Cart-Load-O-Fun:
Designing Digital Games for Trams

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Submitted in partial fulfillment for the requirements for the degree of Bachelor of Media and Communication (Honours)

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19.10.2012
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Abstract

This thesis contains work created within a year of the degree Bachelor of Media and Communication (Honours) at the Royal Melbourne Institute of Technology (RMIT), Melbourne, Australia. I start by summarizing my background and my research interests. I then present my thesis “Cart-Load-O-Fun: Designing Digital Games for Public Transport” in the form of a long academic paper. Finally, I present supporting documents that have informed my thesis as well as my overarching research area of interest in the form of papers that I have published along with co-authors throughout the duration of my Honours degree.
**Statement of Authorship**

This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution, and that, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of this thesis.

[Signature]
Acknowledgements

First and foremost, I would like to acknowledge and thank my supervisor Florian ‘Floyd’ Mueller, for all the support, wisdom and knowledge that he has shared with me.

I would like to thank Adrian Miles for dedicating the time and effort to answering many of my questions throughout the year. I would also like to thank my fellow Exertion Games Lab researchers Joshua Platt, Hsin Yang Ho, Eric Dittloff, Anushka De Mel, Wouter Walmink, Danielle Wilde, Sebastiaan Pijnappel, Ruth Sancho Huerga, Gina Moore, Rohit Ashok Khot, Jonathan Marquez, Alan Chatham, Harry Lee, Eberhard Graether, Christopher ‘Kit’ Mackenzie and Christopher Jones, as well as GEElab members Steffen Walz, Marigo Raftopoulos and Chris Berry.

I am very grateful for the partial funding my team and I received to travel to the conference Fun and Games 2012 in Toulouse, France to present our paper and demonstrate our games. Thank you Stefan Greuter, Roberta Mascitti, the RMIT Marketing Team, and the School of Media and Communication for making it happen.

I would like to express my gratitude toward the many designers and researchers from the workshops at the conferences CHI 2012 and Fun and Games 2012 along with the work-in-progress poster discussion at Fun and Games 2012 as well as the many visitors of our lab, who all took their time to give feedback on Cart-Load-O-Fun.

I would also like to thank Ian Stokes and the Yarra Trams team for granting my team permission to use the tram facilities for our project.

And finally I would like to thank my family, relatives and friends for being supportive, understanding and patient with me during my studies.
Foreword

An Honours Journey into Digital Games: Filling in Gaps, Exploring Missed Opportunities and Many Other Crazy Things

During my studies in the past year I have been fortunate enough to work with many talented researchers and designers, travel to Europe and USA to attend and present at prestigious conferences, win awards, appear on TV and newspapers, and publish a fairly large amount of papers. Along the way I made many new friends, played lots of games, had fun and learned new things.

The following few short paragraphs will summarize the goals and intentions I carried throughout my year of Honours. My journey started with the desire of raising awareness and appreciation of games and play. My game design background drives me to create interesting and memorable experiences. At the same time I feel it is extremely hard to achieve this without creating something that sets itself apart from every other game out there, and being a one-man team does not make it any easier. However, I have been fortunate enough to be working with a whole team of designers and researchers in the Exertion Games Lab -my lab- who have been very supportive.

A lot of what we do in the lab involves exploration; we are encouraged to come up with ideas that push boundaries and expectations of what games can be and are capable of. As researchers in the Exertion Games Lab we envision the future of games and create prototypes that capture the essence of our ideas. A lot of the projects we create in the lab revolve around three key areas; technology, the body, and play. We do this to inspire the games industry and gamers to think about the sorts of experiences the future can hold.

Throughout my year of Honours I have had the goal of wanting to raise awareness and appreciation of games and play. I believe games have the power to change, to move, to lift, and to inspire people. I take pride in making unique and memorable experiences that make people smile. However, from a research point of view, the question “How do I raise awareness and appreciation of games?” has always troubled me. How do I make something that will help me achieve this?

Now that I have reached the end of my journey I understand that it is the process and the journey that helps achieve this. Attending conferences, presenting papers, demonstrating games have been great in inspiring people. However, what has been just as good is the interactions with these as a result of this. Interactions with the new people I have met, the experiences I have shared with them, the many games of Ninja and Lemon Jousting, the laughter and the smiles. This is what I wanted to achieve.

What an exciting time to be living in!
Cart-Load-O-Fun
ABSTRACT
Travelling on public transport can often be an unengaging experience. I see an opportunity to enrich the public transport experience by utilizing digital play in this space, and in response explore the design of a digital game for trams. A study of passengers playing the game revealed 3 dimensions for digital games: utilizing the movement of the space, incorporating the social setting, and orchestrating the attention of the player. I present 7 design strategies for designers who aim to facilitate play in public transport, such as trams, evoking playfulness in users of these spaces, ultimately allowing for more engaging experiences.

INTRODUCTION
Digital games have traditionally been confined to arcades and living rooms. However, the advent of recent technologies such as mobile devices allows us to play almost anywhere. Spaces that we consider playful are constantly expanding and becoming blurred with existing spaces (Montola et al., 2009), some examples being city streets (Benford et al., 2006), shopping malls (Mueller et al., 2012), and public transport (Wilson & Korsgaard, 2009). However, one of the problems that game designers face when designing for these new play spaces is the spatial and social expansion into, or the redefining of an existing space, which may lead to conflict in purpose of the space amongst its different users (Montola et al., 2009). Although the existing spaces may have the potential for play they may not be widely accepted as such. I focus specifically on public transport as one example.

In particular, I focus on trams, and notice two key features:

Firstly, the space is populated with people, so there is potential for social interaction, yet this rarely happens between strangers (Hult et al., 2011). Poremba states “the act of playing provides players with an excuse and an alibi to do things that break social norms and push the social boundary as a means of exploring concepts and their benefits, values or worth” (Poremba, 2007). This motivates me to explore social play in this space through a digital game. According to Mandryk and Inkpen’s studies, players rate engagement more highly when playing against another player than against a computer (Mandryk and Inkpen, 2004). I therefore see a design opportunity to alter the social norm or atmosphere of the space by turning the space into one of social play, allowing passengers of the space to engage in play together to create a more engaging commute.

Secondly, the tram is constantly moving and stopping, an intriguing feature of the space and very different to most other play spaces such as living rooms. In particular, I note that people are moving by means of the tram (and are moved by the tram without moving much themselves).

I see these two features not as problems or challenges but as design opportunities. As such, I was inspired to design a game that draws on these two opportunities. I then use this game to study how tram-riders use such a system to play as part of their public transport experience. This study helps me identify design dimensions for digital games for public transport, and articulate design strategies for designers who aim to support passengers with digital play. In result, my work aims to make the public transport experience more engaging.

RELATED WORKS
My research was informed by related work from three key areas: social games in public, performances and play on public transport, and playful systems designed for public transport.

Social Games in Public
StreetPong is a collaborative digital game situated in a city setting that allows two pedestrians at opposite ends of a pedestrian crossing to play a game of Pong by means of a controller that is attached to the walking-sign post while waiting for the traffic light to turn green (Engel & Michel, 2012). I learn from this project that games in urban environments have the
capacity to engage users of the space in social digital play, and that the technology can bring people together in this space.

Colony, a digital interactive art installation, allows passersby to interact with totems by walking through them or using a mobile device to manipulate and play with them (Innocent, 2009). The totems also communicate with one another using light and sound, encouraging users of the space to interact and collaborate. Colony suggests that having an interactive system in an urban environment can draw attention and spark curiosity in passersby through visual and audio, and also facilitate social interactions among users.

Lummoblocks is a public installation designed to evoke collective interaction in an urban environment (Gutiérrez, 2010). Passersby are able to engage in a game of Tetris using their bodies to control the game. Two players are required to play the game. One of the players controls the direction of a falling block while the other rotates it. This work shows that digital games in public spaces can be performative and engage bystanders, creating a crowd.

I felt inspired by these systems, which inform me of design opportunities for social interactions in public contexts through the engagement of multiple people in these games and systems. This is further supported by the fact that gaming is often as much about social interaction, as it is about interaction with the game content (de Kort et al., 2007).

Performances and Play on Public Transport
Goffman states that playing in public creates the chance to take both players and non-players out of their habitual patterns of social engagement, allowing them to escape everyday social roles, demands and conventions (Goffman, 1972). Public performance groups such as Everything Is OK (Shine, 2009) and the Love Police (Veitch, 2011) draw on play in public with their street satires. For example, the two groups board trains with a megaphone and announce the train carriage the “happy carriage” or the “love train”, spreading awareness of playfulness through humor and satire. By performing in a public space like subways, these two groups challenge the perceived expectations of the users of these spaces. Although being public performances rather than games, I learn from these examples that social play on public transport is possible if orchestrated correctly.

Copenhagen Game Collective’s Train Mafia (Wilson & Korsgaard, 2009) is an extension of the folk game Mafia with a modified rule set designed to be played on trains. The game is played simultaneously on two trains. Players split into two teams and all board a train. Losing players are required to leave the train at the next stop and wait for the next train, where the game continues. A moderator is placed on each train to ensure the games run smoothly. This non-digital game demonstrates the potential for public transport space in a playful manner. This is achieved using player’s social skills as a game mechanic on public transport. My work extends this idea to digital games.

Playful Systems Designed for Public Transport
Artist Daniel Disselkoen has created a simple non-digital game for tram passengers called Man-eater (Disselkoen, 2012). Passengers who are sitting on a window seat can place their head against the window, close one eye and move their head up and down to “control” a piranha sticker placed on the window. The goal is to make the piranha ‘eat’ the heads of pedestrians who are walking along the street outside. Man-eater demonstrates simple ways of engaging passengers and creating a playful atmosphere within a tram. I build upon Man-eater and extend the playful interaction as part of the space to the digital realm, while also offering the opportunity for multiple passengers to engage in play together.

The London-based public transport game Chromaroma (Dynamic50, 2010) uses passenger’s Oyster Cards (Transport for London, 2003) to track and record their locations and awards points for completing tasks and missions, such as visiting unexplored locations. Players are able to compete with one another on a national leaderboard. The game is accessed through a mobile device and provides visualizations of the passenger’s travelling routes. I find this to be an interesting way of engaging passengers, and understand that such games do not disturb or intrude on the privacy or comfort of others in the space. However, I believe there is a missed opportunity to incorporate both the passengers and the immediate physical space into play, and allow for the passengers to engage in play together to facilitate more engaging commute experiences.

When it comes to existing digital systems specific to the tram space, the concept system “Strap Game” (Qian, 2007) sits in this design space, as it aims to augment the public transport space with digital systems. Strap Game involves strapping a small display to the handles that passengers hold onto while travelling, allowing them to play existing games like Tetris through tilting the strap and pressing buttons on the strap (Qian, 2007). I am inspired by this idea that handles and bars, which are important parts of commuting, can be augmented to support playful interactions. Unfortunately, this system is only a proposed concept and therefore there are no further insights available on how passengers would engage with such a bar-controlled game.

I place related work on a graph (Figure 2) that depicts the amount of physical and social demand each work asks of its users. Some works such as StreetPong and Lummoblocks are similar to my research, however they are not in a public transport environment and so
they do not offer much knowledge on how to design for public transport.

To conclude, I have learned that there are existing works that explore the relationship between the player, the game and the audience in a public setting, some of these games being digital games, others being non-digital. However, there is yet to be a digital game within a public transport space with a study that can guide designers on how digital games should be designed for this space. This motivates me to answer the research question: How do we design digital games for public transport?

This is challenging because most digital system fall short when it comes to engaging passengers of the public transport space while also allowing for multiple players within the same space to play together at the same time. My solution is to build a new game that acts as a research vehicle to explore the ways in which digital games that incorporate both the physical and social features of the public transport space can enhance the experience of travelling on public transport. The game will allow me to study how passengers play the game within this space to answer the research question stated above.

CART-LOAD-O-FUN
Cart-Load-O-Fun is a two player collaborative game designed for trams. Two players collaborate to control a single character from a top-down third person perspective. One player controls the character’s movement on the x-axis while the other player controls the y-axis. This is done by holding onto the bars that have sensors attached to them and applying force by squeezing. Holding on tighter increases the value that correlates to the x and y position of the character in the game. I chose squeezing the bar as the means for input as passengers already tend to hold onto bars or handles when travelling and grip harder when a tram is accelerating and decelerating.

Players must work together to collect gems that randomly appear in the level, while avoiding enemy characters which bounce around the level (Figure 3). Each gem collected adds two seconds to the timer. The game usually lasts 60 seconds and is score driven. The game is designed to be picked up and left by passengers with ease as it does not contain a story element or any other complex game mechanics that require extensive time to understand. So far, the game only supports two players at a time, however, I can envision a version of the game with additional sensors that support more players at the same time.

Cart-Load-O-Fun uses two force sensors that are connected to a computer running the game via an Arduino Uno with custom firmware (UnoJoy, 2012). The force sensors are attached onto horizontal and vertical bars of the tram that passengers hold while travelling (Figure 4). This setup makes holding onto a bar a game action.

I initially started with using a pico-projector to project the game onto a flat surface in the space (either on the floor or ceiling), but due to sunlight reducing visibility at times, I also used a laptop screen to display the game to the players. However, I can envision future iterations that mount dedicated display monitors above the windows and onto the walls of the tram.

STUDY
I conducted a study to understand how passengers play and experience Cart-Load-O-Fun as a means of gaining knowledge in how games for tram commutes should be designed. For this study, I gained permission from the local tram authority to install Cart-Load-O-Fun in their trams and observe and interview tram-riders.

Participants
A total of 30 participants played my game on the tram, 20 of which were interviewed afterwards. My team of three researchers interacted with over 50 passengers, including players and non-players on the tram, over 7 tram sessions in a period of a month.
Procedure
We boarded the tram as a team of three researchers, each with a specific task assigned to them (interviewer/announcer, observer/note-taker, cameraman). The game ran for the duration that the researchers were on the tram, which was approximately 40 minutes per session. Only one tram per session was used. I used public announcements to a) make passengers aware of the game and our presence (this was also a requirement of the tram authority) and b) invite players to play the game. The passengers that were invited to play the game included those who had just entered the space and those who were already present. Once players were finished playing the game, I asked if they would like to be interviewed, providing that they were over the age of 18 (I focus on adults in this study as per ethics requirements).

Measurements
The researchers observed participants during game play. This was followed up with a brief interview guided by key questions using the laddering technique (Corbridge et al., 1994). All game sessions were recorded on video (with audio), providing that consent from the participant was acquired. These recordings were used for analysis, to seek common themes coming out of the data while also looking out for synergies and anomalies. Each tram session was discussed with my fellow researchers afterwards. Video logs of the discussions and recorded thoughts were kept after each study. These were analyzed along with the recordings of the participants.

Figure 4. Cart-Load-O-Fun on a tram. The sensors attached to the bars are being squeezed and released by a passenger to play the game.

Challenges
Due to the nature of the space in which the research was conducted, there were several challenges that I faced. For example, passengers constantly entering and leaving the space made it challenging to conduct interviews, similar to the challenges O’Hara identified with games in public city squares (O’Hara, 2008). I addressed this by keeping the play time and interviews brief.

FINDINGS
From my studies conducted on trams, I report on the following (F)indings. Common themes have arisen from these findings, thus I group them into three key categories – the digital, the social, and the spatial.

Reactions to the Game (Digital)
(F1) Cart-Load-O-Fun is compelling
Responses from participants were all positive with eight of the passengers replying with very positive responses.

P3: “Yeah it was fun as, bro.”
P1: “It was great for me, I love it. It was quite cool.”
P2: “You should put that on every tram.”

The smiles the participants displayed during play (Figure 1) further support the sense of enjoyment of the game.

(F2) Perception of travelling time changes as a result of playing
Passengers on the tram perceived time pass by faster while playing the game. This seemed to be a positive result as the five participants who reported this were smiling.

P11: “Time just flies.”
P10: “Yeah, you just zone out, it was good!”
P2: “It's exciting because the travelling might go faster.”

When prompted for the reasons, responses suggest this was tied to the design of the game.

P10: “You’re fully focused on trying to navigate […] you’re just really focused on getting this thing [the character] to where it needs to go.”

One player pointed out it might have to do with playing with others.

P12: “It felt faster with someone else than it did playing something by myself.”

(F3) Comparing to existing methods of pastime
Of 10 participants who filled out my survey, four noted that they play games on mobile devices and handheld consoles while they travel. Additionally, during game play on the tram, three players referred to their previous experiences of playing games on trams.

P10: “When I am playing something on a tram it’d be on my iPhone so it's obviously just a one player thing, no interaction with anyone else on the tram. […] I usually play games anyway on the tram, just on my iPhone. But it's obviously a different, umm, different elements involved.”
P12: “I usually play iPhone games or, like, 3DS or something, on the tram or the trains, and umm, I’m not sure why exactly but the, uhh, it’s that—playing with someone else sort of made it, I dunno, made the trip faster. [...] It felt faster with someone else than it did than playing something by myself.”

(F4) Distracting from other priorities
Three participants pointed out that they were in risk of missing their tram stops while playing the game on the tram. As a strategy to avoid this, one of the players moved their focus from the game to the road and back again to make sure they would not miss their tram stop.

P3: “You might miss a couple of stops.”

P4: “I think that’s about enough, otherwise we’re likely to miss our stop.”

P10: “You can get really lost in the game, probably miss your stop.”

Reactions to and from the other Passengers  
(Social)
(F5) Cart-Load-O-Fun can create a social atmosphere
Players would often express their enjoyment together through grunts, smiles and laughter while playing the game (Figure 5). Four players pointed out the potential the game has in being able to create a social atmosphere on the tram.

P6: “It was fun and original. I guess, uh, making it a bit more, you know, friendly, and stuff. [...] You know, creating, uh, creating some kind of, you know, a sense of community with the users and everything. Yeah, it’s nice. [...] I think it lacks in public transport in general. Like, you’re always uncomfortable looking at people and everything, interacting with them.”

P10: “It was interesting just coordinating a game with someone else there who’s in control of half of what’s happening on the screen. [...] It’s also different ‘cos, usually when you’re playing on your own you’re kind of zoned out in this very, um, like, isolated kind of, um, atmosphere. Whereas playing with someone else and having people watching on as well makes you a bit more aware of your surroundings.”

P12: “To put that into a public space where you have to be playing with someone else that you may or may not know [...] can often be a conversation starter.”

(F6) Verbal communication between players as part of gameplay
Participants would often communicate with each other while playing the game, aiding each other in the form of giving directions. This also happened with players who were strangers to one another.

P12: “Here we go up.”

P13: “Yep. I’m going left and right... I think. [...] Up, up!”

P12: “Yeah, I’m going up!”

(F7) Spectator engagement
During the game sessions I observed many non-player passengers in the space being drawn to the game and enjoying watching as a spectator. This was evident in the smiles and intrigued glances they displayed while observing players play the game. Some spectators decided to try the game after watching other players play.

P13: “It’s good to sort of have something to look at other than outside.”

However, I also noticed that at certain points, some of the spectators had trouble observing the game when other passengers obstructed their view.

(F8) Being self-aware in a public space
Playing Cart-Load-O-Fun in a tram can be a performative experience as there may be spectators at most times. Participants noted the following about being self-aware in a public space:

P12: “I guess it’s just sort of, there was more of a self-awareness, that, uh, I’m not used to, um, when you’re playing a game. [...] The idea of having it in a public space is, it’s intriguing. [...] It felt like I should have been self-conscious, [...] it only sort of lasts a few seconds really, but then once you sort of get into the game, you-you sort of lose that [...]”

P10: “[...] playing with someone else and having people watching on as well makes you a bit more aware of your surroundings. [...] At first I was so concentrated on just getting the character to move that it didn’t really occur to me that other people would be looking on. But then as you kind of start getting the hang of the game and playing it more efficiently, um, yeah, I think you start looking around more. [...] It wouldn’t bother me very much,
I guess I wouldn’t be too self-conscious about people watching me play a game.”

(F9) Declining an invite
I also note that the majority of the passengers declined my invite to playing the game. I asked them why they would not join playing, and the common reasons for declining an invite were: being too tired to play, too old to play, not knowing how to play, not being someone who plays games, having to leave the tram very soon, and the sensors being too high to reach. Although I was curious about some of these answers, I decided to not disturb these tram-riders any further.

Reactions in regards to the Space (Spatial)

(F10) Movement of tram impacting gameplay
The tram constantly accelerated and decelerated between tram stops. Two players explained how the tram moving back and forth impacted their game.

P3: “The ball is moving and the tram is moving and all that, it was like, noo. Haha.”

P11: “The trams stop and go abruptly, it can affect your game play.”

(F11) Location of controller can effect play experience
The force sensors that were used as the input devices were placed on bars located above standing passenger’s heads. These are the bars that passengers hold onto while travelling. Two participants noted that holding onto these bars of the tram for long periods of time may cause irritations in their arms.

P10: “If you’re playing it for a while your arm could get tired, just from squeezing and having your arm in an upright position.”

I also received feedback from a non-player elderly lady, who expressed her interest in playing the game, but was unable to play due to not being able to stand for long periods of time.

DESIGN DIMENSIONS
I use my findings to derive a set of design dimensions for understanding how to design digital games for public transport. I do not intend these dimensions to be an exhaustive analysis of the design space; rather, I use this discussion to highlight interesting dimensions I derived that may not be immediately apparent to researchers and designers who aim to understand the design of digital games for public transport.

Dimension 1: Utilizing the Movement of the Space
My first dimension looks at the extent to which the game allows being controlled by the space, in particular the movement of the space. On one end of the pole of this dimension the game is completely controlled by the player, as is the case with most current games on mobile devices. On the other end, the game is controlled by the movement of the space, in my case, by the movement of the tram. As a result of the acceleration and deceleration of the tram, in Cart-Load-O-Fun the player’s control over the game (i.e. the amount of pressure applied to the sensors) is disturbed (F10). As such, in Cart-Load-O-Fun, there is an ongoing shift of control between the player being in control of the game and the movement of the tram “taking” control of the game.

Designers can place their design along this dimension and vary the degree to which the game makes use of the amount of control taken from the player by the movement of the public transport space, and using it as a game mechanic. I believe this has potential in creating novel experiences, as a moving space is an intriguing feature of public transport.

I identify two key approaches for leveraging movement features of public transport in a digital game: direct and indirect leverage of control.

Dimension 1.1: Direct leverage of movement control
This approach of control involves the game detecting the change in movement of the public transport space using sensor technology (i.e. accelerometer, gyroscope, etc.) and leveraging this in the game directly as a game mechanic. Similar to games on mobile devices that use sensor technology to move and manipulate game objects, sensors attached to the public transport space can assist in feeding data about the movement of the space to the game, which then can be used as a game mechanic. This is the proposed method for the concept game system Strap Game (Qian, 2007).

Dimension 1.2: Indirect leverage of movement control
This method of control relies on the game input of the player to detect whether there is change in movement of the space. This is evident in the conceptual game system Strap Game (Qian, 2007). Sudden disruptions caused by the movement of the public transport space could often lead standing passengers to hold onto the bars or handles in the space to counter the force applied to them. In the case of Strap Game’s handle, which is suspended from a bar, the sudden movement of the space would lead to players moving, which would in turn lead to involuntary tilting of the handle, triggering the sensors within the system. Cart-Load-O-Fun also employs this type of “indirect leverage of movement control” (F10), using player movement as facilitated by the movement of the tram, as game input. Using this method of control can require different (and often cheaper) sensors in comparison to the direct approach. I see this indirect leverage of movement control as a unique design opportunity to further the positive experience of digital games on public transport (F1).

Dimension 2: Incorporating the Social Setting
My second dimension concerns the extent to which the game incorporates the social setting of the space. On one end of the pole of this dimension, the game ignores the social setting of the space, and on the other end, the game facilitates the player actively engaging with and
affecting the social setting that exists on public transport. In Cart-Load-O-Fun, this is done through the game engaging players in a way that is visible to other passengers, motivating a kind of performance: for the participants, playing in front of other people on a tram was a performative activity (F8). The ‘amount’ of performance demanded from the player can be varied through game design. As a result of this, players are able to alter the social atmosphere of the space by creating a spectacle within the space (F5, F7).

Furthermore, Cart-Load-O-Fun asks the player to affect the social setting in another way, too: players who enter the space without a partner must approach and invite a fellow passenger to the game if they wish to play with another player. This invitation may also impact the social atmosphere in the space.

Designers can place their designs along this dimension by varying the degree to which the game asks the player to affect the social space, in most cases this refers to performing. To achieve this, I identify two key approaches: indirectly through reactions, and directly through actions.

**Dimension 2.1: Incorporating the social setting indirectly through reactions**
In Cart-Load-O-Fun, the player’s control over the game shifts when the tram is moving and stopping (F10). When this occurred, passengers displayed emotional reactions, which led to communication between the players. This was expressed through grunts, smiles and laughter, while communication occurred in the form of coordinating commands between the players to avoid the risk of losing the game (F6, F7, F8).

**Dimension 2.2: Incorporating the social setting directly through actions**
One example of how a game might facilitate the player in affecting the social space directly might be through the game explicitly asking the player to perform certain performative actions. I give two examples of this in existing digital games. Guitar Hero (Activision, 2006), a digital rhythm game which uses a guitar as a game controller, encourages performance at certain points during the game by giving bonus points for actions that the player performs, such as lifting the guitar up. The digital game B.U.T.T.O.N. (Wilson, 2011) asks players to carry out playful and often silly actions such as “Act like a monkey” or “Make bird sounds”.

Designers should note that this method of directly affecting the social space through asking for performance may be challenging to some players (F8) as they may go through some extent of evaluation apprehension (Cottrell et al., 1968), a fear of their behavior being judged by others in the space.

**Dimension 3: Orchestrating the Attention of the Player**
My final dimension describes the extent to which the game orchestrates the attention of the player. The two poles of this dimension are made up of the game demanding full attention from the player on one end and the space demanding full attention on the other. Games can demand undivided focus and attention from players, allowing players to enter a zone of flow for optimal experience (Csikszentmihalyi, 1990). While some designers might argue that ‘flow’ must be achieved to create an engaging experience, this may not be desirable in some cases as it may distract the player from other priorities they may have. In my case, players of Cart-Load-O-Fun had the priority of leaving the train when they reached their stop (F4). If players were to enter a state of flow and become isolated from their surroundings, the risk of missing their stop would arise due to the perception of time changing as a result of playing (F2). By allowing the game to orchestrate the attention of the player between the game and the space, players can enjoy both the game and the social space (interacting with other players and non-players, as well as performing and observing the surroundings (F8)) while being mindful of other priorities. Cart-Load-O-Fun supported this to some extent by offering short games that allow players to shift their attention to the tram stops in-between games, however, players were still concerned they might miss their stop (F4); future iterations would need to take this into account.

Designers can place their design on this dimension by varying the degree to which the game demands the player’s attention. This can be achieved through game design, through placement of sensors within the space (F11) and through the sensors detecting change in movement within the public transport space.

**DESIGN STRATEGIES**
I now provide a set of design strategies that I derive from my study. While the above design dimensions provide an abstract framework for thinking about digital games on public transport informed by prior work and my experiences with Cart-Load-O-Fun, the following strategies complement those dimensions by offering practical lessons learned for designers as to how to build better digital games for public transport.

**Strategy 1: Vary the shift of control of the game between the player and the space**
One of the most intriguing aspects of the public transport space is that it moves. My findings show that this was an appreciated feature (F1, F10) and playing a game that leverages this feature was different to existing games that passengers play as a method of pastime (F3). Although it is up to the designers to decide how much of this feature they want to leverage (D1), I believe it is a feature that designers could use to their advantage. In particular, based on the experiences with Cart-Load-O-Fun, I suggest designers make use
of this design opportunity by allowing the movement of the space to vary the shift of the player’s control over the game, shifting back and forth from the player having control to the space taking control to create an engaging experience. This is a feature that the designers of the conceptual game system Strap Game (Qian, 2007) might also benefit from.

Strategy 2: Rapidly vary the shift of control of the game to fuel communication between players
Findings from Cart-Load-O-Fun suggest that the shift of control between the game and the space (D1) creates an opportunity for social interaction to occur during play (F5, F7). This is a result of the movement of the public transport disrupting the player’s control over the game; in particular the rapid shifting back and forth contributes to this (F10). Designers can take advantage of this by fueling the players in communicating with one another through game design (D2). By changing the sensitivity of which the game responds to the movement of the public transport space through game design, designers are able to increase the rate of which this shift of control occurs, fueling the degree to which players communicate as part of the gameplay (F6).

Strategy 3: Exploit the game’s capacity to support player’s self-expression to increase spectator engagement
When playing Cart-Load-O-Fun, players expressed their enjoyment through grunts, smiles and laughter (F5), and they also communicated verbally as a means of coordinating gameplay (F6). Basing off Cart-Load-O-Fun’s ability to create a social atmosphere within the public transport space (F4), I point out and place an emphasis on the ability to engage spectators. Playing a performative game in a space that is populated with other people can gain their attention (F7). Deriving from the extent to which the game facilitates the player in incorporating the social setting (D2), I recommend designers to place their designs on the higher end of the dimension, where players are more self-expressive and performative to allow for a more engaging spectator experience if this is what the designers aim to achieve.

That being said, designers must also keep in mind that not all passengers may want to be engaged in the game. Cart-Load-O-Fun aims to address this by keeping auditory feedback from the game to a minimum (i.e. no constant music in the background, which may become an irritation). Passengers always have the option to look away from the game if they do not wish to view it, but I believe imposing audio onto passengers may disturb some of them, as is the case with the public performances using a megaphone by Everything is OK (Shine, 2009) and the Love Police (Veitch, 2009).

Strategy 4: Use the game to shift the player’s focus from the space to the game to decrease the level of self-consciousness of performing
Certain players may feel uneasy when playing in a public setting like public transport, especially due to the performative aspect of playing in public (F8). My recommendation to designers who wish to address this is to shift the player’s focus from the space to the game (D3). This can be done through game design. By allowing the game to demand more attention, players become more focused on the game rather than the screen. As explained by the designers of the digital game Musical Embrace (Huggard et al., 2012), where players engage in socially awkward play by hugging one another to apply pressure onto a suspended pillow-like controller that sits in between the players, being able to watch and focus on the screen rather than the players and the space allows players to temporarily shift the awkwardness arising from self-consciousness of engaging in performative interaction. This confirms O’Hara’s elaborations on public play and self-consciousness when it comes to play on big screens in urban spaces (O’Hara, 2008).

Strategy 5: Orchestrate the focus of the player frequently towards the surroundings to support other priorities of the player
Players on public transport who have a priority of leaving when they arrive at their stop may be at risk of missing their stop as their perception of time changes while playing (F2), resulting in a distraction from other priorities (F4). By allowing the game to orchestrate the amount of attention it demands from the player (D3), passengers are more likely to be mindful about their priorities. One way of doing this can be through sensing whether or not the public transport is moving. Another simpler way is by keeping games very short.

Strategy 6: Make sure passengers are able to decline an invite
I find it important for passengers within the space to be able to decline an invitation to the game, as some passengers may not be fit or willing to play (F9). This is also important from an ethical view, as players should not be forced into play: Montola et al. point this out in the Ethics and Unaware Participation section of their book Pervasive Games (Montola et al., 2009). Apart from that, designers must acknowledge that some passenger may simply want to relax during their public transport experiences. Therefore I suggest designers keep this in mind while designing their games.

Strategy 7: Place the game in a location visible to spectators
Playing on public transport often creates spectacle. I have found that other passengers enjoy watching players play the game (F7). Thus the passengers are engaged even if they are not playing, and at times are enticed to participate (Sheridan & Bryan-Kinns, 2009). For digital games with a display, I believe it is
important for the display to be visible not only for the players but also for the audience as the location of the hardware can impact both the player’s and the spectator’s experience (F7, F11). This can be done by having both an appropriately sized display and also by placing the display in an appropriate location where bystanders will not obscure it.

For my studies, upon initially using a pico-projector to project the game onto the floor of the tram, I found that spectators had a hard time seeing the projection due to it being blocked by bystanders. In addition to this, the tram’s constant moving and turning corners would at times allow sunlight to shine through the windows onto the projection, preventing the screen from being very visible, hence hindering the experience for both players and spectators.

LIMITATIONS
Firstly, my research investigates digital games on trams in one particular cultural setting. I acknowledge that countries and societies with different social and cultural norms may have different reactions and responses to Cart-Load-O-Fun. Secondly, my research is conducted around a single game. I believe studies around multiple games that require other methods of engagement (for example, competitive play rather than collaborative), may also lead to other findings, however I believe this work presents a useful starting point for future work in this space. Finally, I believe the fact that researchers were present during game play may have impacted the experience and behavior of the players. As such, responses to the game may vary if the game was played without supervision. However, as the tram is a public place, there are other ‘observers’ often present in the form of other passengers, and occasionally ticket inspectors, safety personnel, etc. I therefore believe my insights can be a valuable initial exploration into this exciting field of digital games for public transport, aiding researchers in investigating this domain further.

CONCLUSION
I have presented Cart-Load-O-Fun, a digital game designed for trams. I report on findings from a study conducted on trams. My game acts as a research vehicle to explore the ways in which digital games that incorporate both the physical and social features of the space can enhance the experience of travelling on public transport. I presented 3 dimensions for digital games and provided 7 design strategies as guidance for game designers who aim to facilitate play in unconventional spaces such as trams, allowing for more engaging experiences and ultimately allowing us to rethink where, when and with whom we play.

ACKNOWLEDGEMENTS
First and foremost, I would like to acknowledge my supervisor Florian ‘Floyd’ Mueller, for all the support, wisdom and knowledge that he has shared with me. I would like to thank Adrian Miles for dedicating the time to answering many of my questions. I would also like to thank my fellow Exertion Games Lab researchers Joshua Platt, Hsin Yang Ho, Eric Ditloff, Anushka De Mel, Wouter Walmin, Danielle Wilde, Sebastiaan Pijnappel, Ruth Sanco Huerga, Gina Moore and Rohit Khot. I would also like to thank Ian Stokes and the Yarra Trams team for granting my team permission to use the tram facilities. Finally I would like to express my gratitude toward the many designers and researchers from the workshops of the conferences CHI 2012 and Fun and Games 2012 as well as the many visitors of our lab who took their time to give feedback on Cart-Load-O-Fun.

REFERENCES


Appendix A. List of publications within year of Honours (2012)

Primary author, primary researcher, co-designer. Peer reviewed. 4 pages.
(Presented paper at the conference – 20 minute talk)

Primary author, primary researcher, co-designer. Judged. 5 pages.
(Awarded First Place in Student Game Competition)

Primary author, primary researcher, co-designer. Peer reviewed. 1 page.
(Demonstrated to conference attendees – 3 days)

Primary author, primary researcher, co-designer. Peer reviewed. 3 pages.
(Presented a Poster during the conference as part of the Work-in-Progress)

Co-author, co-supervisor of the research students. Judged. 5 pages.
(Awarded Audience Award in Student Game)

Co-author, co-designer, primary exhibitor. Peer reviewed. 4 pages.
(Demonstrated to conference attendees as part of the Interactivity track – 3 days)

Co-author, workshop participant. Peer reviewed. 4 pages.
(Participated in workshop activities, interacted with fellow workshop attendees)
Appendix B. Bubble Popper: Considering Body Contact in Games

*Paper presentation at the ACM bi-annual research conference Fun and Games 2012.*
Bubble Popper: Considering Body Contact in Games

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ABSTRACT
Exertion games, digital games that involve physical effort, are becoming more popular. Although some of these games support social experiences, they rarely consider or support body contact. We believe overlooking body contact as part of social play experiences limits opportunities to design engaging exertion games. To explore this opportunity, we present Bubble Popper, an exertion game that considers and facilitates body contact. Bubble Popper, which uses very simple technology, also demonstrates that considering and facilitating body contact can be achieved without the need to sense body contact. Through reflecting on our design and analyzing observations of play we are able to articulate what impact physical space layout in relation to digital game elements, and physical disparity between input and digital display can have on body contact. Our results aid game designers in creating engaging exertion game experiences by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

Author Keywords
Exertion games; exertion interfaces; exergames; movement-based interaction; body contact; sports; game design.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design.

INTRODUCTION
Exertion games require players to invest physical effort in order to play the game [6]. Today the most well known commercial systems that allow for such interactions are Nintendo’s Wii, Microsoft’s Kinect and Sony’s PlayStation Move. Although some of the games supported by these systems enable social experiences, these experiences mostly require players stand side-by-side, where they do not experience, and are not expected to engage in body contact.

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We suspect that this is mostly a consequence of the limitations of the involved technology: The Kinect requires players to stay within separate physical spaces as occlusion issues could otherwise occur. Wiimotes and Move controllers are not designed for body contact and cannot be hit against other players. Although we acknowledge that body contact can be a cause for injury at times, we believe one of the reasons why these systems have been criticized for missing opportunities for rich social play [3] is because they do not consider body contact. We take inspiration from such rich body contact experiences ranging from the playful Twister to team sports such as basketball, where players push and block one another to gain an advantage in the game, experiencing the sharing of the physical space around them as a result of and a reason for body contact. We believe overlooking the potential of body contact in exertion games, as most current commercial systems seem to do, is a missed opportunity to support such rich experiences for players.

To explore this opportunity, we present Bubble Popper, an exertion game that considers and facilitates body contact. This is achieved without the need for sensing body contact, hence Bubble Popper also demonstrates how to consider and facilitate body contact with very simple technology. Through reflecting on our design and analyzing observations of play we are able to articulate what impact physical space layout in relation to digital game elements and physical disparity between input and digital display can have on body contact and how to design games that aim to consider and facilitate it.

RELATED WORK
We are inspired by the use of body contact in play and sports, as mentioned above, however, when it comes to digital play, body contact often seems overlooked. Nevertheless, a few digital play systems exist where studies have reported that participants encountered body contact as part of the play experience.

The users of TouchMeDare [2] engage and respond to each other’s body movements on opposite sides of an interactive canvas. The initial design focused on separating the players’ bodies by means of the canvas. However, when TouchMeDare was exhibited in a public setting (a large music festival) it triggered the opportunity for more than one player on either side to be present. These players then engaged in rich body contact actions, appropriating the
Figure 1. Two players competing in Bubble Popper. The player on the right uses his arm to block the opponent.

system so that they could engage in intense body contact, even throw one another around.

Similarly, in the shadowboxing game Remote Impact [7] players hit one another’s shadows, separated by an interactive surface. During deployment it was observed that players like to play with additional co-located players, which allowed for body contact between them. These experiences, where users appropriated digital systems to support their desire to incorporate body contact suggest to us that players can enjoy body contact even if it is part of a digital experience.

A few game designers have recently presented games that suggest that body contact can be explicitly considered in the game design process. One of these games is Wilson et al.’s digitally enabled folk game J.S. Joust [12] that requires players to bump or push each other’s hands or bodies to eliminate them from the game. Move controllers were used to detect motion. From J.S. Joust we learn that digital games can be designed so that they facilitate body contact as a core game mechanic. However, we have yet to gain an analytical understanding of how game designers can support this kind of play.

Similarly, the digital game B.U.T.T.O.N. [11] also facilitates body contact through the game’s design, however, interestingly, the system does not sense it. Players must prevent each other from holding down a button on their controller for more than four seconds while trying to do so themselves. A video of the game in action suggests that the game can indeed facilitate very powerful body contact actions, all without the game system sensing it. We build on this idea of facilitating body contact without sensing it, and present an analytical account of how game designers can achieve this.

There have also been a number of art and interactive installations that have played with the notion of popping bubbles [9, 13]. While we are also inspired by the magical experience of popping bubbles, hence the name of our game “Bubble Popper”, our work differs as it deliberately considers body contact through game design as part of the game experience.

These related works suggest that considering body contact in exertion games could be beneficial for facilitating engaging experiences for players. However, how game design can support this has been analyzed only to a limited extent. Our work therefore explores how body contact can be considered and facilitated in exertion games. We do this by reflecting on the design of Bubble Popper and analyzing play observations.

**BUBBLE POPPER**

Bubble Popper (Figure 1), which emerged from teachings on Exertion Games [8], is a 2-player exertion game. Players are assigned a color, yellow or pink, and then must pop their colored bubbles that appear on the projected surface (Figure 2) by hitting the surface with an augmented glove. When hit, a switch within the glove triggers a mounted infrared LED, which informs a Wiimote positioned close to the projector of the glove’s screen position. The Wiimote is not used as an input pointer, but instead as a sensor for the gloves’ positions [5]. The Wiimote sends this information to a computer, similar to the work by Bencina et al. [1], which triggers the bubbles to pop with a rewarding sound. The rules of the game are simple; the player who pops the most bubbles of their color within 60 seconds wins.

To facilitate this we made sure the bubbles were not static and instead were moving around the digital projection space and bouncing off each other. This not only supported players to move around to keep up with the bubbles, but also afforded colliding with the opponent and their path. In this situation the players had to choose between moving out of the way and letting their opponent score a point, or blocking their path to prevent them from scoring while also giving them an opportunity to score a point for themselves.
INITIAL OBSERVATIONS
We can report on initial observations from three events where Bubble Popper was showcased. Bubble Popper was exhibited in a public shopping mall as part of a digital festival. From our observations of watching the general public play the game we noticed players would initially avoid interacting with one another physically and instead rather politely pop the bubbles closest to themselves. This however was slightly different when the two players were familiar with one another (e.g. those who approached us as a group). We noticed that the players who saw others play using body contact quickly picked up this style of gameplay. Another demonstration was during an International Game Developers Association local chapter meet, with an audience of over 100 game developers. It appeared they played more physical and were less reluctant to holding back. Our final showcase was at a physical health and education conference, we received comments on the potential application of Bubble Popper with children in schools.

FINDINGS
Through reflecting on our design process and observations of play with over 40 participants over the age of 18, we identified the following aspects designers should be aware of when aiming to consider and facilitate body contact in exertion games. We also articulated design strategies on how designers can use these aspects in their work to create more engaging exertion games by considering body contact.

Sensing body contact is not necessary to facilitate body contact and may not even be desired
We do not use complex sensors and tracking equipment to sense body contact as we thought it was not necessary. We believe that designing a game that rewards body contact (through assigning points for successful body contact for example) could take away from encountering body contact as a result of play, and instead may hinder the social experience. Another problem with using sensors to detect body contact is the possibility of the sensors not functioning as intended at all times (i.e. not registering body contact). This could disrupt the game and may frustrate players.

Lastly, designers might also need to consider different sensing scenarios such as skin-to-skin contact, skin-to-clothes contact and clothes-to-clothes contact, making successful sensing challenging.

Considering projection size when spawning digital game elements can facilitate body contact
Through testing and modifying the size of the projection screen in relation to the amount of bubbles spawning we found that no more than ten bubbles at any given time worked best with the projection of approximately 2.5 meters high by 4 meters wide. This provided players with enough room to move freely while also allowing for physically crossing paths when moving from one side of the space to the other. We programmed Bubble Popper so that the bubbles spawn in opposite locations across the large surface, so that players need to move around to reach all bubbles, requiring players to cut across their shared space.

Varying physical disparity can facilitate body contact
Physical disparity, being the distance between the input device (i.e. the gloves) and the display (i.e. the projection), is constantly changing and varies between approximately 0 meters (hitting the bubbles) to 2 meters (moving away from the wall), unlike with sensors such as the Kinect, where the physical disparity is usually quite constant (around 3 meters). Players have to move towards the display to pop bubbles, and away from it to see which bubble to hit next. This demand to alter the physical disparity facilitated players moving around, fueling the potential of body contact occurring.

Predispositions that digital games require players to refrain from engaging in body contact may exist
Our preliminary observations suggest that game designers need to be aware that players may have a predisposition that discourages them from engaging in body contact. We suspect that this could be due to the limited amount of digital games that have supported physical interaction between players in the past. One way of addressing this could be by showing depictions of players engaging in body contact whilst playing, for example as part of an introductory trailer. Another idea could be to dress players in sports uniforms, furthering the idea that body contact can be a fundamental part of the game experience.

Offering other contact opportunities might promote body contact
We believe that the tactile feeling of hitting a wall to pop the bubbles is one of the success factors of Bubble Popper. Unlike with a TV display, Bubble Popper’s projection system allows players to engage in contact with the wall without having to worry about any damage. Through this, players are constantly reminded that contact is “ok”, fostering the notion of engagement through body contact, working against the predisposition that digital games require players to refrain from engaging in contact.
Familiarity between players
Our observations suggest that body contact appears to be facilitated between players who are familiar with one another. Familiarity between players and an audience might also affect body contact, as players are performing when playing Bubble Popper; such a performance might affect and be affected by body contact as part of the experience.

Body contact might lead to aggressive play, raising safety issues
We also want to point out that designers should also consider any negative effects body contact may have, such as overly aggressive play. Previous research in sports science has investigated if body contact affects aggression in sports [4]. In sports such as soccer and basketball, a referee moderates overly aggressive body contact. At this stage we have chosen not to impose rules in this regard. Although research suggests that considering risk can be beneficial in exertion games, limiting the potential for injury should always be priority for game designers. Previous research in sports science suggest that there is a difference between contact and non-contact sports players when it comes to their pain apperception [10], suggesting that body contact in exertion games could affect the physical risk and the perception of this risk.

FUTURE OPPORTUNITIES
We believe further research that explores body contact between more than two players will expand the understanding we put forward. Furthermore, balancing players who have different physical abilities in body contact games could also be a fruitful avenue for future research, extending prior work on non-contact exertion games [8].

CONCLUSION
We have presented Bubble Popper, an exertion game that supports considering and facilitating body contact in digital games. Through reflecting on our design and analyzing observations of play we have articulated what impact physical space layout in relation to digital game elements and physical disparity between input and digital display can have on body contact and how to design games that aim to consider and facilitate it. Our results aid game designers in creating engaging exertion game experiences by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

ACKNOWLEDGMENTS
We would like to thank the team that originally proposed the idea of Bubble Popper (Sevcan Ali, Daniel Beilharz, Luke Dominic-Butterworth, Paco Casarez, Nicolas Hower). Thanks also to Eberhard Graether, Andrew Lewis, Eric Ditloff, Wouter Walmink, Alan Chatham, Harry Lee, Danielle Wilde, Ho Hsin Yang, David Platt and Elise van den Hoven.

REFERENCES
Appendix C. Bubble Popper: Considering Body Contact as Game Ingredient

Student Game Design Competition Entry for the ACM bi-annual research conference
Fun and Games 2012.
Awarded First Place.
Bubble Popper: Considering Body Contact as a Game Ingredient

Abstract
Exertion games, digital games that involve physical effort, are becoming more popular. Although some of these games support social experiences, they rarely consider or support body contact. We believe overlooking body contact as part of social play experiences limits opportunities to design engaging exertion games. To explore this opportunity, we present Bubble Popper, an exertion game that considers and facilitates body contact. Bubble Popper, which uses very simple technology, also demonstrates that considering and facilitating body contact can be achieved without the need to sense body contact. Through reflecting on our design and analyzing observations of play we are able to articulate what impact physical space layout in relation to digital game elements, and physical disparity between input and digital display can have on body contact. Our results aid game designers in creating engaging exertion games by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

Author Keywords
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General Terms
Design, Human Factors
Introduction

Exertion games require players to invest physical effort in order to play the game [5]. Today the most well known commercial systems that allow for such interactions are Nintendo’s Wi, Microsoft’s Kinect and Sony’s PlayStation Move. Although some of the games supported by these systems enable social experiences, these experiences mostly require players to stand side-by-side, where they do not experience, and are not expected to engage in body contact. We suspect that this is mostly a consequence of the limitations of the involved technology: The Kinect requires players to stay within separate physical spaces as occlusion issues could otherwise occur. Wiimotes and Move controllers are not designed for body contact and cannot be hit against other players. Although we acknowledge that body contact can be a cause for injury at times, we believe one of the reasons why these systems have been criticized for missing opportunities for rich social play [2] is because they do not consider body contact. We take inspiration from such rich body contact experiences ranging from the playful Twister to team sports such as basketball, where players push and block one another to gain an advantage in the game, experiencing the sharing of the physical space around them as a result of and a reason for body contact. We believe overlooking the potential of body contact in exertion games is a missed opportunity.

To explore this opportunity, we present Bubble Popper, an exertion game that considers and facilitates body contact. This is achieved without the need for sensing body contact, hence Bubble Popper also demonstrates how to consider and facilitate body contact with very simple technology. Through reflecting on our design and analyzing observations of play we are able to articulate what impact physical space layout in relation to digital game elements and physical disparity between input and digital display can have on body contact and how to design games that aim to consider and facilitate it.

Related Work

We are inspired by the use of body contact in play and sports, as mentioned above, however, when it comes to digital play, body contact often seems overlooked. Nevertheless, a few digital play systems exist where studies have reported that participants encountered body contact as part of the play experience.

The users of TouchMeDare [1] engage and respond to each other’s body movements on opposite sides of an interactive canvas. The initial design focused on separating the players’ bodies by means of the canvas. However, when TouchMeDare was exhibited in a public setting (a large music festival) it triggered the opportunity for more than one player on either side to be present. These players then engaged in rich body contact actions, appropriating the system so that they could engage in intense body contact, and even throw one another around. Similarly, in the shadowboxing game Remote Impact [6] players hit one another’s shadows, separated by an interactive surface. During deployment it was observed that players like to play with additional co-located players, which allowed for body contact between them. These experiences, where users appropriated digital systems to support their desire to incorporate body contact suggest to us that players can enjoy body contact even if it isn’t part of a digital experience.

A few game designers have recently presented games that suggest body contact can be explicitly considered in the game design process. One of these games is Wilson et al.’s digitally enabled folk game J.S. Joust [12] that requires players to bump or push each other’s hands or bodies to eliminate them from the game. PlayStation Move controllers were used to detect motion. From J.S. Joust we learn that digital games can be designed so that they facilitate body contact as a core game mechanic. However, we have yet to
gain an analytical understanding of how game designers can support this kind of play.

Similarly, the digital game B.U.T.T.O.N. [11] also facilitates body contact through the game’s design, however, interestingly, the system does not sense it. Players must prevent their opponents from holding down a button on their controller for more than four seconds while trying to do so themselves. A video of the game in action suggests that the game can indeed facilitate very powerful body contact actions, all without the game system sensing it. We build on this idea of facilitating body contact without the need for sensing, and present an analytical account of how game designers can achieve this.

There have also been a number of art and interactive installations that have played with the notion of popping bubbles [9, 13]. While we are also clearly inspired by the magical experience of popping bubbles, hence the name of our game “Bubble Popper”, our work differs as it deliberately considers body contact through game design as part of the game experience.

These related works suggest that considering body contact in exertion games could be beneficial for facilitating engaging experiences for players. However, how game design can support this has been analyzed only to a limited extent. Our work therefore explores how body contact can be considered and facilitated in exertion games. We do this by reflecting on the design of Bubble Popper and analyzing play observations.

**Bubble Popper**

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To facilitate this we made sure the bubbles were not static and instead were moving around the digital projection space and bouncing off each other. This not only supported players to move around to keep up with the bubbles, but also afforded colliding with the opponent and their path. In this situation the players had to choose between moving out of the way and letting their opponent score a point, or blocking their path to prevent them from scoring while also giving them an opportunity to score a point for themselves.

**Initial Observations**

We can report on initial observations from three events where Bubble Popper was showcased. Bubble Popper was exhibited in a public shopping mall as part of a digital festival. From our observations of watching the general public play the game we noticed players would initially avoid interacting with one another physically and instead rather politely pop the bubbles closest to themselves. This however was slightly different when the two players were familiar with one another (e.g. those who approached us as a group). We noticed that the players who saw others play using body contact quickly picked up this style of gameplay. Another demonstration was during an International Game Developers Association local chapter meet, with an audience of over 100 game developers. It appeared they played more physical and were less reluctant to holding back. Our final showcase was at a physical health and education conference.
Findings

Through reflecting on our design and observations of play we identified the following aspects designers should be aware of when aiming to consider and facilitate body contact in exertion games. We also articulate design strategies on how designers can use these aspects in their work to create more engaging exertion games by considering body contact.

Sensing body contact is not necessary to facilitate body contact and may not even be desired

We do not use complex sensors and tracking equipment to sense body contact as we thought it was not necessary. We believe that designing a game that rewards body contact (through assigning points for successful body contact for example) could take away from encountering body contact as a result of play, and instead may hinder the social experience. Another problem with using sensors to detect body contact is the possibility of the sensors not functioning as intended at all times (i.e. not registering body contact). This could disrupt the game and may frustrate players. Lastly, designers might also need to consider different sensing scenarios such as skin-to-skin contact, skin-to-clothes contact and clothes-to-clothes contact, making successful sensing challenging.

Considering projection size when spawning digital game elements can facilitate body contact

Through testing and modifying the size of the projection screen in correlation to the amount of bubbles spawning we found that no more than ten bubbles at any given time worked best with the projection of approximately 2.5 meters high by 4 meters wide. This provided players with enough room to move freely while also allowing for physically crossing paths when moving from one side of the space to the other. We programmed Bubble Popper so that the bubbles spawn in opposite locations across the large surface, so that players need to move around to reach all bubbles, requiring players to cut across their shared space.

Varying physical disparity can facilitate body contact

Physical disparity, being the distance between the input device (i.e. the gloves) and the display (i.e. the projection), is constantly changing and varies between approximately 0 meters (hitting the bubbles) to 2 meters (moving away from the wall), unlike with sensors such as the Kinect, where the physical disparity is usually quite constant (around 3 meters). Players have to move towards the display to pop bubbles, and away from it to see which bubble to hit next. This changing disparity facilitated players moving around, fueling the potential of body contact occurring.

Predispositions that digital games require players to refrain from engaging in body contact may exist

Our preliminary observations suggest that game designers need to be aware players may have a predisposition that discourages them from engaging in body contact. We suspect that this could be due to the limited amount of digital games that have supported physical interaction between players in the past. One way of addressing this could be by showing depictions of players engaging in body contact whilst playing, for example as part of an introductory trailer. Another idea could be to dress players in sports uniforms, furthering the idea that body contact can be a fundamental part of the game experience.

Familiarity between players

Our observations suggest that body contact appears to be facilitated easier between players who are familiar with one another. Familiarity between players and an audience might also affect body contact, as players are performing when playing Bubble Popper, such a performance might affect and be affected by body contact as part of the experience.

Body contact might lead to aggressive play

We also want to point out that designers should also consider any negative effects body contact may have, such as overly aggressive play. Previous research in sports
science has investigated if body contact affects aggression in sports [3]. Although research suggests that considering risk can be beneficial in exertion games [8], limiting the potential for injury should always be priority for game designers. Previous research in sports science suggest that there is a difference between contact and non-contact sports players when it comes to their pain apperception [10], suggesting that body contact in exertion games could affect the physical risk, and the perception of this risk, involved.

**Future Opportunities**
We believe further research that explores body contact between more than two players will expand the understanding we put forward. Furthermore, balancing players who have different physical abilities in body contact games could also be a fruitful avenue for future research, extending prior work on non-contact exertion games [8].

**Conclusion**
We have presented Bubble Popper, an exertion game that supports considering and facilitating body contact in digital games. Through reflecting on our design and analyzing observations of play we have articulated what impact physical space layout in relation to digital game elements and physical disparity between input and digital display can have on body contact and how to design games that aim to consider and facilitate it. Our results aid game designers in creating engaging exertion game experiences by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

**References**
Appendix D. Bubble Popper: The Body Contact Experience

Demonstrated during the conference to attendees at the ACM bi-annual research conference Fun and Games 2012
Bubble Popper: The Body Contact Experience

ABSTRACT
Although some of today’s popular exertion games support social experiences, they rarely consider or support body contact. We believe this limits opportunities to design engaging exertion games. To explore this opportunity, we present Bubble Popper, an exertion game that considers and facilitates body contact with simple technology. Through reflecting on our design and analyzing observations of play we are able to articulate what impact physical space layout in relation to digital game elements, and physical disparity between input and digital display, can have on body contact. Our results aid game designers in creating engaging exertion experiences by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

Author Keywords
Exertion games; exertion interfaces; exergames; movement-based interaction; body contact; sports; game design.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design.

BUBBLE POPPER: THE EXPERIENCE
Exertion games require players to invest physical effort [1]. Today the most well known commercial systems that allow for such interactions are Nintendo’s Wii, Microsoft’s Kinect and Sony’s PlayStation Move. Although some of the games on these systems enable social experiences, these experiences mostly require players to stand side-by-side, where they do not experience, and are not expected to engage in body contact. We take inspiration from rich body contact experiences ranging from the playful Twister to team sports such as basketball, where players push and block one another to gain an advantage in the game.

Figure 1. Two players competing in Bubble Popper. The player on the right uses his arm to block the opponent.

Bubble Popper (Figure 1), which emerged from teachings on Exertion Games [1], is a 2-player exertion game projected onto a flat vertical surface. Players are assigned a color, yellow or pink, and must pop their colored bubbles by hitting the bubbles on the projected surface with an augmented glove. The rules of the game are simple; the player who pops the most bubbles within 60 seconds wins.

We encourage body contact through game design and adequate physical space and size. To facilitate body contact we made sure the bubbles were moving around the digital projection space and bouncing off each other. This not only supported players to move around, but also afforded colliding with the opponent and their path. In this situation players have to choose between moving out of the way and letting their opponent score a point, or blocking their path to prevent their opponent from scoring while also giving themselves an opportunity to score a point.

In our demonstration, we require a projector to display our game. The projection surface needs to be a sturdy wall that can withstand rough hits. We will bring the laptop running the game as well as the gloves and sensors.

Our results aid game designers in creating engaging exertion experiences by guiding them when considering body contact, ultimately helping players benefiting from more engaging exertion games.

REFERENCES
Appendix E. Designing Digital Games for Public Transport

Presented as a Work-In-Progress Paper including a Poster at the ACM bi-annual research conference Fun and Games 2012
Designing Digital Games for Public Transport

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ABSTRACT
Commuting on public transport can be a very unengaging experience that often involves sitting or standing for long periods of time. We see an opportunity to enrich the commuting experience by exploring digital play in this space, and in response aim to deploy a social exertion game designed for public transport. Our game will act as a research vehicle to explore the ways in which digital games that incorporate both the commuter’s body and the social setting can enhance the experience of unconventional play spaces, in this case, public transport. We aim to provide guidance for game designers who consider play in unconventional spaces such as trains and trams, evoking playfulness in users of these spaces, allowing for more engaging experiences.

Author Keywords
Exertion games; exergames; play; unconventional play spaces; public transport; game design.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human Factors; Design.

INTRODUCTION
Games generally occur in defined play spaces and are governed by rules. The act of accepting these rules and stepping into the space of play is sometimes referred to as entering the ‘magic circle’ – the metaphorical space in which play occurs [9]. This magic circle often also denotes a physical space, for example digital games have traditionally been confined to arcades and living rooms. However, the advent of recent technologies such as mobile devices allows us to play almost anywhere. Spaces that we consider playful are constantly expanding, for example, devices allows us to play almost anywhere. Spaces that we traditionally been confined to arcades and living rooms.

However, the advent of recent technologies such as mobile devices allows us to play almost anywhere. Spaces that we consider playful are constantly expanding, for example, devices allows us to play almost anywhere. Spaces that we traditionally been confined to arcades and living rooms.

The London-based public transport game Chromaroma [4] uses commuter’s Oyster Cards [12] to track and record their locations and awards points for completing tasks and missions, such as visiting unexplored locations. Players are able to compete with one another on a national leaderboard.

The game is accessed through a mobile device and provides

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Fun and Games’ 2012, Toulouse, France — September 4-6, 2012
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visualizations of the commuter’s travel routes. We find this to be an interesting way of engaging passengers during public transport rides, but not so different to existing iPhone and Android games that are commonly played during commutes. We understand that these methods of pastime are easily accessible and do not disturb or intrude on the privacy or comfort of others in the space, but we also believe there is a missed opportunity to incorporate both the passengers and the immediate physical space into play, and allow for the commuters to engage in play together in order to create more engaging experiences.

**CART-LOAD-O-FUN**

When we look at public transport, namely trains and trams, we notice two key features:

Firstly, the space is populated with people, so there is potential for social interaction, yet this rarely happens between strangers. Secondly, the train or tram is constantly moving and stopping, an interesting characteristic of the space and very different to most other play spaces such as living rooms.

We see these two features not as problems or challenges but as design opportunities. As such, we aim to design a game that makes use of these features.

Our project is called Cart-Load-O-Fun. We use two force sensors that are attached to the horizontal bars of the train or tram that passengers hold on to while travelling. Our current game involves two players collaborating in order to control a single character in the game. One player controls the character’s movement on the x-axis while the other player controls the y-axis by holding onto the bars that the sensors are attached to. Holding on tighter increases the x or y value. Players must work together in order to collect the gems that randomly appear in the level while avoiding enemy characters. Each gem collected adds two seconds to the timer. The game usually lasts 60 seconds and is high-score based. We project the game onto a flat surface in the space (either on the floor or ceiling), alternatively there is a screen that displays the game.

**STUDY**

We aim to explore the reactions of passengers to the games we deploy in the public transport space in order to understand how games for the commuting experience should be designed.

**Participants**

We invite the passengers in the public transport space to play the game. These include passengers who have just entered the space and who are already present.

**Measurements**

Participants will be observed during the game, which will be followed up with a discussion and an open interview process guided by key research questions using the laddering technique [3]. All game sessions will be recorded on video (with audio). These recordings will be used to assist the analysis, to compare previous reports, look for synergies and anomalies, as well as to inform ongoing game development. The primary researchers conducting the interviews will keep video logs of their findings and thoughts after each study. These will also be analyzed along with the recordings of the participants.

**Procedure**

The game is installed in an open area of the tram. Players are free to play alone or with others. Once players are finished playing the game, they are asked if they would like to be interviewed.

**Analysis**

We will look for common themes that arise throughout our data collection, these will be discussed with co-researchers. The researchers will also be keeping a video log where they speak about their opinions and findings after each study. This will also help us analyze our data.

**Challenges**

Due to the nature of the space that we are conducting our research in, there are several challenges that we face. For example, passengers constantly entering and leaving the space makes it hard to engage them in play and in conducting interviews afterwards. We address this by keeping the game simple and the play time and interviews very short while still being able to capture enough data to analyze. Our game is designed to be picked up and dropped by passengers with ease as it does not contain a story element or any other complex game mechanic that requires extensive time to understand.

**PRELIMINARY FINDINGS**

From our studies conducted on local trams so far, we can report on preliminary findings.

Playing on public transport is a performative activity as other passengers are constantly watching the players play the game. Therefore it is important for the display to be visible for not only the players but also for the audience as they also seem to enjoy the experience of being an observer. Thus the audience are engaged, allowing for observation or even participation [10].

Placing a game in an unconventional play space like public transport easily gains the attention of the people in the space, as it is not a common sight to see such events occurring in the space. However, we still find it difficult to engage even the curious passengers. As expected there is a social barrier to entry.

Several players have reported that the tram moving back and forth has an influence on the game, and that they sometimes try to resist the acceleration and deceleration of the tram. We find this to be unique to a tram, and the fact that the tram is able to manipulate the player’s control over the input to be a very interesting game mechanic that can be leveraged.
LIMITATIONS
Our research investigates the role of play in one particular unconventional play space (i.e. public transport, namely trams). Naturally, there are many more. However, this is only the first step into such an investigation. As such, this research only provides a snapshot of a particular unconventional play space. Nonetheless we believe our insights are a valuable starting point for researchers to investigate this domain further.

CONCLUSION
We have presented Cart-Load-O-Fun, a work in progress project. We report on preliminary findings from studies conducted on local trams. Our game acts as a research vehicle to explore the ways in which digital games that incorporate both the commuter’s body and the social setting can enhance the experience of unconventional play spaces, in this case, public transport.

We aim to provide guidance for game designers who consider unconventional play spaces such as trains and trams, evoking playfulness in users of these spaces, allowing for more engaging experiences, ultimately allowing players to rethink where, when and with whom we play. We aim to further enhance our study and therefore enrich our contribution.

REFERENCES
Appendix F. Musical Embrace: Using Social Awkwardness as a Game Ingredient
Student Game Design Competition Entry for ACM bi-annual research conference Fun and Games 2012.
Awarded Audience Choice Award.
Musical Embrace: Using Social Awkwardness as a Game Ingredient

Abstract
Some social situations can be awkward. However, socially awkward situations are not always negative; examples from the entertainment domain suggest that they can also result in memorable and engaging experiences. Yet so far, there has been little exploration into social awkwardness and digital games. In response, we present Musical Embrace, a digital game that requires physical contact between strangers through the use of a pillow-like controller that requires pressure from their torsos to move through a virtual soundscape. Through our observations from demonstrating Musical Embrace at an open house event, we developed a set of strategies to engage players in socially awkward digital play. With our work we hope to guide game designers when considering social awkwardness as a compelling ingredient in digital games.

Author Keywords
Exertion game; social awkwardness; digital play; body contact; tangibles; uncomfortable interactions.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factors

Introduction
Digital games are generally considered as offering positive
entertainment experiences. Social awkwardness, on the other hand, is often considered a negative experience that can involve stress and lead to mental and physical suffering due to fear and anxiety [1]. Interestingly, Benford et al. propose that uncomfortable interactions, such as those facilitated by social awkwardness, can work to enhance the entertainment experience as opposed to diminishing it [1]. This notion stems back to humans’ fundamental need for stimulation, arousal and excitement and is common where feelings of thrill may arise from a combination of fearful anticipation, followed by an extreme physical sensation, and then euphoria of relief at having survived [1]. Examples where these types of experiences are fostered are extreme sports and theme park roller coasters.

Our focus is on uncomfortable interactions arising from social awkwardness, and ways in which digital games could be enhanced by social awkwardness created by physical contact, similar to what exists in some traditional, non-augmented games. For example, in the game Twister, players climb over each other in an effort to put hands and feet on certain parts of the floor, creating awkward physical contact between players. Similarly, the coconut game requires two players to maneuver a coconut from their bellybuttons towards their lips without using their hands. In both games players deliberately engage in socially awkward situations in order to experience an engaging play experience.

Based on these investigations on uncomfortable experiences and their engagement benefits, we present Musical Embrace (Figure 1): a novel digital game that requires physical contact between strangers as they need to apply strong pressure, collaboratively, to a suspended pillow controller using only their torsos in order to move through a virtual soundscape. We have demonstrated Musical Embrace at an open house event, and through our observations and design knowledge we have developed a set of strategies to facilitate socially awkward digital play that engages players rather than drives them away.

In the next section, we present what we learned from previous work that inspired Musical Embrace. Then we present insights from player observations and articulate strategies that might help other designers when considering social awkwardness as digital game ingredient.

**Related Work**

Many game platforms also allow players to engage with bodily interactions, such as the Nintendo Wii, Sony PlayStation Move and Microsoft Kinect. However, these platforms generally require physical separation between players due to both sensor technology and the interactions typically used, such as arm swinging. We believe that by having players stay apart, there is a missed opportunity for exploring social awkwardness and bodily interactions.

There are a number of existing games that provided us with inspiration. One digital game that explores intense physical bodily interactions is Bubble Popper [5]. In this game, body contact between two players is not only allowed, it is also promoted in the digital game through a competitive element. Although Bubble Popper does not require bodily interaction between players, the game demonstrates that bodily interactions can be encouraged through digital game design.

Another game exploring body contact is Combiform, a digital game platform featuring four combinable handheld controllers. Although this game platform does not focus on social awkwardness, we draw inspiration and consider the importance of co-located, co-attentive social interactions among players in order to facilitate an engaging experience [6].
A game that does aim to use bodily contact while possibly inducing social awkwardness is the iPad game Fingle, in which players are led to touch each other’s fingers as they try to keep their fingers on certain spots on the iPad [2]. Fingle demonstrates that bodily interaction can be encouraged through collaborative game elements, and utilizes social awkwardness to create engaging play. Our project seeks to create more intense bodily contact, as well as critically examine the impact of such interaction on the experience.

Additionally, an important aspect of social awkwardness is the existing relationship between players. A system that explores awkwardness and bodily contact between strangers specifically is the Mediated Body. It involves touching another person, which is assumed to be socially awkward, but can yet lead to "performative and behavioral" immersion between the participants [3]. From this system, we draw insights into how digital systems and tangible interactions alter the social dynamics between strangers.

In sum, although interactive systems have supported bodily interactions and created social awkwardness amongst players, we see further opportunity to explore how intense bodily contact and social awkwardness in digital games can enhance players’ experiences. In response, we present Musical Embrace, a digital game that promotes social awkwardness through bodily interactions in order to facilitate an engaging experience.

Musical Embrace

In Musical Embrace, two players are invited to enter the game space, which includes a pillow-size device hanging from the ceiling at around chest height, as well as a large screen placed to the side. Players are invited to apply pressure to the pillow, but as it is hanging off a rope, they have to do it from both sides at the same time. The players are only allowed to use their torsos to touch the pillow; no direct contact is permitted with their hands, but they can use their arms to embrace the other player to intensify the pressure (Figure 2).

Besides the intensity, the location of the pressure applied on the pillow is also important. The players navigate a virtual world from a first-person perspective that is displayed on the screen. This virtual world is populated with a set of destinations that represent sound sources. By applying pressure to the four corners of the pillow, the players navigate from destination to destination, hearing pleasing sounds when they get closer, and by applying pressure at different intensities, they determine the speed at which they travel. The objective of the game is to navigate to as many sound sources as quickly as possible. After two minutes, the game ends and players hear a sequential track of all the sounds in the virtual environment.

Technical implementation

To create our pillow controller, we encased a Wii Balance board in foam padding and wrapped it in cloth. The virtual world is created with Unity, and we used Glovepie to communicate between the two via Bluetooth.

Experiencing Musical Embrace

Musical Embrace was presented, along with other games from our "radical games" class at an open house event at our university. The audience was in the game design field or shared related interests. More than 40 people participated.

A journey of social awkwardness

Benford et al. suggest that discomfort is usually not the overall goal but rather a momentary point on a journey through a digital experience [1]. They use the classic five-act performance structure consisting of exposition, rising
action, climax, falling action, and denouement to articulate this journey [1]. We found that our participants also experienced this structure.

EXPOSITION
The first stage, exposition, involved the initial framing of what to expect in the game. Since the game was prominently placed near the entrance of the lab, everyone entering the space witnessed others playing. There was also a video showing how the game is played in a cartoon style. This informed participants what to expect when they would start playing.

RISING ACTION
The second stage corresponded with the player’s decision to participate. Awkwardness appeared to increase, reflected by the players’ reluctance to follow through with the game as they found themselves next to a stranger, wondering what sort of interactions this stranger would engage in and permit.

CLIMAX
The climax stage occurred when the players began playing, when “anticipation turn[ed] into actual experience” [1]. This saw players beginning to act upon the pillow in order to navigate the virtual space and locate the various sound sources. We observed many players laughing, yet often nervously, when they discovered bodily actions together that resulted in positive outcomes in the game, i.e. triggered a sound destination.

FALLING ACTION
Here players accepted the social awkwardness as a means to an end, and as a result, players began to embrace the intimate nature of the game, and enjoyed having tackled the initial discomfort together (Figure 3). They also started to explore new and interesting ways of interacting, such as bending their torsos back.

DENOUEMENT
Once the game came to a close, players reflected together on what they had just experienced. This stage also paved the way for feedback, resulting in many suggestions on how the game could make a contribution beyond entertainment; for example it was suggested to use the game as a tool for dancers to make warming up and stretching more engaging.

Strategies for Social Awkwardness
Poremba states that “the act of playing provides players with an excuse and an alibi to do things that break social norms and push the social boundary as a means of exploring concepts and their benefits, values or worth” [4]. This explains why players would want to engage in a game around social awkwardness. However, playing is a voluntary activity, and players can always stop, therefore restoring the preexisting social boundaries. In general, humans tend to avoid social awkwardness; therefore game designers aiming to create successful game experiences face the challenge of encouraging players to enter and stay in a state of play despite awkwardness, while also engaging players through and with awkwardness. By means of our observations as well as the knowledge gained through creating Musical Embrace, we identify a set of game design strategies to engage players with, through and despite social awkwardness.

Required collaboration (through)
The setup of the pillow, i.e. hanging it off a rope, calls for two players to collaboratively apply pressure from both sides. Players realized that they needed their partner in order to play, facilitating engagement through social awkwardness.

Mapping unusual bodily actions to a virtual world (through)
Players’ bodily actions are mapped to actions that enable them to traverse the virtual world. While this gives players...
the aforementioned "excuse" for their socially awkward bodily actions, we found that our game was strengthened by creating an unusual mapping of bodily to in-game movement; for example, players must twist their hips to go backwards in the game world. This encourages the players to explore the set of actions available to them, giving them further justification for socially awkward actions. This exploratory aspect, facilitated by the virtual world, seemed to contribute to players' enjoyment.

**Virtual world on screen as social sanctuary (despite)**
The screen, which displayed the virtual world, not only provided players access to the virtual world, but also functioned as social sanctuary when the experience became too awkward. Players who seemed uncomfortable redirected their attention to the screen more in order to shift the focus from the uncomfortable bodily interaction to one of virtual traversing, using the visual display as social sanctuary to retreat from the afforded awkwardness.

**Performance setup (with)**
The public setup of the game allowed players to perform to an audience, which some seemingly enjoyed. Performing to an audience was also a way for players to experiment with the social awkwardness of the experience, for example one man lifted up a woman to shift the awkwardness of the experience to one in which he became a public performer.

**Future Work**
Our own investigations, as well as player feedback, has highlighted interesting avenues for future development in the area of social awkwardness in games such as: can playing such a game break social boundaries? Can social connections be fostered faster through this game than playing a mouse and keyboard game? Do games around social awkwardness have the potential to help understand or help treat social interaction disorders, such as displayed by Asperger's syndrome?

**Conclusion**
We presented Musical Embrace, a novel digital game that uses social awkwardness facilitated by bodily interactions as a successful game ingredient. Through our observations and knowledge gained through creating the game, we identified a set of game design strategies to engage players with, through and despite social awkwardness. Moreover, our game raises the bigger question of whether games, and digital play, can help us further understand how we as human beings interact with each other. With our work we hope to guide game designers to consider social awkwardness as a compelling ingredient in digital games.

**References**
Appendix G. Hanging off a Bar
Interactivity exhibit at the annual ACM research conference CHI 2012.
Abstract
Exertion Games involve physical effort and as a result can facilitate physical health benefits. We present Hanging off a Bar, an action hero-inspired Exertion Game in which players hang off an exercise bar over a virtual river for as long as possible. Initial observations from three events with audiences ranging from the general public to expert game designers suggest that Hanging off a Bar can be engaging for players and facilitate intense exertion within seconds. Furthermore, we collected suggestions for what game elements players believe could entice them to increase their physical effort investment. These suggestions, combined with Hanging off a Bar as research vehicle due to the easy measurement of exertion through hanging time, enable future explorations into the relationship between digital game elements and physical exertion, guiding designers on how to support exertion in digital games.

Keywords
Exertion games; exertion interfaces; whole-body interaction; exergames; sport; game design
ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces - Miscellaneous.

General Terms
Design, Human Factors

Introduction
Exertion Games are digital games where the outcome of the game is significantly informed by physical effort [4]. The most prominent exertion game systems today are consoles such as Microsoft’s Xbox Kinect, Nintendo’s Wii and Sony’s Playstation Move. Although they are believed to provide physical health benefits [3], they have been criticized for promoting only limited physical effort investment, especially when compared to existing sports activities [2]. One reason for this could be that the sensors involved mainly aim to capture flailing of body limbs as generic input, rather than focusing on specific exertion actions. In contrast to this, we present Hanging off a Bar, an exertion game that aims to facilitate intense exertion.

Hanging off a Bar
Hanging off a Bar emerged from our teachings on Exertion Games [5]. One of its aims is to challenge our understanding that Exertion Games necessarily require bodily movements: Hanging off a Bar is aimed to be intensely exhausting, yet users do not move much. The game plays with an action hero theme, inspired by narratives where the protagonist hangs onto something over a river or similar, demonstrating that hanging with pure handgrip strength can be very tiring and is not as easy as most movies make it appear.

In Hanging off a Bar, the player grabs onto an iron bar and begins hanging freely. A pressure mat underneath the bar interprets the hanging to start the game and a counter projected onto the floor displays the time hung (Fig. 1). The projection also includes a digital river, motivating the player to keep on hanging. After 10 seconds, a virtual raft floats down the river. Once the raft arrives under the feet of the player, the player can

Figure 1. Hanging off a Bar.
let go of the bar and jump “onto” the raft, allowing some recovery time for the arms and hands. However, the raft continues to float down the river, and so the player must grab the bar again. Over time the rafts get shorter and the gap between each raft longer. The goal is to hang on for as long as possible.

Most closely related to our work are the yoga-inspired instruction sets that use the Nintendo Wii Balance Board [6] as they also focus on particular body poses that facilitate exertion. However, our approach is a game rather than an instructor-based system. In consequence, we see this as an opportunity to use Hanging off a Bar as a research vehicle to explore the relationship between digital game elements and exertion. We present preliminary observations from the general public and expert game designers playing the game as well as report their suggestions on which digital game elements they believe could entice them to invest increased physical effort in order to fuel such explorations.

Observations of playing Hanging off a Bar
We report on initial observations from three separate events where we exhibited Hanging off a Bar. The first event coincided with an art gallery’s open reception, attracting people interested in interactive art. Our second event was in our lab, where we hosted the International Game Developers Association’s local chapter meet, which attracted over 100 expert game designers. Our third event was in a public shopping mall, where the game was accessible to the general public as part of a digital festival. Preliminary feedback from these events suggests that players found the experience engaging despite the physical effort involved, as participants were eager to play. Participants learned quickly from watching others play the game, suggesting that Hanging off a Bar was easy to engage with. The game was also sufficiently challenging as intended: although fit players such as rock-climbers achieved scores of over 2 minutes, typical hanging times were under a minute, while some finished in less than ten seconds.

Suggestions to entice exertion
Hanging off a Bar allows the easy measurement of participants’ effort investment through the logging of hanging times. Furthermore, the specific software implementation allows for the easy modification of the digital game elements. These features make Hanging off a Bar a convenient research vehicle for planned future work where we aim to explore the relationship between game elements and exertion. In order to fuel this exploration, we now present suggestions players had in terms of which game elements they thought could entice them to increase their physical effort investment.

Better graphics
A number of the game designers saw opportunities to improve the graphics towards photorealism, proposing that increased visual fidelity could facilitate increased physical effort investment.

Facilitating fearful emotions
Hanging off a Bar plays with the idea of dropping into a river, fostering fearful emotions. It was suggested that we play with these emotions through additional game elements, such as virtual crocodiles or fire, in order to entice more effort investment.
Hanging together
Although Hanging off a Bar currently supports only one player at a time, we often saw bystanders cheering a player on, turning it into a social experience. Software modifications could also allow bystanders to trigger the appearance of rafts upon seeing players getting tired. Hanging socially might encourage increased effort, in line with social facilitation theory that suggests that the presence of others can influence performance [7].

Virtual audience
Another avenue to socially extend the game could be to include a virtual audience. Further investigation could examine if a player’s exertion changed depending on if the audience is controlled by software or by humans. For example, the virtual audience could be controlled by the player’s friends who submit cheers through a website, similar to the Facebook chants enabled in the Nike+ jogging app [1].

Conclusion
We have presented Hanging off a Bar, an Exertion Game that leverages intense physical effort over a very short time. Initial observations with a wide range of users suggest that the game can be engaging. The simple exertion activity of hanging allows using Hanging off a Bar as a convenient research vehicle to explore the relationship between exertion and game elements. To inform this exploration, we have asked players what they think would entice them to invest increased physical effort, and the themes of better graphics, facilitating fearful emotions, hanging together and virtual audience emerged. Future work will show if and by how much these elements can increase player exertion. Eventually, Hanging off a Bar will help to develop strategies for the design of future exertion games, ultimately resulting in better exertion games, helping players to profit from the many benefits of exertion.

Acknowledgements
We like to thank the team around Luke Sayers, Jack Crosby, Josh Tatangelo and Lauren Rashleigh for originally suggesting the idea and Andrew Lewis and Kyhil Duggan for supporting this project.

References
Appendix H. Future User Research for Exertion Games

Future User Research for Exertion Games

Abstract
Exertion is gaining currency in digital game design. Exertion games promise increased athletic performance and hence health benefits. They also offer enhanced engagement due to the coupling of physical engagement with digital gameplay. Addressing these converging perspectives is one of the challenges currently faced by researchers. To illustrate the implications for game user research and provoke reflection about future challenges, we describe our current research on Joggobot, a flying robot companion for joggers. We present a set of questions from our work that we believe represent some of the key challenges researchers will face when considering robots in exertion games. Through these questions, we aim to support research into the future of exertion games and develop guidance for designers to create better game experiences that leverage the many benefits of exertion for players.

Keywords
Exertion games, exertion interfaces, whole-body interaction, exergames, sport, game design, jogging, running, quadrocopter, human-robot interaction
ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Exertion Games are digital games where the outcome of the game is significantly informed by physical effort [5]. The most buoyant exertion games today are enabled by console game systems such as Microsoft’s Xbox Kinect, Nintendo’s Wii and Sony’s PlayStation Move. Exertion applications running on mobile phones that people use as part of their exercise routines are also on the rise: for example the Nike+ [1] is used by thousands of joggers who track their performance and share it with others online to engage in competitive races, such as “who ran the most kilometers this week?” Exertion games are an important area of research, as they have been applauded for their potential to offer health benefits, in particular combating weight issues, contributing towards addressing the obesity epidemic [3].

Exertion games pose unique challenges, but also opportunities for researchers interested in understanding the user experience when engaging in these play activities. Previously, we detailed evaluation methods available to researchers of exertion games, arguing that borrowing techniques and tools from both qualitative and quantitative colored disciplines such as sports, psychology and interaction design could be fruitful [6]. Combining methods may beneficially provide insights into the convergence that characterizes many exertion games in terms of their design objectives. Firstly, exertion games are meant to be engaging, as it is believed that more engaging experiences will result in increased participation. Secondly, exertion games are meant to facilitate increased athletic performance, ultimately resulting in improved health outcomes. Although these two objectives often complement each other, experience from traditional sports suggests that physical activity is not always engaging for everyone [4]. The same could apply to exertion games, and researchers are faced with the challenge on how to address this convergence in their investigations.

Game user research for exertion games
To extend this work, we present our current position on game user research informed by explorative research undertaken in the Exertion Games lab1. We believe that advances in technology combined with increased acceptance of robots in the population suggests that robots, autonomous embodied systems, will play a more prominent role in exertion games in the future. Robots will enable novel experiences for exertion game users, but also pose new challenges for researchers conducting research around these exertion experiences. We use an example project, Joggobot, to illustrate our thinking in this space. By pointing out the challenges and opportunities robots offer to exertion games, our aim is to a) inspire game researchers to consider robots in their game designs and b) inform game user researchers about the opportunities as well as the challenges they might face in the not so distant future.

Joggobot
Our recent research project Joggobot is an autonomous flying quadrocoptor that functions as a companion for casual joggers (Fig. 1). Joggobot accompanies joggers during their runs. The aim is to transform the often

1 http://exertiongameslab.org
solitary exercise activity of running into a more engaging experience. Through a visual marker on the jogger’s T-Shirt, Joggobot knows where the jogger is and can respond accordingly: Joggobot can speed up to motivate the jogger to run faster, it can fly next to the jogger to accompany him or her, similar to jogging with a dog, and it can perform flying “gestures” to entertain the jogger, distracting them from the discomfort of exercise, or communicating to speed up or slow down. We are also experimenting with input from a heart rate sensor to enable the Joggobot to perform actions such as warning the participant when she/he reaches unhealthy exhaustion levels.

Our goal with Joggobot is to explore how a jogger and their flying robot could interact in order to offer an engaging jogging experience. This forms part of a larger research agenda on how robots can contribute towards more compelling exertion activities.

Although not a screen-based computer game, we see the interactions with Joggobot as a form of digital gaming. We view jogging itself as a game in which participants voluntarily strive towards a goal through less efficient means [7]. Initial observations with Joggobot suggest that participants easily engage with it in a playful manner. Future research aims to apply further insights from computer gaming research to the Joggobot experience.

**Joggobot illustrating challenges for future game user research**

Joggobot serves as a provocative research example to illustrate the challenges for game user researchers when considering robot interactions in future game experiences. We now highlight the challenges we encountered in our investigations to date, by framing them as stimulating questions:

- How should the robot’s behavior be designed and what should the robot’s role be? A coach or a companion? Could the design address both of these...
approaches, and if so, how might a desired balance be achieved?

- Robots are embodied systems. What should the role of the embodiment be and how should this embodied nature be considered when conducting user research in games? Can embodiment be utilized so that it inspires, triggers, motivates and facilitates physical skills?

- People often attribute social behaviors to robots [2]. How should this be considered in our approach to user research in games, and, furthermore, exploited in the way we design these robots? Could the robot be a source of psychological support (for example by monitoring the jogger to promote confidence and security), in particular to people with motor difficulties (such as to support rehabilitation programs and special target groups like an elderly population).

- If both sports and computer gaming are considered games and play, what can they learn from each other and how could knowledge from both be exploited in our approaches to user research in games?

- Robot research is in its early days, as such, technical issues can be numerous. How do we consider this when doing user research on the resulting game experiences?

**Conclusion**

We have argued that exertion games are an important part of the digital game research design space, and detailed how these games pose unique challenges, and also opportunities for user research in games. Building on this, we have used the Joggobot project, a flying robot companion for joggers, to provoke thinking on what might lie ahead for game user research in the - possibly not so distant - future of exertion games. Our intention is to open up this provocative issue for discussion.

**Acknowledgements**

We would like to thank Eric Dittloff, Harry Lee, Wouter Walmink, Joshua Platt, Dan Torre, Wendy Ju, Jennifer Lade, Lisa Dethridge, Connor O’Kane, Jonathan Duckworth and Wolfgang Gräther.

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