subject likes the activities spread out. The creator of weird park proclaimed that “You get to go on one of those things when you spin around in circles and its kinda like a maze.” This subjects drawings and thoughts on **Weird Park** suggest that he was much more interested in a fast...
moving play with many activities such as spinning in circles and running through a maze. The second drawing of interest was named **A Park! Thingamabob**. The main focus of this park was climbing and jumping. This subject's design had quite a few ladders and required the user to jump from ladder to ladder while at great heights above the playground surface. The designer of **A Park! Thingamabob** supported this with his explanation of what one does in the park: “well you just like climb up a ladder then you jump onto another ladder then you go up another ladder.”

(ii) What children wish they could do on the playground
A few of the children had more futuristic ideas for playground that reached further into what they wish they were able to do as opposed to what they already do just on a larger scale. One of the subject's playground design had direct references to one of their favorite video games and took names and characters directly from it. This did prove useful though as the child expressed a desire for a way to express qualitative aspects of his playground experience: “find a thing called a smash ball when you break it You can have one of four powers it depends on your personality.” This quote suggest that this user would like a way to differentiate himself and customize his playground. One of the final drawings of interest had the most digital presence out of all the designs. This subject's drawing **Hall of Imagination** this subject's playground contained a feature called the “Hall of imagination... It can be anything you imagine...like a hairy guy with a bunch of chocolate pudding...” These ideas were the most futuristic and implied the ability to use your imagination to create whatever environment you wanted.
Design Out Loud

How children might interact with wireless handheld devices on the playground

The final part of the study involved presenting the concept seen previously during discussion of instrument 2, discussing it and then asking a few interview questions. The concept was well received with the children in its purely physical form and the introduction of the digital aspects sparked even more interest. When the groups were asked to consider what else they might like to do with their Nintendo DS on the playground issue of tactile feedback was one of the first to be mentioned “...it moves with you and when you go down it goes wrrrrrrrrh...” this indicated that the subject wanted their digital experience to sense their motion and respond to it through sound. Another issue of great importance brought up by one of the subjects was the ability for those without a Nintendo DS to participate. Ideas of sharing with friends and possibly being able to rent a DS were brought up. It was suggested that there be “Nintendo DS’s in a Basket... Like 3-D goggles”. This idea is likely to have stemmed from the baskets of 3D glasses at the beginning of 3D movie rides at amusement parks.
Discussion
The key findings from Design Out Loud were that this particular group of children enjoyed spinning, climbing, and a journey as part of their play experiences. In terms of what children wish they could do on the playground it was suggested that there be more customized qualitative aspects. These aspects would provide children with a more personal playground experience. On the far end of the digital world it was suggested that one be able to imagine anything they wanted. The children responded very well to the presented concepts and from their responses and the discussion a desire for tactile feedback and a reduction in the level of technology became evident.

Design Opportunities
The findings from Design Out Loud have helped reveal what playground opportunities this group of children prefers and how to better introduce digital aspects to that experience. In terms of pure physical activities climbing spinning and running activities have become the main focus. An overall simplification of the digital interface to allow for more to participate and the utilization of tactile feedback versus visual feedback through screen based interface were the resulting design directions for the digital aspects.
With the concept work from the first phase and the information gathered from *Design Out Loud* a second phase of concept development began.

There were several key factors that were to drive the new phase of concept development. The physical preferences of the journey, climbing, jumping and spinning were chosen as the physical aspects to drive the design. The idea of a journey influenced the choice of site. Feedback from *Design Out Loud* regarding visual feedback, motion detection, imagination and sharing of technology caused a large shift in the role of wireless technology.
Shift in Technology

The Nintendo DS was the initial focus for the wireless device. After considering that not all children have access to a Nintendo DS, the design direction of the wireless device shifted. Further, Nintendo DS was designed such that the user would be stationary and does not lend itself well to movement or interaction during movement. This lead to ideation about what form might be best for a child while interacting in a physical environment.

Figure 52. Concept sketches of RFID wristband
Concept development quickly narrowed in on a RFID wristband as the most effective form for the digital experience. The wristband size lends itself much better to movement. In departing from the complex forms of feedback embodied in the Nintendo DS, the wristband relies solely on motion detection and visual feedback through light. Communication with the playground is achieved through RFID tags and miniature wireless transmitters.
Prototype: RFID Wristband

In order to address issues of scale and material rough prototypes were made of the wristbands. Prototypes were roughly designed in 3D modeling software and 3D printed. These pieces then served to create a plaster mold that silicone was poured into. This created a flexible prototype that could be wrapped around the wrist. Initial prototypes were too small and the scale would not have been able to accommodate the electronics required. The silicone material was too flexible a material and lead to the choice of a harder thermoplastic polyurethane.

Figure 53. Images of RFID wristband prototypes
Figure 54. Images of RFID wristband prototypes
Wristband RFID Communication

The wristbands provide feedback to the children about their playground activity through a series of illuminating LEDs. In addition to the unique RFID in each wristband, there is a wireless transmitter that participates in the data flow cycle diagramed below.

![Diagram of wristband RFID communication.](image)

- Unique RFID in wristband tag recognized by playground activity.
- Feedback about activities transmitted to wireless transmitter in wristband.
- Feedback through increasing light activity.
With varying data relaying needs it was necessary to utilize two wireless technologies to communicate effectively. The first technology would be Radio Frequency Identification which would uniquely identify the child’s presence at particular points. The wireless device would be equipped with a non powered RFID chip that would respond to signal sent out from a large range RFID reader. An example of the scale of such a technology is seen on the left in figure 56. These technologies are tiny, inexpensive and ubiquitous.

The second technology would be a short range wireless system much like that in the nintendo DS. This system would be responsible for relaying RFID information back to the wireless device that would then result in feedback given through the wireless device.

Figure 56. Image of RFID tag.
Funky Bars

The first of two physical play elements to be further pursued were the set of monkey bars shown to the children during the Design Out Loud research study. This concept was well received by the children but was in need of further development. The initial cross member would have been difficult to manufacture and did not utilize the most effective manufacturing methods.
The **Funky Bars** are the final design for the element that embodies the climbing aspects that the children voiced during the *Design Out Loud* study. The Funky Bars utilize glue laminate uprights and a bent tubular steel construction. The Funky Bars interact with the wristband at each hand hold by recognizing the presence of the wristband through the RFID technology covered earlier.
**Whirly Bird**

In response to the children’s desire to spin the *Whirly Bird* was pursued. The Whirly Bird allows for children to spin around the structure while approaching the ground plane. It also provides a repeatable activity that can integrate well with the wristbands.

Figure 58. Sketches of Whirly Bird
The final iteration of the **Whirly Bird** has evolved to incorporate a rigid structural member to prevent the children from swinging back into the structure. It also utilizes glue laminated uprights for support. Three rings are provided for multiple holding configurations. The whirly bird interacts with the wristband by communicating information about the child's trip down the spiral.
Prototype: **Whirly Bird**

With the proposal of the very dynamic action of the **Whirly Bird** it was important to construct a proof of concept prototype. This prototype would allow for testing of the swinging action and to test the strength of material proposed. The prototype was constructed in the school metal shop and the final prototype was installed in a friend's backyard.

Figure 59. Images of Whirly Bird prototyping process.
There were a few key results from the testing of the prototype. The action of swinging around the spiral did not function as participated and was rather ungraceful. The results of the swinging action brought about the second key part of testing. The whirly bird prototype was actually quite dangerous and resulted in the user swinging back into the structure. This action had been anticipated but not to the degree it actually occurred. Even with the functional results being undesirable the most positive result was the validation of the strength of material. The structure was quite stable and the cantilevered elements withstood the load of myself and another adult male.

Prototype: Whirly Bird

Figure 61. Image of adults hanging from structure to demonstrate the strength of material
Siting The Experience

With the idea of a journey occurring in almost all of the children’s drawings it became evident that the space the activities were to occupy needed to evolve beyond a flat plane. The Huckleberry Trail in Blacksburg Virginia was chosen as the theoretical site for this journey. The Huckleberry Trail is a 5.76 mile trail that connects the town of Blacksburg and Christiansburg. The initial mile of the Huckleberry trial on the Blacksburg side is set just behind a residential area easily accessible to children and adults. This area is heavily wooded and provides for a safe place for a journey for children with its proximity to the community. The Blacksburg Public library is also situated at the trail head and would serve as a place for borrowing of wireless devices to be used upon this journey.
Quick concept sketches were made to display how the Whirly Bird and Funky Bars might stand in relation to the trail and also to each other. The placement of the pieces aimed to create a fluid flow between the two based on the movement of the children playing on them.
Flow of the Journey

The introduction of the journey as part of the playground experience and the simplification of the level of wireless interaction resulted in the creation of a flow for how the child and data flows through out the experience.

The digital experience was simplified to a wristband system that provides increasing illuminated feedback about their activities. The wristband was developed further to react specifically to the children’s journey, climbing, and spinning activity. This feedback information is then uploaded to a web site that tracks their activity on the playground.

Figure 64 Diagram of types of wristbands
Figure 65. Diagram of wireless journey along the trail (opposite)
Funky Bars

Whirly Bird

Future Activity

User with Wristbands

Data flow

Journey
The following section presents the final proposed design that resulted from the investigation into: How might digital and physical play inform each other and create a playground experience that provides outdoor physical activity while still maintaining pace with the digital experiences children have become enjoy so much?
Digital + Physical: Rethinking the Playground
Final Proposed Design
Digital + Physical: Rethinking the Playground

Final Proposed Design
RFID Wristband

The wristband was developed as the means for integrating digital play into the purely physical on the playground. It sends and receives data about play activity and provides feedback to the children about their playground experience. The wristband is a simple means to provide children with the digital feedback they find in many of their more advanced digital experiences while maintaining a form that lends itself to movement and does not interfere with pure play.
Figure 68. Solidworks renderings of RFID wristband
Wristband Features

1. On/Off
2. Thermoplastic polyurethane construction
3. Key ring attachment
4. Clasping action
5. Magnetic clasp
6. Journey wristband
7. Spinning wristband
8. Climbing wristband
Wristband Experience

1. Arrive at beginning of trail. Wristbands activate upon arrival and display total score.

2. Play mode is activated by pressing sun button twice.

3. Pick a place to start playing.

4. Go on a journey, spin, and climb to elevate play activity level on wristbands.

5. Once play activity has filled up the user receives a one large play point of light on their total score.

6. User continues to play increasing play activity level until fills up again resulting in an additional large play point of light on their total score.


8. Finishing playing and head home.

9. Upload Play Points to web site.

Figure 69. Storyboard of use for RFID wristband
4. Go on a journey, spin, and climb to elevate play activity level on wristbands.

5. Once play activity has filled up the user receives a one large play point of light on their total score.

6. User continues to play increasing play activity level until fills up again resulting in an additional large play point of light on their total score.

8. Finishing playing and head home.

9. Upload Play Points to web site.
Web Site Experience

The web site serves to tie together the digital and physical experiences and provide a means to share the experience with friends. As the children journey to, spin and climb on the **Whirly Bird** and **Funky Bars** points of light are tallied. One full bracelet of light activity translates into one large play point. These play points along with information about their achievements on the Funky Bars and Whirly Bird are then uploaded to a web site. The child can personalize their own page and view their play points along with their friends.

Figure 70. Diagram of wristband communication with web site
Figure 71. Screen shot of web site page
Digital Playground!
Huckleberry Trail, Blacksburg VA

Whirly Bird
Stats:
Number of Rides: 34
Revolutions: 725
Hang Time: 3hrs 12min
Longest Spin 47 seconds

One play point on web site
Wristband Communication Diagram

Feedback about activities transmitted to wireless transmitter in wristband.

LED clusters light up and provide feedback.

Unique RFID tag recognized by playground activity.

Figure 72. Diagram of wireless communication
Figure 73. Dimension drawings of RFID wristband

Wristband Dimensions

Units: Inches
Funky Bars

The **Funky Bars** are a funky twist on the traditional monkey bars. Rings rest along an undulating steel cross member. These rings are free to move along the bar increasing the challenge of crossing and the methods of crossing. The simple galvanized steel and cedar laminate construction blends well into its organic environment along the trail.

Figure 74. Solidworks + Photoshop rendering of Funky Bars (opposite)
1. Enter Funky Bars activity zone and wristband activates.
2. Climbing wristband blinks twice to indicate you are in the Funky Bars activity zone.
3. Once on Funky Bars platform individual RFID tag is recognized.
4. While traversing the rings information is collected about the trip across.
5. Each ring point has an interaction point that has an individual RFID antennae that records the presence of the unique RFID chip in the wristband.
6. Information from each interaction point is then transmitted to the main computer in the funky bars which then sends wireless signals to the wristbands causing them to light up and show achievement.
7. Information about your time to cross the funky bars, number of hand holds used and times crossed are what increase the number of lights illuminated.
8. Compare with friends.
9. Try again or choose another activity.

Figure 75. Storyboard of use for Funky Bars
1. Enter Funky Bars activity zone and wristband activates.

2. Climbing wristband blinks twice to indicate you are in the Funky Bars activity zone.

3. Once on Funky Bars platform individual RFID tag is recognized.

4. While traversing the rings information is collected about the trip across.

5. Each ring point has an interaction point that has an individual RFID antennae that records the presence of the unique RFID chip in the wristband.

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7. Information about your time to cross the funky bars, number of hand holds used and times crossed are what increase the number of lights illuminated.

8. Compare with friends.

9. Try again or choose another activity.
**Funky Bars**

Components

1. Galvanized mandrel bent 2” OD steel tubing
2. Cast aluminum ring
3. Thermoplastic elastomer ring handle
4. Exterior grade plywood steps
5. Cedar glue laminate

Figure 76. Solidworks renderings of Funky Bars
Funky Bars Dimensions

Figure 77. Dimension drawings of Funky Bars
Finite Element Analysis

The main climbing structure of the *Funky Bars* consists of long mandrel bent piece of steel tubing. Due to the length of this member and the loading that it would have to withstand it was important to ensure that a structural member that long was feasible. Using the finite element analysis program Cosmos the cross member was subjected to simulated loads of 200 pounds on the surface area where the climbing rings contacts. This load simulates 11 very large adults hanging on each ring. The simulation indicated that under static loading the center of the cross member would only deflect 0.5 inches. The images to the left display the loading and deflection through out the member. With a minimal deflection of 0.5 inches and a factor of safety of over 5 it would be reasonable to begin prototyping this cross member.
The **Whirly Bird** stemmed from the children’s desire to spin. Children are able to grab one of the rings at the end of the swing arm and spin themselves around the structure. The swing arm rolls along an off axis circle allowing the children to leave the ground. The interior of the structure has two places for other children to sit and watch as their friends spin around them.
Final Proposed Design

I’m Whirly Dizzy

1. Enter Whirly Bird activity zone and wristband activates.
2. Spinning wristband blinks twice to indicate you are in the Whirly Bird activity zone.
3. Once one of the whirly bird rings is grasped individual RFID tag is recognized.
4. While spinning around the Whirly Bird information is collected about the trip around.
5. Each ring point has an interaction point that has an individual RFID antenna that records the presence of the unique RFID chip in the wristband. Additionally the pivot point in the center collects information about the speed of spinning and how long you have ridden without stopping.
6. Information from each interaction point is then transmitted to the main computer in the Whirly Bird which then sends wireless signals to the wristbands causing them to light up and show achievement.
7. Information about your spinning speed, longest spin and total number of revolutions are what increase the number of lights illuminated.
8. Compare with friends.
9. Try again or choose another activity.

Figure 80. Storyboard of use for Whirly Bird.
1. Enter Whirly Bird activity zone and wristband activates.

2. Spinning wristband blinks twice to indicate you are in the Whirly Bird activity zone.

3. Once one of the whirly bird rings is grasped individual RFID tag is recognized.

4. While spinning around the Whirly Bird information is collected about the trip around.

5. Each ring point has an interaction point that has an individual RFID antennae that records the presence of the unique RFID chip in the wristband. Additionally the pivot point in the center collects information about the speed of spinning and how long you have ridden without stopping.

6. Information from each interaction point is then transmitted to the main computer in the Whirly Bird which then sends wireless signals to the wristbands causing them to light up and show achievement.

7. Information about your spinning speed, longest spin and total number of revolutions are what increase the number of lights illuminated.

8. Compare with friends.

9. Try again or choose another activity.
Digital + Physical: Rethinking the Playground

Final Proposed Design
Whirly Bird
Components

1. Galvanized mandrel bent 2”OD steel tubing
2. Swing arm
3. Swing arm circular track
4. Swing arm roller
5. Swing arm pivot
6. Swivel rings
7. Exterior grade plywood seating
8. Cedar glue laminate

Figure 81. Solidworks renderings of the Whirly Bird.
Final Proposed Design
Figure 82. Solidworks + Photoshop Rendering of Whirly Bird
Figure 83. Dimensioned Drawings of Whirly Bird.
Figure 84. Images of 3D printed 1/12 scale model
The majority of the design work for this thesis has been developed through the use of 2D methods. The 1/12 scale model was created to explore the 3D form further and serve to display how the forms of the **Whirly Bird** and **Funky Bars** interact with a designed landscape.

The Whirly Bird and Funky Bars pieces were 3D printed and the landscape was constructed from CNC milled medium density fiber board.
Figure 85. Images of 1/12 scale model
Figure 86. Images of 1/12 scale model Funky Bars
Final Proposed Design
Digital + Physical: Rethinking the Playground

Figure 87. Images of 1/12 scale model of Whirly Bird
Figure 88. Images of 1/12 scale model Funky Bars
Continuing the Journey

Design is a continuing process. The resulting designs from this investigation are merely one direction that the combination of digital and physical play could have taken.

The initial research and direction tried to place equal importance on each the digital and physical but as the design work progressed the physical elements began to dominate.

Through this work it became evident that with time digital play will evolve with technology but physical play may remain the same. As digital technology changes it is important that the play experience remain regardless of the state of technology. It is for that reason that purely physical experiences dominated the digital experiences in this investigation.

Pure play fuels imaginations and provides children with the means to become creative. Imagination and creativity are what fuel design. Creating opportunities for that through pure physical play is what will continue to provide children with the ground work to become designers and innovative problem solvers.

This investigation has only been the very begin-ning of combining the Digital + Physical elements of play. Continuing this journey would absolutely require the design thinking of landscape architects, interaction designers, child psychologists, design researchers and endless others.

It has been said many times and in many different ways: It is not about the destination, but about the journey. It is this designer’s opinion that this applies very well to the design process and that the design of anything is a journey and the most valuable things are what you learn along the way.
Bibliography


Appendix A: Design Out

Loud Drawings
Appendix A: Design Out
Loud Drawings
Appendix A: Design Out
Loud Drawings
Appendix A: Design Out
Loud Drawings
Appendix A: Design Out
Loud Drawings
Appendix A: Design Out
Loud Drawings
Verbal Description of Research

The following activity is going to be used as research for my graduate school project. The information gained from this activity will serve to support the ideas in my project. The activity today is going to involve imagining and creating a playground for the year 2100. You will be given a creative activity for the design of the playground of the future. This design will be created using various makers and paper. During the creation of the ideas the interviewer will be asking you to think out loud about your ideas and explain as you create. After each design is made the interviewer will be asking you a series of questions about your designs. We will be video recording the activities today and it is not necessary to be recorded if you do not wish to be. So, if you would not like to be recorded please let me know and we will turn off the video camera. If at anytime you decide you no longer want to participate you can stop and will not get in trouble. Does anybody have any questions? If you understand the what we will be doing today and would like to participate please let me know by saying “I would like to participate”.

**DESIGN OUT LOUD! Create the Future of Video Games and Playgrounds**
Hi Jr. designers I need your help. Today each of you will be imagining a playground for the year 2100. I would like you to imagine how a playground might be in the year 2100 and create it using the supplies we have on the table. There are no limits, so be creative and don’t be afraid to have wild ideas. On the table are some design supplies that we all can share. Also, in front of each of you is a large sheet of paper. Use this paper to imagine and create the blueprint of the playground of the future. Feel free to use draw as much as you like and label the parts. While you are imagining and creating make sure to think aloud about your ideas. That way we can learn more about it and understand how you would play on the playground of the future!
Appendix D: Design Out Loud playground of the future interview questions

**DESIGN OUT LOUD! Create the Future of Video Games and Playgrounds**

Playground of the future interview

1. What is the name of your playground of the future?

2. What do you do on this playground?

3. What kind of activities are there on your playground?

4. What are the names of these activities?

5. How do these activities work?

6. What do you like best about this playground?
Post Concept Presentation Interview

1. Would you like to play on a playground like this?

2. What else might you like to do on a playground that works with your Nintendo DS?

3. Would you like to add anything to this design?