ToDIGRA
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Introduction

Frans Mäyrä, Katriina Heljakka & Anu Seisto

Editors’ Introduction to the Special Issue

Even while digital games have meant a major transformation for the landscape of games and play, it can also be argued that all games are always also physical – or hybrid – by their nature. With traditional board or card games, for example, it is obvious that the tactile quality, materials and design of game boards, cards and playing pieces contributes to the look and feel of the game. And yet it is also equally clear that the physical characteristics of chess pieces, for example, do not contribute to the dynamics of game play in chess in a similar way as the rules of chess do. However, if the chess pieces are designed in non-conventional ways, like by making them very heavy, huge in size, or slippery, for example, the role of physical dimensions is again brought to the forefront of our game experience.

This special issue is a collection of papers which started their life as working papers, drawn from ongoing games research projects that were presented in the 2013 Game Studies spring seminar in the University of Tampere. Titled “Physical and Digital in Games and Play”, this seminar aimed on one hand to highlight the unique characteristics both material and immaterial aspects hold in games and play, but also to bring the digital and physical game studies into closer contact and dialogue with each other. Fifteen research papers were presented in the seminar, and afterwards the selection of articles in this journal issue were chosen and expanded through the standard process of double-blind peer-reviews and editorial work. We want to thank both the authors and the anonymous reviewers for their hard work in the preparation of this issue.

It is clear that while all games have some aspects that relate more to their designed nature, and some performative dimensions that appear
only when they are played with, the ongoing developments in information and communication technologies have meant that the relation of material and immaterial in games and play has changed, and is continuing to change as new technologies are being introduced. While an early video game like PONG (Atari, 1971) was certainly interesting both in terms of its rule system (as embedded in its electronic circuits) and in level of the material design of its arcade cabinet, the current developments in more advanced game controls and sensor technologies that have started to blur and redefine the traditional characteristics of computer and video games. PlayStation digital camera accessory EyeToy (Sony/Logitech, 2003) is an example of how pattern recognition and the sense of vision has become an element of video games, while the physicality afforded by the Wii Remote (Nintendo, 2006) has built upon accelerometer and optical sensor technologies in order to translate the movements of player’s physical body into game events. More recently, the Skylanders game series (Activision, 2011-) has utilized NFC (Near Field Communication) tags, embedded in physical character figures, which are then used to “import” these characters into the digital video game.

There is remarkable range of research issues that relate to the interplay of physical and digital in games and play, starting from the fundamental questions about the ontology of games (the ways in which games or play can be said to exist), and concluding in detailed discussions of individual games, or their physical and digital elements. The use of wireless technologies, various sensors, the growing popularity of mobile games as well as the many transmedia extensions of games into other media, or games related merchandise that also links with and extends the reach of games in different ways are just some examples of the directions which the research in this area can take. The selection of papers in this issue is of course not able to address all such areas, but together these seven papers are capable of mapping out some contours of this, rapidly expanding area. The dialectic of analog and digital is certainly proving to be one of the most fruitful catalysts for the ongoing attempts to redefine and
rethink what “game studies” actually are, and which questions should it address.

The seven papers of this issue are organised loosely in an order where we move from experimental work on playful, physical technologies towards more specifically games related research areas.

The first paper is by Stephanie de Smale, and it is titled “Building Material: Exploring Playfulness of 3D Printers”. In her article de Smale investigates the playful dimensions of 3D printers and the evolving practices around them. The author draws attention to how this rhetorically new, albeit professionally established technology affords playful engagement through a case study of the Ultimaker Original. The author suggests that the aspect of play is mediated both digitally (software) and physically (hardware). By addressing the materiality of open source development and creative processes in relation to the Ultimaker, de Smale argues that 3D printing stimulates its users to ludic engagement with the 3D printer by i.e. hacking it. As a result the author points out how these playful practices can be seen as part of a general development towards the ludification of culture.

The second article is joint work by Paul Coulton, Dan Burnett, Adrian Gradinar, David Gullick and Emma Murphy, and titled “Game Design in an Internet of Things”. The authors address the nature of game design in reference to the emerging Internet of Things. They consider the emerging convergence between games and the Internet of Things (IoT) by analysing contemporary physical/digital objects. In current times the boundaries between both the ontology and dimensions of toys and games are blurring and we are witnessing a growing interest of developing physical play affordances in virtual gaming platforms. This, as the authors suggest, creates new requirements for interaction design, both in terms of product and computer interface design. The article provides several examples of existing products that demonstrate novel takes on game design, such as Skylanders: Spyro’s Adventure from Activision and Disney Infinity.
The authors then utilise Bill Verplank’s framing of interaction design to consider the changing role of affordance when interaction takes place between both screens and phygital objects. Coulton et al envision a future in which creating game objects linking the physical and digital will require the adoption of broadly-based design sensibilities.

The third article is by Alison Gazzard, Mark Lochrie, Adrian Gradinar, Paul Coulton, Daniel Burnett and Daniel Kershaw, and it is titled “From the Board to the Streets: A Case Study of Local Property Trader”. The article describes an interesting case of a mobile location based social media game, extending and combining features from previous concepts e.g. FourSquare social media mobile application and the traditional Monopoly board game. A good and extensive overview on the subject of the relation between board games and respective digital games is given. NFC and QR code technologies are used to combine the physical and virtual worlds, making it possible for the players to move around the city and interact with local businesses. The use of technology and integration of players with the community updates the traditional Monopoly and offers excellent possibilities for new experiences.

The fourth article is authored by Frederika Eilers, and it is titled “SimCity and the Creative Class: Happiness, Place, and the Pursuit of Urban Planning”. This article reports an experimental study on the SimCity game. Employing a material culture method the author engages with the game manuals along with notebooks and presentations of Will Wright, the creator of SimCity, in order to clarify design work inspired by spatial representations, models and maps. In comparison, Eilers reviews the writings of urban theorist Richard Florida to evaluate similarities regarding cities and personalities and compares social engineering in the game and in urban planning theory. SimCity is addressed by Eilers as an artefact and its societies are discussed in reference to Florida’s creative class. The cultural analysis employing material culture methodology reveals the significance of places and happiness. At the same time SimCity poses unique problems since it reflects a simplified version of reality
like a road map or a model. The author suggests a discussion of benefits and limitations of framing the SimCity game in material culture, in play theory and in game theory to reinvigorate critiques of both Simulated and Floridated cities. Subsequently, Eilers concludes that any social and spatial assumptions the game conveys should be critically approached if used in education.

The fifth article of this issue is by Inger Ekman, titled “‘That’s Not a Secure Area’ – Physical-Digital Sound Links in Commercial Locative Games”. The author presents a detailed dissection of how sound is utilized in seven commercial locative games, based on first-hand play experiences. The article also contributes by revealing gaps between the research knowledge and current industry design practices. Sound is commonly underused modality in interactive systems despite the fact that, as a spatial sense, it is able to provide rich contextual cues and therefore effectively link real and virtual. The results highlight several interesting viewpoints into how sound is used as well as underused in recent games.

The sixth article is jointly authored by Karl Bergström and Staffan Björk, and it is titled “The Case for Computer-Augmented Games”: The authors discuss the benefits of using digital information and communication technologies to augment and facilitate traditional (non-digital) gameplay, rather than implementing games that rely completely on computers. They present earlier related work, such as Ishii’s concept “Computer-Supported Collaborative Play”, and the experimentation that has took place within the pervasive gaming research field. The main part of the article is based on several case studies where the authors have participated in the design and evaluation of computer-augmented games like “Wizard’s Apprentice”, “M.I.G” (Mobile Intelligence Game) and “Undercurrents”. Several different techniques are used in these experiments, including board game augmented with RFID-tagged game tokens, computer-simulated dice, and online, PC-based communication tool for helping share secret information in a tabletop role-playing game situation. The authors then proceed to present key dimensions for computer-augmented games, and use the
identified dimensions to further explore the design space of CAGs (Computer-Augmented Games).

The concluding, seventh article presents the work by Marcus Carter, Mitchell Harrop and Martin Gibbs, and is titled “The Roll of the Dice in Warhammer 40,000” In this article, the humble many-sided dice is taken under scrutiny. In the context of non-digital strategy game Warhammer 40,000 (W40k) the use of dice holds a particularly notable role. Typical to the tradition of war games, W40k is focused on turn-based simulation of battles, where attacks of each units are arbitrated with the help of rules, unit statistics, and dice. In this case, tens of regular, six-sided dice can be rolled at the same time, creating a small-scale physical and audio-visual spectacle as handfuls of dice simultaneously roll on to the table. On the basis of their interviews and participant observations of W40k players, the authors argue against some of the previous literature in computer augmented play. While it seems intuitively easy to claim that the ‘boring’ tasks of dice rolling and calculations of results should be augmented with digital technology (such as e.g. using a smartphone application), these chores actually appear to serve important social functions for strategy game players. Also, the physicality of playing with real dice contributes important audio-visual components to the gameplay of this type of tabletop games. The authors name as “digital augmentation fallacy” the tendency to overlook such functions in traditional, physical elements of games.

As this selection of studies shows, the diversity in physical-digital game studies is great, and there are several interesting directions where both experimental work, analysis and theoretical scholarship can proceed in the future. Consequently, this issue can be read also as an invitation for “hybrid game studies” – more interdisciplinary and critically aware phase of research which would challenge the division lines in academia, and as “hybrid turn” would challenge the relative isolation of such fields as board game studies, digital game studies, transmedial or hybrid media studies, and experimental, playful design research, for example.
Building Material

Exploring Playfulness of 3D Printers
Stephanie de Smale

Abstract

This article explores the practice of 3D printers from a playful perspective. Using the Ultimaker Original as a case study, it addresses the question of whether the practice of open source software and hardware in 3D printing is inherently playful and how the user affects and is affected by its playability. After examining the materiality of open source development and hacking processes in the Ultimaker Original, I will argue how playfulness of 3D printing stimulates hacking the 3D printer. From a broader perspective, the playful practice of 3D printing can be seen as part of a general development towards the ludification of culture.

Keywords

Play, Playability, Playful Media, 3D Printing, Open Source Software, Open Source Hardware, Ludification, Hacking, Ludic culture

Introduction

In his recently published manifesto, game scholar Eric Zimmerman argues ‘the 21st century will be defined by games’ (2013). He states ‘when information is put at play, game-like experiences replace linear media. Media and culture in the Ludic Century is increasingly systemic, modular, customizable, and participatory. Games embody all of these characteristics in a very direct sense’ (Ibidem). Although I do not disagree with Zimmerman, perhaps a more nuanced approach is desirable. ‘Game-like experiences’ relate in a direct sense to playing computer games, and involve skills and knowledge related to
games. As Katie Salen and Zimmerman himself have argued, there are multiple layers of playful expressions, game play, ludic activities and being playful (2004, p. 304). Where game play is the most rigid structure, ludic activities are less formal and being playful is a much broader category of play. Many game scholars agree that digital technologies seem to advance a culture of play (Raessens 2006, Montola et al. 2009, Deterding et al. 2011). And some scholars argue, there is a ‘ludic turn in media theory’ (Raessens 2012). In this article I propose to analyse cultural practices from a play perspective instead of a game perspective, which opens up an entire spectrum of media objects for game research. One such a recent phenomenon is the development of consumer 3D printers.

3D printing as technology is not a new technology – it has been around in professional industries for decades. However, in popular discourse there is rhetoric that 3D printing offers ‘the promise of control over the physical world’ (Lipson and Kurman 2013). Any object can be made digitally, and printed physically. ‘3D printing gives regular people powerful new tools of design and production’ (Ibidem). This rhetoric of newness is something that is often seen in digital technology (Kücklich 2004, Lister et al. 2009, Schäfer 2011). The problem with the rhetoric of progress is that it stays on a macro-level, and does not account for the dynamic process on the micro-level between user and design. Scholars like Patrick Hood-Daniel, James Floyd Kelly and Brian Evans write about the design process and how a 3D printer works but remain descriptive in their literature.

3D printing for consumers is an idea that has been in development since 2004 by Adrian Bowyer and a select group of enthusiasts in the RepRap Project (RepRap 2013a). One of those people was Erik de Bruijn, who together with Siert Wijnia and Martijn Elserman invented the Ultimaker, an ‘open source, large build platform derivative of the RepRap project’ (RepRap 2013a). Companies like RepRap and Ultimaker supply do-it-yourself (DIY) kits for users to build their own 3D printer. When looking into the production of these consumer 3D printers, I found that companies like Ultimaker have a large community of users that ‘hack’ the software and hardware in these
printers, and in turn help to innovate this technology. There seems to be certain playfulness in the practice of building and hacking a 3D printer. In addition to functionality and usability, playfulness is becoming an important aspect of the user experience (Arrasvuori et al. 2011, p. 1). As Marc Hassenzahl argues, emotional responses to a device or product depend on the interaction between perception, emotional responses in various situations, and the subjective nature of the experience (2003, p. 33),

This article deals with the notion of playfulness of the 3D printer Ultimaker Original. It addresses the question of whether the practice of open source software and hardware in 3D printing is inherently playful and how the user affects and is affected by its playability. Play perspective allows me to review the playfulness in the building and appropriation of DIY 3D printers, and their focus on open source software and hardware practices. This perspective of play serves as a hermeneutical tool to analyze hacking as a playful practice. Also, it permits me to investigate the ontologically playful nature of media phenomena like 3D printers. Game scholar Julian Kücklich argues that users experience freedom in media practices when submitting by the rules, which relates to the experience of pleasure of being in- and out of control (2004). According to Joost Raessens (2012) and Douglas Mark Rushkoff (2012) this dynamic constitutes four levels of playability, which can be understood as four stages of a player’s interactivity. These four stages allow for different emotional experiences of playfulness, which is materialised in the playful experience (PLEX) framework (Arrasvuori 2011). Together these views on the notion of play and playability will form lenses to which this article investigates hacking the Ultimaker Original as a playful practice, and its playful affordances.

Having studied the practice of the Ultimaker intensively for two months and visiting the Ultimaker company in Geldermalsen (Holland) to learn more about open source hardware and software processes in 3D printing, I will use it as my main case study. Also, I have reviewed a selection of academic literature and media texts on 3D printing. To investigate the playfulness in the practice of 3D
printing, I will first analyze the relationship between the user and the design process in open source software (OSS) and open source hardware (OSWH) in the Ultimaker. Furthermore, by comparing the modularity of OSS and OSWH processes with LEGO bricks, I will frame 3D printing as a ludic activity. Lastly, to argue for hacking as a playful media practice I will explore the relationship between different levels of playability and hacking practices.

3D Printing is Lego for Grownups


Popular discourses speculate about the meaning and future use of 3D printing. Every time an innovation is sold to the public, there seems to be an analogy with Star Trek. This time it is the Start Trek Replicator. “Tea. Earl Grey. Hot” a favorite drink from Captain Jean-Luc Picard, played by Patrick Stewart, is ‘printed’ by the replicator. This example is mentioned regularly as a future that we are moving towards (Carlson 2012, CNN 2012, De Wereld Draait Door 2012). The American company Makerbot has named their 3D printers ‘Replicator’ (Pettis 2012a). In Fabricated: The New World of 3D Printing (2013), robotics scholar Hod Lipson and technology blogger Melba Kurman provide the reader enough food for thought on the possibilities of 3D printing. Starting their book with a glimpse into the future through science fiction, the authors argue how 3D printing gives us control over the physical world.

Lipson and Kurman emphasise the instrumental materiality of 3D printing. Through examples in education, fashion industry, cuisine and science they argue that 3D printing will ‘close the gulf that divides the virtual and physical worlds’ (2013, p. 14). According to them, the convergence between physical and virtual worlds will happen in phases:

“First we will gain control over the shape of physical things. Then we will gain new levels of control over their composition, the material they’re made of. Finally, we will
gain control over the behaviour of physical things.”
(Ibidem)

In this quote ‘control over physical’ means making all objects from the physical world that were hard to replicate before 3D printing. Through the translation of shapes and materials into binary language it is possible to print designs with holes, curves and inside chambers with different blends of previously incompatible materials. The authors claim 3D printing technology allows for a new materiality. Digital virtual is the space where laws of nature like gravity do not apply and virtual objects are easily distributed and remixed. In the digital physical, the laws of nature are translated into code, are remixed, distributed and then translated back again into a new physicality (Lipson and Kurman 2013, p. 13-7). By stating this, the authors imply that there is a digital/physical dichotomy, and argue 3D printing can resolve this gap.

Utopian discourses like these are blind sighting for what is really going on, and raise the need for a critical evaluation of the actual material aspects in 3D printing. Although 3D printing makes digital 3D models into physical objects, the authors seem to claim that a new physical reality shall emerge. This modernist belief in progress is something that clings to technological developments. Many scholars have criticized a recurring rhetoric of progress in technological developments like 3D printing (Kücklich 2004, Lister et al. 2009, Schäfer 2011). As I will show later on, materiality of 3D printing lies in the process of open source software and hardware. Seemingly, the materiality is not in the stuff that comes out, but the processes around 3D printing.

Open source tinkering

Open source innovation kick started development in 3D printing for consumers. It all started with RepRap. RepRap is a ‘low cost open source rapid prototyping system that is capable of producing its own parts and can therefore be replicated easily.’ (RepRap 2013). Fueling the machine and its development, there is a large group of
hackers who create and share ideas on the RepRap Wiki. Other rapid prototyping systems, or 3D printers like Ultimaker or Makerbot, are based on RepRap developments (Makerbot 2012, RepRap 2013b). It is important to note that this development is based on open source ideology. Open source software (OSS) is based on the value that software is freely released. ‘Free’, in this context, means free for the public to distribute, modify and use. Or as information scholar Steven Weber argues, ‘when you hear the term free software, think “free speech” not “free beer”’ (2004 p. 5)\(^1\).

The Open Source Initiative (OSI) has defined the core of free software in the Open Source Definition. OSS is based on open distribution, available for everyone and modifiable (Weber 2004, p. 5). Officially, for software to be called open source it has to meet the requirements defined by the OSI\(^2\). OSS is opposite from software that is closed, not open for distribution and protected for commercial reasons. At first impression OSS may not seem commercially interesting in terms of intellectual property or copyright. However, OSS has proven to be very successful at stimulating innovation and development (Weber 2004, von Hippel 2005). This is something that we see in the development from high cost, to low cost 3D printers:

> “[T]he cheapest commercial machine would cost you about €30,000. And it isn’t even designed so that it can make itself. So what the RepRap team are doing is to develop and to give away the designs for a much cheaper machine with the novel capability of being able to self-copy (material costs are about €350).” (RepRap 2013b)

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1. The term Free Software was coined by software freedom activist Richard Matthew Stallman, founder of the GNU project. GNU project’s objective is to give freedom and control to computer users and their devices, by collectively developing and sharing software that is based on the rights for users to: Freely run the software, copy and distribute, study and modify the software (http://www.gnu.org/gnu/manifesto.html.en).

2. Extra information legal issues regarding the licencing in open source software and hardware, see the article ‘Towards Open Source Hardware’ by John R. Ackermann (2009).
Open source innovation like the RepRap Project has helped to develop ‘lessons that show that users can create, produce, diffuse, provide user field support for, update, and use complex products by and for themselves in the context of user innovation communities’ (von Hippel 2005, p. 14). This group of programmers fosters the use, sharing and remodeling of software and advocate to contribute improvements. So, OSS is modular, digital and easily changeable due to its open distribution and availability. However, what is interesting in 3D printing, is also the openness in sharing designs and knowledge about hardware.

The open source equivalent to hardware is called open source hardware (OSHW). OSHW works on the same principles as OSS. However, they are not a new phenomenon. DIY electronics have been around since tinkering with the radio. Fittingly, Tucson Amateur Packet Radio (TAPR) gives a commonly used definition of OSHW on their website:

“Open Hardware is a thing – a physical artifact, either electrical or mechanical – whose design information is available to, and usable by, the public in a way that allows anyone to make, modify, distribute, and use that thing. In this preface, design information is called “documentation” and things created from it are called ‘products’.” (TAPR 2013)

Even though OSHW borrows most of its definition from OSS, the open design and sharing of blueprints for hardware differs from the nature of open source software. Software, because of its digital nature, cannot be patented. It can only be kept private. Hardware, on the other hand, is tangible and accompanied with legal issues like patents and intellectual property (Ackermann 2009). While OSS and OSHW are different on an instrumental level, they are interrelated. In some sense OSHW is the physical form of OSS. They are part of the same family where voluntary participation and actions like making, modifying, and distributing are central.
Experimental production is motivated by curiosity in knowing, pleasure in tinkering, learning about the ins and outs of a machine, and fueled by ideologies like the belief that this work can benefit society. In open source development von Hippel highlights fun, intellectual stimulation, creative experience, greater knowledge and acknowledgement as important factors (2005, p. 60-61). In 3D printers, autonomy, informal learning, relatedness and meaningful experience can be seen as important motivations for participating in development (de Bruijn 2011, p. 20-3). It is the curiosity to know how technology works, and the desire to break open the machine. Participants in the RepRap movement have argued ‘it’s good fun as well as a learning experience’ (quoted from de Bruijn, p. 22). Although fun and informal learning seem to be important motivation, there also seems to be a belief in the broader societal significance in creating and building 3D printers. It is fueled from the intrinsic motivation that availability of 3D printers will have a big impact on society. ‘The thought of helping to make 3D printing far more accessible [sic.] to most households and third world countries in the hopefully not-too-distant future’ (Ibidem, p. 23). Experimental production of technology like 3D printers is an informal way of building, or tinkering.

While the ideological motivations of availability and access are also important to consider, I want to zoom into the way pleasure and informal learning can fuel open source innovation. Michel Resnick and Eric Rosenbaum describe tinkering as a specific approach to making and development. ‘The tinkering approach is characterized by a playful, experimental, iterative style of engagement, in which makers are continually reassessing their goals, exploring new paths, and imagining new possibilities’ (2013, p. 164). Resnick and Rosenbaum explore the possibilities of tinkering in education for young students, and have worked together with the LEGO group to use LEGO Mindstorms in projects. Just like von Hippel, Resnick and Rosenbaum argue for playful ways to collaborate and gain knowledge about technology.
Pleasure in tinkering seems to play an important role in the development of 3D printing. In some ways, 3D printing is like LEGO for grownups. The physicality of OSHW invites tinkering, playing with the machine. This resembles LEGO bricks, where the user can build, rebuild and share new inventions and ideas. Open source is flexible and can be used for different goals. The user can look into the software and hardware design, because of its open nature. Participation is voluntary, and the earlier successes of open source development are inviting. The interest in 3D printing seems to be more about the technology and how it works. The intrinsic motivations of the participant, and the playful building bricks are creating deeper knowledge and understanding of the technology in 3D printers. But to learn the extent of how the playful nature of the machine stimulates tinkering, I will take the reader deeper into the process of building a 3D printer.

Playful Process in Building 3D Printers

How-to-tinker

After seeing the playfulness in open source, lets take a closer look into the process of tinkering for the user. One of the problems in critically examining the newness of 3D printing is the descriptive nature of academic literature on the subject. When reviewing some books on 3D printers, a lot of them are about building a 3D printer, how to choose one, or how to use one. In Printing in Plastic: Build Your Own 3D Printer (2011) authors Patrick Hood-Daniel and James Floyd Kelly explain in detail how to build your own 3D printer. The authors take the reader step by step through the process of cutting the material and assembling it, assembling the motor and motor mount, the thermoplastic extruder, filament drive, mounting electronics, fixing the wiring like connecting power to the motherboard and motor, and finally installing the software (Hood-

3. LEGO products are constantly designed, targeted and sold to adult players as well. Some LEGO products are even used in the contexts and sites of serious play such as idea agencies and the like, see the book Toy Box Leadership. Leadership Lessons from the Toys You Loved as a Child, by Ron Hunter Jr. and Michael E. Waddell (2008).
Daniel and Floyd Kelly 2012. In Practical 3D Printers (2012) Brian Evans also describes how a 3D printer operates. The printer control application brings in the 3D model and sends it to a slicer application. Then, the printer control communicates with the firmware (specialized code), which runs on the electronics platform. The firmware controls electronics hardware to send the 3D objects according to the instructions received from the printer control and send data (temperature, positioning and other information) back to the control application (2012, p. 29). When building a 3D printer, the user learns into detail how the different parts make up the machine, how they operate and communicate with each other.

Because experiences is subjective in nature, it is impossible ‘to design an experience, but it is possible to design for an experience’ (Schifferstein and Hekkert 2008, Arrasvuori et al. 2011) In order to find out how the design affords playful experiences in building a 3D printer, lets try to break open the black box. In order to do this, we will need to examine its affordance, design and appropriation. According to Schäfer, all three aspects are intertwined: ‘appropriation is related to affordance, because the material characteristics and the design choices affect the act of appropriation. Design and the specific material qualities form the basis for use and appropriation’ (2011, p. 20).
Firstly, looking at the affordance of 3D printing is describing its specificity. Here we are looking at the material aspects of the object, and the stuff that it is made of. Consider, for instance, the design of a couch and how it is made sit on. ‘Affordance describes two characteristics, the material aspects, or the specificity of an object or a technology, and the affordance imposed on it through the design’ (Schäfer 2011, p. 19). Secondly, when examining the design the need for ‘evaluation of the specific features of materials used for a designated object, and an evaluation of the user’s appropriation to be incorporated into a next level of development’ (Ibidem, p. 19) arises. Lastly, by looking at the appropriation of 3D printing, this allows us to see the integration of 3D printing in everyday use, and how the users are adapting and transforming its original design. What is so interesting in the design aspects here is that the modularity of OSS and OSHW allow for a multitude of modifications. Users adapt and modify both software and hardware to fit their wishes and needs. Schäfer also argues the process of design is influenced by the maker’s own social context and political mindset (Schäfer 2011, p. 19).
this case, the open source ideology of sharing design, no commercial ownership and giving back to the community plays an important role.

Some scholars argue playfulness is an important part of product design, and state there has been a shift from ‘functional experiences (i.e., perceived usability and usefulness), to emotional experiences, the pleasures of using a product’ (Arrasvuori et al. 2011, p. 2). In their research, Arrasvuori et al. differentiate emotional experiences into several categories. The playful experience (PLEX) framework consists of 22 types of emotional manifestations: captivation, challenge, competition, completion, control, cruelty, eroticism, exploration, expression, fantasy, fellowship, humor, nurture, relaxation, sensation, simulation, submission, subversion, suffering, sympathy, and thrill (Ibidem, p. 2). These different types of emotion serve as an important indication of the different types experiences the user goes through. For instance the thrill in discovering how the system of building a 3D printer works, the pleasure in experiencing the first 3D printed object, made by the printer that was assembled by the user his/hers own hands. Also, the frustration when a mistake means the device has to be de-assembled again. But these emotional states are important in learning how the machine works, and create pleasure in building a 3D printer.

The emphasis on the descriptive working of the technology diminishes the playful aspects of the tinkering process. Fortunately, in these ‘how-to’ books there are important clues that can show us how users interact with the rules of 3D printing. They show materiality in the practice of 3D printing and how design is made to evoke emotional experience. As mentioned before, an important motivation of putting together and developing a 3D printer is the pleasurable experience of knowing how the device works and learning new knowledge. Although the concept of emotion is complex and problematic, some scholars have attempted to develop frameworks for measuring and analysing emotional experience (Desmet 2005, Norman 2005, Arrasvuori et al. 2011). ‘Using a product with a particular product character in a particular situation has certain emotional and behavioral consequences’ (Hassenzahl 2003, p. 33).
Hassenzahl emphasizes how the subjective nature of experience is a culmination of its interaction with the perception of the device, and the emotional response to the product, create the user’s subjective emotional experience. ‘People construct the apparent product character based on the particular combination of product features and their personal standards and expectations’ (Hassenzahl 2003, p. 33). The level of playability of the 3D printer depends on the expectations and tinkering experience of the user and the affordance of the product. A user, or player who wants to learn how a 3D printer works and use it, is able to work his way through the instructions, and following the rules. However, the playful design seduces the user to discover, and perhaps try to alter the 3D printer by reshaping the open source design.

Tinkering with hardware

The material design of the Ultimaker is plywood. This design has two specificities that draw the user into modifying a 3D printer. First, plywood in its bold form invites the user to be creative. You can change the color and finish if you like, or just keep it as it is. Secondly, the user has to put all the pieces of the Ultimaker together. The materials that are used to build the frame of the printer invite the user to modify the printer by changing the appearance, modifying from the inside creates deeper knowledge on how the device works. The affordance of plywood invites the playful experience of expression, where the user can be creative and use the 3D printer as a blank canvas. And it is also a form of relaxation, an easy modification that can be done without specific technical knowledge.

The only parts that come ready made are the electronics. The electronics include many parts that work together to build a 3D printer (Evans 2012, p. 30). Mostly, and as it is in the Ultimaker, a user doesn’t have a lot of choice which electronics come with the printer. Ultimaker uses open source RepRap based electronics that has up to 5 stepper drivers. These steppers are used to drive the x-, y-, z- axes and the extruder. Although the electronics comes ready made, the user still has to hook it up to the printer itself. The user
uses, or appropriates the 3D printer by actually assembling and de-assembling it. This way, tinkering with a 3D printer is actually part of its everyday use. In this process, the user can choose to either play the rules of the game, or break them and create something new that changes the shape or functionality of the 3D printer. Depending on the level of knowledge, the user can take control of his device and remodel the design, and some of the affordances. Later on I will dig into some examples of users whose modifications turned into innovations in the Ultimaker.

The big advantage when building a 3D printer, or in the case of the Ultimaker assembling it, is that the user really gets to know what kind of device they are dealing with. The user is not only building or assembling his or her own 3D printer, but also gaining knowledge about how this device works from the inside out. The affordance and design of OSHW invite the user to play. In 3D printing ‘play is a style of engaging with the world, a process of testing the boundaries and experimenting with new possibilities’ (Resnick and Rosenbaum 2013, p. 163). The user explores the underlying system of 3D printers by taking one piece, inspecting it and putting it together with other pieces, which in turn allows for the discovery of a new functionality. There is a constant feedback loop of captivation, exploration, discovery, challenge and completion.

Tinkering with software

As Resnick and Rosenbaum stress, a user can also tinker with software. They see ‘tinkering as a style of making things, regardless of whether the things are physical or virtual’ (2013, p. 166). Open source software in particular invites the user to try out different programs, or even create new ones. In the Ultimaker, there are different examples where users appropriate different types of software to fit their needs. A 3D printer has different types of software that work together to control the printer.

Control boards need firmware loaded on its microcontroller to make electronics come to life. Firmware is responsible for interpreting G-
code commands sent to the electronics from the printer (Evans 2012, p. 35). Ultimaker firmware can run on Sprinter, but more commonly used is Marlin, which is based on Sprinter (Ultimaker 2013b). Each firmware has its own features, and the open source design from Ultimaker allows for different types of firmware to be installed, giving the user more freedom to choose a program or develop one of their own. These choices create a sense of ownership over the device, which invites the user to play with the system of the printer.

There is a separate application called a slicer to generate the path for the printer extruder, which takes a solid 3D model and slices it into layers suitable for 3D printing. This process makes the code that tells the 3D printer where to move the extruder, when to extrude plastic, and how much to extrude. These commands are called G-code, and are sent from the printer control software to the firmware on the electronics. The electronics are responsible for interpreting these codes to control the printer motors and heaters. The most widely known slicing engine was Skeinforge, developed by a user in The RepRap Project (Evans 2012). Different companies use different engines, with all of their own algorithms. A downside of Skeinforge is the time it takes to translate 3D model into slices (Mazzotta 2013). Right now Ultimaker uses Cura, which has its own slicing engine and is a lot faster than Skeinforce.

The printer control application is the user interface. The host software, also named printer interface or printer control, is where the whole tool chain comes together (Evans 2012). From this application the printer connects and communicates to its firmware; moves the three different axes; reads and sets temperature for the hot end and the print bed; launches the slicer application and prints the 3D models. Ultimaker currently runs on Cura. Interestingly, the engine is developed by Ultimaker user David Braam as a better and faster alternative for Skeinforge. The Cura Engine is open source C++, and the console application is open source Python. It has been made as a better and faster alternative to the old Skeinforge engine. Although

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4. Cura was a solution for the usability of ReplicatorG. ReplicatorG is a printer control originally developed by 3D printing company Makerbot. ‘Where Skeinforge was the
Cura is fully preconfigured to work on the Ultimaker, you can also use it for RepRap printers.

The open source design of the Ultimaker invites the user to modify and tinker with the software. And the modification done by David Braam, originally an Ultimaker user, is a prime example how tinkering can lead to innovation within the 3D printing community. Braam developed Cura in his spare time to improve the functionality and user interaction (Benchoff 2013). In an interview with Braam, he states Cura is a lot more playable. You can ‘play around with your 3D model, turn it around, play around with settings’ (Mazzotta 2013). Sharing his open source program with the community, the program quickly became the new standard for the Ultimaker printer control. This example illustrates how the playful design of the Ultimaker and its open source affordance allows users to appropriate their device. Hacking the software of the 3D printer is a high level of playability that revolutionizes the game by changing the rules. Of course specific knowledge and programming skills are needed, but it illustrates how the playful experience of informal tinkering is an important factor in innovation within the community.

In short, because of the openness in affordance and the design, a user is invited to play with their 3D printer. The feedback loop in assembling the printer allows for multiple playful experiences, which vary on the basis of knowledge, skill, environment, and personal interest of the user. The modularity of the Ultimaker is like playing with LEGO, where the user learns how to build use and appropriate their printer. The tinkering affordance of the Ultimaker created space for developers like David Braam to create an application like Cura. The really interesting part about the open source system of the Ultimaker is that the design and affordance allow modifications on both the physical and the digital level, expanding modularity not only on a software level, but also on a hardware level. As such, the ontology of the 3D printer can be seen as playful. Its modularity slicing engine that was widely adopted in the early days of the RepRap project, ReplicatorG, and the popularity of the MakerBot printers made this application synonymous with 3D printing’ (Evans 2012, p. 43).
invites the user to play just like with LEGO bricks: tinker, experiment, and appropriate your 3D printer any way you like.

Playful Printer, Playful Practice

Playfulness of 3D printing

The modularity and open source development in 3D printing are playful. But 3D printing is also a playful practice. Kücklich argues that a perspective from game studies is especially fruitful to analyze media phenomena, because of its flexible nature and ability to both preserve and criticize their own theoretical framework (2004). When looking at 3D printing from a play perspective, it is necessary to further define it. When we are talking about play, Katie Salen and Eric Zimmerman argue ‘play is free movement within a more rigid structure’ (2004, p. 304). When looking into the way play manifests itself, the authors group three types of play; game play, ludic activities and being playful (Ibidem, p. 303).

The practice of 3D printing is a ludic activity. Ludic, meaning ‘of or related to play’ can be play activities that not only form games, but also non-game behavior we call playing’ (Ibidem). Being playful ‘refers not only to typical play activities, but also to the idea of being in a playful state of mind’. Here the authors are referring to ordinary activities (Salen and Zimmerman 2004, p. 303). Tinkering with a 3D printer can be seen as a ludic activity. It is intentional and informal play, but still has some formal rules like the earlier discussed tool chain. In order to work properly, electronics need firmware to operate. Interestingly, as mentioned earlier, the modularity of open source has a playful nature. As shown before, models like open source are inherently playful.

Just as the open source system is both digital and virtual, the boundaries between play and non-play seem to fade. Media phenomena like 3D printing account for multiple transgressions of the boundary between play and reality (Kücklich 2004, p. 14). For instance, our mobile phones give us access to the Internet, carrying
potential play with us everywhere we go. He argues there is ‘ambiguity between openness and closure’ (Ibidem). Media practices are ludic, and transgress the playful boundary between digital and everyday life. Moreover, as Kücklich argues, old dichotomies of virtual and real world, or open and closed do not apply (2004). Here he is referring to augmented reality, where play is still mediated by the mobile device.

In 3D printing, the aspect of play is mediated both digitally (software) and physically (hardware). The user is actively involved in the physical creation of a user’s 3D printer. Like LEGO, the user gets a kit, which the user has to assemble his/herself. Instructions are given with tutorials that are also accessible via the Ultimaker website (2013a). The hybridity of both the physical and the digital aspect pose the need for a higher consciousness of the playfulness in open and closed spaces. 3D printing transgresses openness/closure of play and non-play and rethinks the blurred space of media practices.

Because of its affordance, the open source system is interchangeable. According to Rushkoff “‘open source” development can be seen as infinite games’ (2012, p. 248). He argues for a distinction between finite and infinite games and draws his argument based on the theory of James P. Carse:

“The rules are changed when the players of an infinite game agree that the play is imperiled by a finite outcome – that is, by the victory of some players and the defeat of others. The rules of an infinite game are changed to prevent anyone from winning the game and to bring as many persons as possible into play (Carse quoted in Rushkoff 2012, p. 248).

Like Carse, Rushkoff makes a distinction between games as finite, or infinite games. Whereas the rules of a finite game have winners and losers, an infinite game is changed to prevent anyone from winning.

In the infinite play of open source, the rules of the game – as defined by OSI – are, availability, open distribution and open for
modification. Interestingly, in 2012 Makerbot CEO Bre Pettis announced that the hardware of their latest 3D printer, Replicator 2, is not open source (Cnet 2012). Makerbot decided to go against the code of conduct, and not release the software and designs for their latest printer. This caused a real uproar in the OSHW community and lead to a few intense discussions on the Makerbot forum about ethics and intellectual property (Pettis 2012a, Brown 2012, Giseburt 2012). The real pain was caused by the commercialization of a product that once belonged to open source play. Even though the first Makerbot designs are inspired on RepRap, Makerbot decided to change the rules of the game and use closed code and hardware on their latest model. Which, in the eyes of the open source community, is spoiling the game. From a neo-liberal perspective, they can be seen as a winner. However, from a hacker perspective, the company of Makerbot is cheating. And as such, Makerbot is prevented from winning. The open source system can be seen as an infinite game, where there is a constant oscillation between the digital and physical materiality.

Hacking as a playful media practice

So, when looking at 3D printing from a play perspective, 3D printing is informal, ludic and infinite. The practice of hacking can be seen a mode of media consumption. ‘Hacking as play has been seen as inseparable from the demands (in terms of expertise and time) of programming’ (Lister et al. 2009, p. 291). Early home computing for the producers and users meant programming. To run most programs a basic knowledge of code was required. Just as in early home computers, 3D printers require technical skill on both the hardware and software side. The user has to know or learn the ‘language’ of 3D printing. How does the printer control ‘talk’ to the G-code in the firmware? What software is best suitable for my needs, and if there isn’t any, can I build it? Of course, there are many different types of users.

As we have seen in the notion of play from Salen and Zimmerman, play can exist in both ludic activities and ordinary activities. So what is the scope of playful interaction between the players and
3D printing? Although it was Huizinga (1951) who first theorized different types of players, Raessens (2012) and Rushkoff (2012) have both argued these different levels account for different levels of playability in media practices. The practice of 3D printing can have four different levels of playability; the regular user, the cheater, the modder or programmer. First, there is the user who accepts the fact that the ‘rules of a game are absolutely binding and allow no doubt’ (Huizinga 1955, p. 11). This would be the type of user that would just be interested in the technology and how the user can play the game. In the Ultimaker, this is the user who ‘just’ assembles the printer. However, open source ideology allows and maybe even entices the user to start fooling around with the process. The cheater who “pretends to be playing the game” (Ibidem) operates at the second level. This player – for example the one who uses cheat codes in computer games – is aware of the explicit and implicit rules of the game and tries to deploy them (against the rules) to his own gain. Users who make use of the available open source applications for the Ultimaker, but do not share their new ideas with the community, can be seen as cheaters. This can be an explanation of the harsh response of the 3D printer community on Makerbot’s decision to patent their products. At the third level we have the spoilsport, or the modder, “the player who trespasses against the rules or ignores them” (Ibidem). This is the user that modifies the game if the system affords it. OSS and OSHW afford for an entire reconstruction of the design and functionality of the 3D printer. Painting the Ultimaker can be seen as a form of light ‘modding’. Finally, there is the ‘outlaw, the revolutionary’ (Ibidem, p. 12). Users like David Braam have modified the everyday use of the 3D printer by creating a new printer control, which revolutionized the speed and functionality of the Ultimaker.

In the Ultimaker, the rules of the game stimulate the player to experiment and bend the rules. Download other software, play with settings, and if possible, try to improve your model to your liking. Hacking the 3D printer becomes a level of playability and part of the media practice. Not everybody will redesign their Ultimaker to make it fit their needs. Regular players people just like to print 3D objects. However, the more skilled a user is, the more freedom in
the system they experience. Playful practices such as building the Ultimaker ‘teach players to think in an active way about complex phenomena … as dynamic, evolving systems’ (Turkle 1995, p. 70). The player gains new experiences and affiliations, and preparation for new learning, something that literacy scholar James Paul Gee calls ‘active learning’ (2005, p. 24). The next level is, how can I improve my machine, and this is where hacking as a practice comes to life. As Rushkoff argues, the degree ‘to which playability is introduced to a closed system, reflects the extent to which its participants can set their own rules’ (2012, p. 249). The modder and programmers are exempting practices of hacking. The more the user hacks, develops or modifies, the more knowledge over the technology the user gains.

It is clear that the playfulness of 3D printing lies more in its technology and practice, than the act of printing. And as we see in the Ultimaker, hacking as a playful practice contributes largely to this development. Looking at the regular player, the objective is just to print cool objects. The tinkering involved is just putting the Ultimaker together, and when it works, it works. ‘[P]lay itself usually consists of learning those rules of the game world, as well as the interface’ (Rushkoff 2012, p. 251). But as Küchlich argues, the pleasure in playability for the user is the ‘individual who upholds the rules simply for the sake of the pleasure she derives from submitting to them’ (2004, p. 33). Being able to print anything you like depends on submitting to the rules of the interface. But interestingly, the rules of playing with the Ultimaker are almost teasing to bend the rules and appropriate the machine to your liking, either physical or digital. This itch can be traced back to the ‘intimate relationship between pleasure and control’ (Ibidem). In the open source system, a player gets rewarded for their hacks and modifications. Hacking as a playful practice ultimately leads to more control within this system.

Oscillation of in- and out of control

According to Rushkoff the level of playability reflect autonomy and agency of the player (2012). But in the open source system, breaking the rules is an unwritten rule. So I think we should make the
distinction here between individual agency and autonomy and systemic agency. Ultimaker has a close relationship with its modders and programmers. The company rewards hackers with the opportunity to develop their hacks to products and stimulates users to build new stuff, like LEGO. On their website, the company advocates the freedom to hack your 3D printer any way you like, either the hardware, software, electronics or material (Ultimaker 2013a). Increasing agency comes in different forms; personal pleasure; a deeper knowledge of the technology and working for bettering the community. As Kücklich argues, the pleasure of control exists on multiple levels, on an individual and systemic level (2004, p. 36).

Let’s zoom into an example of an individual level: the Ulticontroller, created by Bernhard Kubicek in 2011 for Ultimaker Original. In 2012 he wrote his personal experience down in a ‘tale of how a mere playful hardware hack developed into a product’ (Kubicek 2012, p. 1). Bernhard Kubicek bought the Ultimaker Original and put it together in 2011. Ultimaker allows users to use different types of firmware on their 3D printers. Kubicek describes how he modified the firmware Sprinter to run on the Ultimaker Original, and ‘made this configuration available to other people in the growing Ultimaker community’ (2012, p. 1). He worked together with people from this community to increase the usability and to spread his hack. Because of the technical affordance of Sprinter to support SD cards, he developed the idea to print directly from an SD card in the Ultimaker. This means a user can print without the use of a computer and the software (Ibidem). He developed his first prototype, and writes:

“The choice of how it should do what it should do were done by me: a guy who chooses mind over body, who is more concerned about his coffee machine than about his clothes. A guy who prefers building things to having a vibrant social live. Me, who dislikes apple, and loves Linux. Me, wanting to dominate the machine, knowing exactly what I want. Me, the typical hardware hacker, most likely your brother in arms. My satisfaction depends on how fast I can control the machine”(Ibidem, p. 2)
This quote illustrates pleasure of being in control (of the machine). On a personal level, Kubicek’s pleasure comes from governing his own machine and a better understanding and deeper knowledge of the rules that govern the OSS and OSHW system.

In the example from Kubicek, we can see that the user has gained more autonomy. But the moment commercial interests are involved the oscillation of being in- and out-of control is visible. When other users and eventually Ultimaker got interested in the Ulticontroller, and organized a hackathon to tinker with the first prototype of the Ulticontroller. The biggest problem was that his hack wasn’t aesthetically attractive, and needed more development:

“It was like he spoke a different language when he argumented. He wanted one button and an encoder, ideally combined. [...] For them [Ultimaker], the panel would be a nice add on to selling more printers. For me it was a nice hack” (Kubicek 2012, p. 3).

After the hackathon, Kubicek handed control over to Ultimaker, who developed the second prototype. For the hack to become a product that Ultimaker could sell, Kubicek had to hand over control of the device. According to himself, he was too involved emotionally; ‘If somebody pointed out how I could improve my panel, it most often felt like a personal insult’. Here the loss of control is unpleasant at first, however later on the loss of control is pleasurable again.

Improvements on the prototype proved to be a success: ‘the brain could not figure out, why it is so much better now than any of my designs attempts. I liked the shape. Honestly, I never thought about that’ (Kubicek 2012, p. 4). Eventually, Kubicek learned more about industrial design principles, and gained a deeper knowledge on developing workable prototypes for the 3D printing community. Furthermore, on the Ultimaker store, they give full credit to Kubicek and link to his personal story (Ultimaker 2013c). As Kücklich argues, ‘the loss of control is often experienced as enjoyable – if it alternates with the experience of being in control’ (2004, p. 38). It is because of
this oscillation of being in- and out of control on an individual level, that hacking – as a practice – seems to give more control to the user.

Kücklich argues ‘the media practices that have emerged with new media technology draw attention to the fact that users are not content with the level of control they are granted by the producers of this technology’ (2004, p. 36). He is referring to ‘illegal’ download activities and ‘ripping’ of CD’s and DVD’s. From the constructivist micro approach, the practice of hacking gives more control to users because of the dynamic relationship of affordance, design and appropriation. Redesigning the system, or changing the rules increases ‘the notion of pleasure the user experiences (Kücklich 2004, Raessens 2012, Rushkoff 2012). Further research can go deeper into the relationship of control and agency on the systemic level.

So, from a play perspective 3D printing is an informal, infinite play in both hacking as a practice, and the nature of 3D printing. In this type of play, the rules are to break the rules. Just like LEGO, 3D printing is made out of building bricks that can be built, broken down, rearranged and put back together in a new form. There are multiple levels of playability, where the modder and programmer have the highest control on an individual level. There are still commercial interests that have agency on a systemic level, so further research may look into the dynamic relationship between the individual and systemic relationship of control.

Conclusion: Learning to Play by the Rules

As I have argued in this article, for now, 3D printing is more about the development of its hardware and software, than about the stuff that comes out when you hit print. This development is made possible by the collective effort of enthusiastic hackers. Where hackers used to be political activists in claiming the ‘open space’ of the Internet (Barlow 1996), now they are integrated in neo-liberal activities and invited in hackathons and forums to share ideas and knowledge. According to Henry Jenkins, this active involvement of media culture has begun to alter the character of new media. He recognizes the crossing of
grassroots movement and corporate media through the concept of *Convergence Culture*: Media-savvy consumers turn into participants and are creating their own knowledge communities (Jenkins 2006). This influences the use of playful media. In this light hacking becomes a playful media practice. On a meso-level, companies like Ultimaker seem to stimulate such an environment, however more research needs to be done about their business relationship and the dynamic between user and producer.

According to Schäfer, material aspects have to be considered when analysing the use, change, and modification of technology like 3D printing. He argues that ‘affordance describes two characteristics, the material aspects, or the specificity of an object or a technology, and the affordance imposed on it through the design’ (2011, p. 19). Analysing the black box of the 3D printer shows its playfulness on a physical and digital level. The modularity of both software and hardware, and its open source design invites modification. As Rushkoff argues, open source can be seen as infinite (2012). Participants and nonparticipants work together implicit or explicitly. I have argued from a play perspective; the hybridity of physical/digital hacking in open source environments stretches playful activities into a playful nature.

In their discussion on playful media, Montola et al. postulate the function of pervasive play in teaching media literacy skills. They argue it is a ‘societal response to the need for advanced media literacy’ (2009, p. 276). This is in agreement with Resnick and Rosenbaum, who see hacking ‘as a valid and valuable style of working, characterized by a playful, exploratory, iterative style of engaging with a problem or project’ (2013, p. 164). This article has been an effort in showing how hacking as a practice teaches vital skills and knowledge of the 3D printer and its open source design. Open source software and hardware design break the 3D printer up into modules. The modularity of 3D printing is like playing with LEGO. LEGO bricks can be put together, broken apart, shuffled and appropriated in different ways. In this process, the user gains more knowledge on its technology. From a wider perspective, the hacking
the 3D printer can be seen as part of a general development towards the ludification of culture.

Seeing media phenomena through the lens of play opens up new perspectives on the relationship between user and producer. In this article, I have considered playability as a capability that can occur on four levels; the player that accepts the rules; the cheater who chooses to follow or break the rules; the modder who creates new situations within the game’s framework; or the programmer who either fundamentally alters the game, or designs a completely new one (Raessens 2012, Rushkoff 2012). When looking at the development of 3D printing, the modder and programmer are the players who gain a higher notion of control over the machine. The modder changes software, like what type of firmware is being used, or installs an open source upgrade to fit his/her needs. The programmer takes it to the next level, and creates OSS like David Braam, designing a new printer control that fundamentally changes the way the 3D printer is used. Hacking as a practice gives the user more control on an individual level.

It becomes apparent that ‘playability is dependent on the dialectic of being in control and out of control’ Kücklich 2004, p. 38). From a constructivist approach, hacking the Ultimaker, the user gains a higher level of control over the machine, deeper knowledge and autonomy. Bernhard Kubicek upgraded the usability of the Ultimaker by adding a controller, making the computer obsolete during printing. This micro-level of playability is related to the notion of control over the machine. From a meso-level, hackers, producers and 3D printing technology are actors in a complex process. Further research from a play perspective in the dynamic network of actors and actants may shed more light on conditions in which ludo-capitalistic, cultural and technological factors are playfully shaped, and shaping.

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Abstract

Whilst no consensus yet exists on how the Internet of Things will be realised, a global infrastructure of networked physical objects that are readable, recognizable, locatable, addressable and controllable is undoubtedly a compelling vision. Although many implementations of the Internet of Things have presented these objects in a largely ambient sensing role, or providing some form of remote access/control, in this paper we consider the emerging convergence between games and the Internet of Things. This can be seen in a growing number of games that use objects as physical game pieces to enhance the players’ interaction with virtual games. These hybrid physical/digital objects present game designers with number of interesting challenges as they i) blur the boundaries between toys and games; ii) provide opportunities for freeform physical play outside the virtual game; and iii) create new requirements for interaction design, in that they utilise design techniques from both product design and computer interface design. Whilst in the past the manufacturing costs of such game objects would preclude their use within games from small independent games developers, the advent of low cost 3D printing and open software and hardware platforms, which are the enablers of the Internet of Things, means this is no longer the case. However, in order to maximise this opportunity game designers will need to develop new approaches to the design of their games and in this paper we highlight the design sensibilities required if they are to combine the digital and physical affordances within the design of such objects to produce good player experiences.
Keywords

Introduction

There is little doubt that the video game industry is in a period of massive upheaval and despite the recent revisions of all the major consoles there have been a great many media reports predicting the ‘death of console gaming’ (Cousins 2013). This pessimistic view is primarily fuelled by significant reduction in console games sales over recent years and comes at a time when the popularity of social and mobile games has risen exponentially (Cousins 2013). Console games developers are arguably becoming risk averse and primarily concentrating on sequels rather than new titles (Czarnota 2013). This relates to the fact that their development costs are so much higher compared to developers of mobile, PC and social games who are able to be much more creative and speculative in their game designs as their financial risks are much lower. The tools associated with the development of mobile, PC and social games are also much more accessible to those who may be interested in a broader range of interactive entertainment such as experience designers and digital artists; some of whom are beginning to explore much more challenging themes within games such as sexual orientation (Anthropy 2012). These factors mean that there is a very real possibility that disruptive innovation (Christensen 1997) could occur within the console games industry with the emergence of cheaper console alternatives that double up as set-top boxes for streaming television and film, or ones based on advances in 3D printing, open-source operating systems, open hardware, and improved connectivity which could radically change the market.

Many of the enabling technologies that are fuelling this potential disruption are also at the heart of the so-called Internet of Things (IoT) which also has the potential to create a platform to explore innovative interactive entertainment. Although a clear consensus has yet to be established on how to realise the IoT, a global infrastructure
of networked physical objects (Kortuem, Kawsar, Fitton, and Sundramoorthy 2010) or things that are readable, recognizable, locatable, addressable, and/or controllable via the Internet (NIC 2008) is undoubtedly compelling for a range of industry sectors including games and toys. While many implementations of IoT have presented the objects in a largely ambient sensing role or as some form of remote access or remote control, arguably the most successful implementation yet seen is the game *Skylanders: Spyro’s Adventure* from Activision which places the object (thing) at the heart of the activity by using it to control the characters within the game (Coulton 2012). Skylanders is a Role Playing Game (RPG) in which the characters are actually Radio Frequency Identification (RFID)/Near Field Communications (NFC) enabled physical game pieces that are used to swap characters in and out of the virtual game using the ‘portal’ (RFID/NFC reader which connects to the console via USB or Bluetooth). One of the other unique aspects of the game pieces is that a character’s type, name and abilities are modified through game play and stored on the physical game piece rather than on the console. This focus on physical/digital (phygital1) things produces a number of very interesting effects such as: blurring the boundary between toys and games, expanding existing modes of game play to the physical world, providing the opportunity for physical play outside the game, creation of innovative phygital interfaces, and a novel business model around the figures (Coulton 2012). Disney Infinity (//infinity.disney.com) now offers a similar concept to Skylanders with NFC collectable figurines synchronised to game play using an NFC enabled base, but they have added a free form, ‘sandbox’ mode of gameplay within the video game. While Skylanders and Disney Infinity are arguably the most successful examples of IoT in terms of games there are also a number of ‘app toys’ starting to appear such as LEGO’s, ‘Life of George’ (//george.lego.com), Disney’s App Mates (//www.appmatestoys.com) and the YetYet from Totoya Creatures (www.totoyacreations.com). Except for these few examples, toys and

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1. We are using the term phygital as a way of emphasizing that these are a class of objects that have not simply had some digital functionality embedded within them but are connected devices whose functionality and operation is designed to exist simultaneously in both virtual and physical space.
games are two developer communities that largely operate independently, yet this novel interplay between toys and games facilitated by IoT could bring them together to produce new and mutually beneficial opportunities in terms of both games, and new economic models (Ng 2012). Whilst research is starting to emerge to describe the hybrid games/play that these objects facilitate (Kultima, Tyni, and Mäyrä 2013) in this paper we are concerned with the factors that game designers must consider in relation to the interaction modalities available in the design of these objects for their inclusion within virtual games.

Physical game objects

The game objects we are considering here can also be viewed as a form of Tangible User Interface (TUI), where TUIs can be defined as providing a physical form of digital information and facilitates the direct manipulation of the associated bits (Ishii 2008). However, as these game objects are generally located within the game space on a screen, they could also be considered a form of Augmented Virtuality (AV) in that they conform to its general definition of physical objects that are dynamically integrated into, and can interact with, the virtual world in real-time (Drascic and Milgram 1996). Although it is not wholly compliant with Drascic and Milgram’s original definition which related to the mixing of visual images from the real object within the virtual world on a display (Drascic and Milgram 1996), as demonstrated by projects such as Augurscope (Schnädelbach, Koleva, Flintham, Fraser, Izadi, Chandler, Foster, Benford, Greenhalgh, and Rodden 2002), the physical location of the object on the screen presents a comparable effect. In terms of AV games there are few specific examples relating to games as the majority of research relates to Augmented Reality (AR) (Bernardes Jr, Tori, Nakamura, Calife, and Tomoyose 2008) and Table Top AR in particular (Kato, Billinghurst, Poupyrev, Imamoto, Tachibana 2000). Indeed many of the desired features for TUI design in AR (Kato et al 2000) are applicable to AV. In particular, the features of:
1. The form of objects should encourage and support spatial manipulation (Kato et al 2000); 
2. Object affordances should match the physical constraints of the object to the requirements of the task (Kato et al 2000).

An additional consideration for game designers creating objects is that some of the interactions made possible with such objects may be representative of what Jesper Juul (Juul 2009) describes as mimetic interfaces in relation to casual games like Wii Sport and Guitar Hero. These games require players to perform actions that closely resemble the physical activity required by the avatar on the screen. These interfaces make games easier for players less familiar with the more ‘traditional’ configuration of game controllers utilizing buttons and joysticks to pick up and play casual games. As Juul describes, the requirement for players to strum the guitar controller in Guitar Hero requires no explanation as most would be familiar with the image of a musician playing a guitar. Whilst this prior knowledge may make learning the game easier, it also means that if the game challenges these expectations it is likely to put players off as there is a ‘metaphor mismatch’ (Hinske and Langheinrich 2004) between the game and controller.

Whilst descriptions of mimetic interfaces might suggest they are the same as Natural User Interfaces (NUI) they do not hold to the definition offered by Daniel Wigdor and Dennis Wixon (Wigdor and Wixon 2011) “natural refers to the user’s behaviour and feeling during the experience rather than being the product of some organic process” and, indeed, suggest a natural experience “is NOT best achieved through mimicry”. This description leads us to suggest that mimetic interfaces should be considered as a subset of the broader area of NUI.

Another interesting component within this classification discussion is the emergence of game interfaces based on real world artefacts
such as in the game Rocksmith from Ubisoft. This game comes with a cable that allows players to plug their own guitar into an Xbox 360, PlayStation3 or PC. In addition to the expected song tutor activity the system also provides a ‘Guitarcade’ of mini games that are designed to practice specific techniques. For example there is a ‘Space Invaders’ themed activity to help improve fret placement. In some ways such games invert the NUI paradigm as, arguably, the natural interface for many of the mini games would rightly be a traditional game controller.

Whilst the classification of phygital game objects is complex what is clear from the previous discussion is that game designers must draw from a wide range of disciplines that consider interaction modalities if they are to ensure that their design of such objects enables players to effectively operate in real and virtual space. In the following section we present a discussion around the design of such objects that draws understandings from both product design and computer based interaction design through which game designers might address this challenge.

Interacting with objects

In terms of general interaction design there are many ways that it has been presented but in this research we will utilize the sketch by Bill Verplank (Verplank 2009) recreated in Figure 1 as the basis for discussion.
Verplank frames interaction design as a designer answering the three questions: How do you do? How do you feel? How do you know? (Verplank 2009).

If we start with ‘doing’ then Verplank distils this to a consideration of whether the interaction is continuous or discrete (represented by the handle and button respectively within the sketch) and while both of these are applicable, and available, in the design of phygital game objects we must extend this also to consider that they are likely to be implemented as a combination of real or virtual interactions. Game designers must, therefore, consider carefully how such interactions are used and combined so that it ‘makes sense’ to the player. For example, in Skylanders adding a physical game character to the portal causes both a color change on the physical portal and the character to materialize on the screen which is important when considering the focus of the player as we shall discuss later.
In terms of how the users ‘feels’, while he considers this in relation to the users physical senses Verplank presents it in relation to the medium through which the interaction is presented to the user. This draws upon the work of Marshal McLuhan and his definition of a media as “any technology that ... creates extensions of the human body and senses” (McLuhan, M., McLuhan, E., and Zingrone 1996). McLuhan categorized media in terms of ‘hot’ and ‘cool’, whereby a hot media, such as print, is one that dominates one particular sense absorbing our attention and leaving little room for participation, while a cool media (sometimes described as fuzzy) that engages across our senses leaves space for participation (McLuhan, Fiore, and Agel 1967). When McLuhan wrote this original definition he considered television as a cool media although nowadays it would more likely be considered towards the hot end of the spectrum when compared to games and this illustrates that these are, as McLuhan intended, not static definitions but dynamic concepts. Arguably the Internet doesn’t really fit into McLuhan’s definition as it both encourages participation but it also commands our attention and often dominates our senses. As the phygital game objects under consideration would be expected to expand the interaction across many the player’s senses they are likely to appear at the cool end of the spectrum. In relation to the overall design of phygital objects, cool features are likely to attract and engage whereas hot features can be used to provide very specific activities, such as help, and designers would normally be expected to consider a combination of these within the design. For example, an interactive character toy could be used to voice the hints and tips of a game, specific combinations of interactions with the toy could unlock special powers, or using the toy in a certain physical location might unlock special locations within the game.

The final question of ‘how we know’ is illustrated by Verplank as paths and maps and he argues that often the best overall interaction design utilizes a combination of both (Verplank 2009). Note this categorization is derived from Kevin Lynch’s work in his 1960 book, ‘The Image of the City’, which studied how people developed an understanding of the layout of a city. Paths are primarily step–by-step instructions that guide the user through an interaction and it
is generally regarded as the easiest form of interaction as the user only needs to know one step at a time (path knowledge). Paths are commonly used in situations that require immediate action by users who are likely to be experiencing the required interaction for the first time (i.e. emergency door release) or in game tutorials. Maps essentially represent knowledge obtained through the interface affordances that help users construct coherent mental models from which new tasks and uses can be inferred. The knowledge maps build on affordances through the interactions performed by the users in multiple scenarios using objects and systems that provide similar interactions. Thus the interaction design of phygital objects for games requires games designers to not only fully understand the virtual aspects the affordances they are perhaps used to, but also to extend these to include the affordances we associate with physical objects to ensure their overall game design does not cause confusion for the player. It is therefore important to consider the concept of affordance in more detail and in the following section we present such a discussion.

Affordances of PHYGITAL Objects

The original concept of affordance was conceived by Ecological Psychologist James J Gibson (Gibson 1977) to define the actionable properties between the world and a person. He uses the example of a flat surface that affords ‘sitting on’ whereas a ‘pointy’ one would not. The important aspect of this is that an affordance of an object exists whether it is acted upon or not. The concept of affordance was most notably developed for design by Donald Norman extended from what he regarded as Gibson’s ‘real affordances’ to include ‘perceived’ affordances (Norman 2002). He argued that affordances “play very different roles in physical products than they do in the world of screen-based products” (Norman 1999) and unlike Gibson he also believed that affordances could be dependent on the experience, knowledge, or culture of the users (Soegaard 2003), for example, in Japan you would expect to read comics right to left and front to back. Further, Norman uses this as a means of distinguishing between the properties of an object that are controllable by a designer and
those that are fixed. In the case of the design of real objects, both the actual and perceived affordances are controllable, whereas for screen-based interaction generally only the perceived affordances are under the control of the designer, “as the computer system comes with built-in physical affordances” (Norman 1999). For example, all computer screens support the affordance of touch whether they are touch sensitive (i.e. respond to the touch) or not. If we add a graphical target on a touch sensitive screen we are providing visual feedback that advertises the affordance that touch interaction is supported, and this creates the perceived affordance of the user. This is an important point as it emphasises that while game designers might be used to incorporating the established perceived affordances within the built-in affordances of gaming systems and their controller, computers, or phones, they are unlikely to have contributed to the built-in affordances of the physical systems as these have traditionally been the preserve of product designers.

Bill Gaver stressed further the importance of affordances for design when stating “affordances exist whether or not they are perceived, but it is because they are inherently about important properties that they ‘need’ to be perceived” (Gaver 1991). Gaver also introduced with the concept of ‘sequential affordances’ which describes how in many situations a user’s action on a perceptible affordance then leads to new information relating to the next affordance in the sequence. In relation to games design this concept of sequential affordance can be considered alongside procedural rhetoric, for as the meaning of the game is communicated through participation (Bogost 2008), so are the affordances of its interaction design. To help designers consider the ease of use of the object/system they are designing, Gaver developed a figure (Gaver 1991), which considers whether perceptual information is available to users which we have recreated as Figure 2.
In this diagram a false affordance exists when there is no action possibility although the perceptual information implies that there is, however, others would argue that in such a case it is not that the affordance is incorrect but rather it is that the perceptual information is incorrect (McGrenere and Hon 2000). This would occur if a game designer created a physical object with a feature that looks like a button that could not actually be physically pressed. A correct rejection occurs when there is no affordance and no perceptual information to specify it whereas a hidden affordance exists when the affordance is present but the specifying perceptual information is not. Dan Saffer suggests hidden affordances may actually be regarded as ‘discoverable’ (Saffer 2013) in recognition that designers may deliberately allow them to be revealed through accidental use or deliberate exploration. This is similar to the practice of game designers leaving hidden elements, or ‘easter eggs’, within their games that are discovered by accident, this practice hints at a possible interesting opportunity yet to be applied to game objects. For example a poseable toy relating to an in-game avatar could unlock unexpected abilities when physically manipulated into a certain position by the player.

Whilst recognising Gaver’s contribution, McGrenere and Hon state that in order to “use affordances to evaluate and improve design,
it is useful to think of the degree of an affordance” and to “regard affordances as binary is to oversimplify them” (McGrenere and Hon 2000). To illustrate this they created Figure 3, which presents a two-dimensional space where one dimension describes the ease of which an affordance can be undertaken and the other dimension describes the clarity of the information that describes the affordance. Each dimension is a continuum and the goal for the designer is to first determine the necessary affordances and then to maximize each of these dimensions (McGrenere and Hon 2000). We suggest that phgital objects should be considered as dynamically traversing this space and designers should endeavour to unite approaches to affordances from both the physical and digital domains dynamically throughout the game. This means that game designers cannot consider real or perceived affordances separately or that these affordances are fixed and must address both of these throughout the design and testing of a game.

![Figure 3: Improving Affordance Design adapted from McGrenere and Hon (2000)](image)

Alongside affordances, Norman also defined ‘cultural conventions’ (Norman 2002) which also serve to constrain user interaction and derive from users’ conventional interpretations of how they should
interact with a particular artefact (in our case the game object). Norman further subdivides these cultural conventions into physical, logical, and cultural constraints. Physical constraints are related to the artefact, for example, in the case of Skylanders and Disney Infinity the figures can only interact with the virtual games when in contact with the portal or base and the NFC reader has a detection range of approximately 2 centimetres. Logical constraints are when users make judgements to deduce the nature of the interaction. For instance in Call of Duty as our avatar represents a human soldier we assume it can perform the physical actions we ourselves might perform. Cultural constraints are conventions shared by a cultural group. There are many shared cultural conventions in games that are reflected in things such as house rules but more noticeably in relation to game genre. For example we expect casual games to be short with very simple interactions. The challenge for game designers is in understanding which conventions they might inherit when designing a game object of a particular form.

The final section of our discussion considers the game space within which the interaction takes place. In his book *The Casual Revolution* Jesper Juul (Juul 2009) divided game space into: player space, screen space, and 3D space in order to highlight that in many casual games, such as those using Wii Sports, the player space plays a much more significant role than many more traditional console games (Juul 2009) especially to the audience. This division of game space provides a useful way for designers to consider where the focus of attention is for the player might be when interacting game objects in screen-based scenarios. This consideration will allow designers to clarify: in which space and how the interaction takes place; and in which space and how feedback on that interaction is presented to the player. Figure 4 provides two such interaction scenarios and unlike the casual games explored by Juul the question whether the games are either single or multiplayer does not dominate the discussion as it is anticipated both scenarios would support either type of game are more concerned

2. House rules are rules not formally part of the official rules of the game but are devised by the players themselves and can range from small additions to whole scale deviations in game play.
which space is the focus of attention for the player/s currently playing the game rather than others who may be watching the action.

1. In this scenario the screen of the tablet provides a surface through which the physical game objects interact with a virtual game that could be represented in either 2D or 3D space.

2. In this scenario movements of the physical object are transferred to the screen via a wired/wireless link and as with the previous case the virtual game can be represented as either 2D or 3D space.

It is important to note that although these scenarios are indicative of many of the current implementations of games incorporating phygital objects they are not the only possibilities and designers are free to explore the configuration of such interaction spaces. For example, scenario (a) allows relatively limited interaction by the player as the physical object needs to be in contact with the screen throughout play, although this could easily be combined with a wireless link from...
scenario (b) to allow much more information to be transmitted. Note that in this paper we have not considered either the communication technology the game objects might utilise (i.e. Bluetooth LE, WiFi, ZigBee, etc) or which architecture they might utilise to support the development of services (i.e. web service devices, virtual cloud devices, and peer to peer devices) which would undoubtedly affect the operation of the object.

Putting these technical considerations to one side if we return to our scenarios and consider the likely focus of attention of the player in these situations we can see that whilst scenario (a) provides a space where the player can switch focus between the physical object and the virtual game relatively easily, in scenario (b) their focus may change considerably and it is much more likely that feedback from the game on the screen could be easily missed. Whatever the nature of the overall game space created, designers need to consider carefully how the player will interact within each of the sub-spaces during the course of the game and in the case of toys the virtual game may not be present at all within some play activities. Therefore all possibilities need to be given serious consideration when creating the object.

Having provided some general guidance of factors that must be considered for the design of phygital game objects in the subsequent section we will provide practical examples of how these may be put into practice.

Interacting with PHYGITAL Objects

In this section we explore the creation of game objects with examples that incorporate specially designed 3D game objects and the customisation of a Makie doll (/makie.me). Makies are 3D printed poseable action dolls whose faces and features are designed by the customer. A web interface and iPhone app allows users to choose what the Makie looks like by adjusting: the eyes, nose, ears, jaw, smile, hands, feet, hair, and clothes. The other valuable feature in relation to this project is that the head and torso of the Makie have been deliberately left hollow to allow owners to ‘hack’ their doll
with electronics such as Lilypad Arduino (a specially designed slot is provided in the Makie head for this device).

In the following sections we consider the two scenarios previously defined in relation to the design of the objects and their interaction.

Direct Interaction of Phygital Objects with Touch Sensitive Screens

In this first section we consider scenario (a) by evaluating how phygital game objects can be created that exploit the underlying technology of multi-touch input devices, such as the iPad, rather than by the creation of of new gestural interactions that are then associated with the objects (Buxton, Hill, and Rowley 1985). Where early touch sensitive phones and tablets employed resistive touch screens, which required physical pressure to be applied to create a touch event, capacitive touch screens, seen on the vast majority of current phones and tablets, exploit the electrical properties of the human body through mutual or self capacitance. Therefore any phygital game objects produced must allow the conductance of the player fingers to pass through them and onto the surface of the device in order that they register an interaction. An illustration of how simply this concept can be achieved is shown in Figure 5a whereby a Makie was fitted with clothes made from conductive cloth allowing the charge from the players fingers to be transferred to the surface of the iPad running an app that presented the surface as if it was water.
In Figure 5b we present another example that extends this approach by creating the game objects using conductive material. In particular, we consider the objects for use within a iPad game we have dubbed Pong+ (Burnett, Coulton, and Lewis 2012). The game is played with the iPad horizontal and using physical game objects as ‘mallets’, as you would in the physical game of Air Hockey, but with a virtual game ‘puck’ as might be seen in the Atari classic Pong. The game mallets were 3D printed, painted with conductive paint (//www.bareconductive.com), and have conductive cloth fitted to their base to mimic the touch points that might otherwise be produced by multiple fingers. Placing this particular implementation into context it can be regarded as a fully embodied dynamic spatial tangible interface (Ullmer and Ishii 2000). The research associated with this game not only highlighted the benefits of the physical affordances of the mallets over an alternate purely virtual implementation it also highlighted that the number, size and spacing of the touch points that can be tracked simultaneously within such a game is highly device dependent (Burnett et al 2012). This is because
no standard exists that specifies these parameters for either phones or tablets which means that designers may have to invest considerable time evaluating the capabilities of many devices if they are aiming for cross platform compatibility of their game objects.

This approach creates passive objects and thus differs from the work presented by Yu et al who proposed active objects (i.e. ones containing there own power supply and electronics) for tangible interfaces (Yu, Chan, Lau, Tsai, S.S., Hsiao, I.C., Tsai, D.J., Hsiao, F.I., Cheng, Chen, Huang, and Hung 2011). The scheme of Yu et al is to electrically modulate touch points at frequencies they suggest are beyond what is likely to be produced by human fingers but is still detectable by the device (Yu et al 2011). They offer this as a solution that overcomes the limitation of passive solutions that can only support a limited range of information within a single object. However, while they present no users studies they do state that because of computational speed required for the device to detect this frequency modulation “limits the use to static objects” (Yu et al 2011) and as such would drastically limit its applicability for many games genres and suggests it would be better suited to simple app toys (Hinske et al 2008, Mandryk et al 2000).

Interaction with Phygital Objects

In this section we explore the scenario (b) in which players interact directly with the object but not physically with the screen. To illustrate this concept we have taken advantage of the Makie as a digitally playful object in that it supports hacking to allow it to detect other objects. In Figure 6 we present a Makie that has a Near Field Communication (NFC) reader fitted within its interior and which is based on a Lilypad Arduino coupled to NFC module that supported the development of a bespoke antenna which could be fitted into the torso of the Makie. Turning the Makie into an NFC reader means that any associated Makie virtual world can be extended with any number of additional items, similar to the way that the readers of Skylanders and Disney Infinity allow the characters to be swapped within the games. The interaction of these new objects with the Makie can
then be transferred to a game running on a phone, tablet or console wirelessly using either WiFi or in this case low power Bluetooth. It is worth noting that as an alternative for, or in addition to, the NFC reader, other sensors such as accelerometers, magnetometers or a gyroscope could be added to detect specific movements of the Makie.

Figure 6: Makie augmented with NFC reader
To illustrate how other alternative scenarios might emerge we have combined scenarios (a) and (b) to create a novel implementation of the old arcade classic Space Invaders as shown in Figure 7. In this game a 3D printed object is used to control the position of the players ‘base’ and then a micro switch provides the ‘fire’ control via a low power Bluetooth link. At present the switch is implemented using a separate RFduino (//www.rfduino.com) board and switch shield although these could be redesigned to fit within a single game object.

Phygital Object Design Spiral

While we envisage the phygital game objects would follow the design spiral shown in Figure 8, in which an, idea is explored through different alternative solutions which are prototyped and tested to obtain a suitable final solution we recognise that a key aspect that will faced by many small independent game designers creating phygital objects is how to extend the spiral beyond the maker culture, from which many such objects emerge, into a fully fledged production cycle. Whilst open source hardware and low cost 3D printers facilitate the easy prototyping of game objects they would generally be
considered as too expensive for large scale production. In order to reduce costs designers are generally required to shift production towards injection moulding and bespoke electronics. This is an important consideration for the designers of such objects as it will likely require a large injection of capital to facilitate this type of production in specialised factories. However, as we are seeing many examples of prototype devices successfully gaining such capital through crowdfunding sites such as Kickstarter (http://www.kickstarter.com) this does not represent an insurmountable barrier.

![Image of the IoT Object Design Cycle](image.png)

**Figure 8: IoT Object Design Cycle**

**Conclusion**

We are undoubtedly undergoing a period of change within the video games industry and seeing a shift from the dominance of the major consoles towards devices and systems that arguably support more experimental game design. Whilst the growing dominance of phones and tablets in the computing world is a significant factor, it is further
fuelled by advances in 3D printing, open-source operating systems, open hardware, and improved connectivity.

Although the first examples of IoT game objects are principally emerging from the major game publishers and often relates to an established brand, the low barriers to entry of these technologies means they are well within the reach of small independent game developers. However, creating physical objects requires new considerations to be adopted within the overall interaction design, as they need to combine both digital and physical interactions within a unified player experience.

Designers therefore, are not only confronted with simply discrete and continuous interactions they must consider whether they are implemented either in a real or virtual manner. How they are combined is likely to require a number of prototypes if the final outcome is to ‘make sense’ to the player.

By considering the interaction through the terms of hot and cold media which relates to the medium through which they are represented aids designers in considering interactions that go beyond the current dominance of vision and touch. The concepts of hot and cold are also useful to consider how information or feedback is presented to players.

The notion maps and paths helps us consider the knowledge obtained by players through the interface affordances, which helps them construct coherent mental models from which new tasks and uses can be inferred. However, as was discussed, although the affordances of physical objects may be readily perceived through their design, in the case of virtual systems the perceptual information which reveals the affordance needs to be dynamically attributed. Such information is not simply either perceived or not perceived it exists on a continuum which relates to a player’s ability to undertake a particular affordance which in turn is affected by dynamically changing cultural conventions associated with certain affordances.
The subdivision of the game space into player space, game space, and 3D space is a useful way for designers to consider where the focus of the player’s attention may be and where, and how feedback for a particular interaction is presented to the player. We would acknowledge that this subdivision reflects the current dominance of screen-based interactions and therefore new models may need to be developed that reflect alternative game spaces and ones in which the object may be the dominant entity.

In our examples we have considered the two scenarios that represent the main approaches to facilitating the interaction between a physical object and screen based virtual games. The first scenario utilises the screen of a tablet as surface through which the physical objects interact with a virtual game in either 2D or 3D space. The primary approaches for creating such objects are either passive or active with a greater range of information being offered by active objects. However, passive objects are better suited for dynamic and continuous interaction with the surface of a phone or tablet. The second scenario is whereby movements of the physical object, or interactions with the physical object, are transferred to the screen via a wired/wireless link. Whilst this approach enables the inclusion of a greater number of objects, and potentially the detection of more complex interactions, it comes at the cost of greater complexity of the phygital object. The final example shows that these two scenarios are merely two of many possibilities available that game designers are free to develop these hybrid interactions in ways they feel are most appropriate to the game.

Within this research we have presented a design spiral for phygital objects that illustrates that while the design process may incorporate aspects common to many forms of design the movement from techniques associated with the maker community to ones more suited to large scale production is a particular challenge for manufacturers.

Finally we reiterate that this paper is speculating on a future in which creating game objects that link the physical and the digital presents an exciting and practical opportunity for game designers. However, such
objects require interaction design approaches that not only utilise understandings from product design and graphical user interface but also how they might effectively be combined dynamically. In this research we have highlighted a range of design sensibilities that game designers will need to adopt if they are to create such games.

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From the Board to the Streets

A Case Study of Local Property Trader

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Abstract

The boardgame of Monopoly has undergone various iterations since it was first published in 1934. Versions have included location-based varieties of the game, involving mobile media devices that have taken the boardgame to the city streets as a way of engaging players with location in new ways. This article examines a new version of Monopoly, titled Local Property Trader that works with NFC/QR code technologies in order to encourage players to move around the city and interact with local businesses. In doing so, the project hopes to highlight how location-based games can use social media data to update a traditional game into more contemporary contexts. Correspondingly, the differences and similarities of taking a boardgame and reworking it for the city streets are explored through ideas surrounding location, player and map as key points of intersection between the two media forms.

Keywords

Monopoly, Boardgame, Location-Based Game, Social Media, Place, Community, Trading, Social Capital

Introduction

The concept of Monopoly has been traced back to 1903 (originally named “The Landlord’s Game”, created by Elizabeth J. Magie Phillips), where the game was originally constructed as an educational tool to explain the theories of tax and the negative aspects
of private monopolies. Philips continued development with her game up until the 1930s where she added the ability to buy, sell and develop land. However, it was not until 1934 when the Parker Brothers conceived the original game of Monopoly. It is believed that this first version of the game heavily involved a participatory design element, whereby people contributed to the games design, which consisted of a 4 x 10 square board game, with cards associated with the properties and the ability. The ability to buy and sell properties was also extended to include the adding of extra value through purchasing of houses and hotels. In the British version of the game, players strive to take over parts of London, from the cheaper brown squares of Old Street and Whitechapel to the much more affluent purple spaces of Mayfair and Park Lane. By gaining money through chance, by the roll of the dice and the spaces the players’ piece lands on, the aim is to build up your property portfolio, accumulate rent and avoid jail (hopefully whilst continuing to Pass Go). The nature of the game existing on a board, with twelve potential playing pieces, means the game automatically lends itself to multiple players, thus existing within a wider social circle of play. Here, the dialogue between players becomes part of the game itself, as each person watches out for any cheating when money is passed between the banker and the player, and players anxiously wait to try and gain their wanted for section of the board.

But what happens to a boardgame such as Monopoly when the hard-backed board is taken away, and replaced by the city streets? And what can be learned from converting a boardgame to a real-world location-based game as a way of educating people about the social value of property in their local area by involving the game playing community in maintaining places? This paper explores these questions as it tracks the development of a locative mobile-based game titled Local Property Trader (LPT). By taking common themes of Monopoly, such as land ownership, property development, and the accumulation of wealth, LPT seeks to update the boardgame by taking these rule sets to the streets of Manchester in the UK in order to educate both players and the owners of highstreet businesses about ‘social capital’.
Background

The traditional game of Monopoly is transformed into a location-based platform as LPT draws upon social media data as a way of reworking parts of the overall game mechanic. The use of social media starts to emphasise the importance of place within the spaces we frequent between home and work as we seek to move about areas within our social lives. As Beth Ward (2013) notes in the Local Leaders Network section of The Guardian newspaper, “Towns of the future need to offer something different and attract customers to ‘the experience’”. In many ways this experience can be based around current gaming and social media forms as a way of re-appropriating the Internet, as so often blamed for high-street decline, into a new way of thinking about and revitalising the city. Previous attempts to encourage people into the local area have occurred throughout the UK, such as using the ‘Bristol Pound’ as a form of local currency to be spent on the highstreet. However, LPT seeks to utilise local communities in a different way, through the integration of social media networks such as Twitter in order to create a game platform that promotes the highstreet and associated social and cultural values inherent in keeping such physical places alive and active.

Whereas other Monopoly derived location based games such as The Landlord game (Quip Media Ltd, 2013) integrate buying property based on location, there is no integration between player and the physical company, and no real incentive for the company to try and get players to check in. Games such as these focus purely on player point-scoring and reward and, as such, do not fully integrate the social nature of play beyond the player’s own friends network. Here, the game is structured around individual player worth, rather than the importance of play or community. Similarly, Monopoly games run in town centres, such as the yearly event run in the city of St Albans in the UK, do include the social spaces of play but only last for one day, therefore do not allow companies to reap the long term benefits of extra footfall into their businesses. This game is similar to a treasure hunt, allowing players to explore the city and claim properties, but within a limited time and with a quicker end goal. Distributing the
game to the city streets maintains a level of the social nature of boardgame play but it does not translate the underlying values of place, property, value, taxation and wealth as so integrated into the boardgame version. It is by discussing the translation of multiple aspect of the Monopoly boardgame to the location-based game LPT that this paper starts to address some of these issues as the spaces of the real world are negotiated by both player and potential business.

Starting to solve the problem: location as leisure

In distinguishing between our work, home and social lives, Ray Oldenburg writes of the “third place”. The third place is discussed as “a generic designation for a great variety of public places that host the regular, voluntary, informal and happily anticipated gathering of individuals beyond the realms of home and work”. (Oldenburg 1989, 16). Of course, not everyone necessarily frequents a third place everyday but it is a useful term to sum up some of our leisure based activities in relation to people’s movements around villages, towns and cities. As Oldenburg notes, “third places” manifest themselves in the coffeehouses, pubs and cafes we visit, and although his work was first published in 1989, this is a concept we can now use today in discussing various location-based media. The integration of global positioning systems (GPS) into a wide array of mobile phones, and the growth in ‘app’ culture through operating systems such as iOS and Android have seen a variety of applications available that enable users to log or ‘check-in’ to different virtual locations. Similarly, we are able to locate ourselves physically within the quotidian landscape. By carrying the phone we, as users, have access to a vast database of information about the area around us, things to do and how to get there. Routes between places can be mapped, and various directions by foot, car or public transport can be recommended through a couple of place searches and clicks. Whatever the purpose of location-based media platforms and services, it can be seen that by checking into these locations and sharing this information with others within their network, is a way of people showing where they are, whether that be the ‘first place’ of their home life, the ‘second place’ of their work life or the various ‘third places’ that they frequent between the
two. It is for this reason that the city streets can become a game board, transferring ideas from traditional boardgames based on the conquering and identification with place, such as Monopoly, and extending it into location-based platforms. It is some of these ideas that start to change in the integration of the location-based game with the online network of activity, as opposed to the fixed social spaces of the boardgame. To start exploring some of these questions we posed the following:

- How can location-based games be integrated with social media platforms in order to raise awareness of issues in physical spaces (such as the decline of the high-street in the UK)?
- What are the benefits in using NFC/QR code technologies in location-based games compared to GPS technologies and how does this affect the player’s engagement with the physical spaces of the game?
- How could contextual awareness within games influence the game play and what is needed to balance the ambiguities?

In writing about the ludic possibilities of the city streets, Fereiss (2007, 218) notes, “Cities are dynamic places of change and transformation…Within the game of urban possibilities, the city is a constantly changing stage, forever reinventing and redefining itself on the basis of its performer’s creativity and interactions.” Although this is a statement about real-world play, this could also be interpreted to sum up the possibilities within the boardgame of Monopoly. The structure of Monopoly changes with the player’s engagement with places on the board, changing patterns of play and changing the dynamic. Here we can see that the rhythms are place change through the interaction with the board. As Lefebvre (2004) notes, “Everywhere where there is interaction between a place, time and an expenditure of energy, there is a rhythm”.

From the Board to the Streets 71
These rhythms of events allow the player to adapt their game performance based on this changing flow of information. In 2013, where issues of high street wealth and the decline in local businesses in the UK are at the forefront of constant debate, the fluctuation of property value remains less constant than within the confines of a game such as Monopoly. Here the rhythms of interaction are changed by physical footfall, and a sense of continued community in local areas. By making potential players aware of how they can engage in their own local spaces, LPT seeks to utilise communities of players to investigate their local streets in new ways, and to create new rhythms. It is via the social nature of play and the integration of social media in particular that LPT seeks to address some of these issues.

Social games often refer to a game that is being played as a way of social interaction. Typically these games have a simple user interface, are easy to understand, and allow players to socialise during play. As a rule of thumb, social games often appeal to a wider non-gaming audience referred to as ‘non-gamers’, or ‘casual gamers’ (Juul 2010). This type of gamer is fundamentally challenging the notion of the gamer demographic with the widely reported claim that the average social gamer is a 43-year-old woman (Ingram 2010). Although the evolution of digital social games and mobile social games have been around for many years (even pre iPhone), it is the game ecosystems of mobile platforms and the openness of social networks that has provided a method to distribute mobile games to a wider audience (therefore providing a truly social experience). On the mobile phone, social games often utilise functionality from existing social networks such as Facebook. This linkage means that these games can spread remarkably quickly, for example the game FarmVille saw its peak reach 83 million active monthly players, only eight months after launch\(^1\). At the core of social games is a ‘sticky’ component to keep players engaged and more likely to return, sometimes leveraging the same game mechanics and psychological signals seen in slot machines, or in the case of Farmville, creating a regular appointment whereby the players must regularly return to check their virtual crops.

Although such social games are on the rise we do not yet know if they will maintain long-term engagement amongst players (Kirman 2010). However, maintaining the social nature of play is a vital component of LPT. Integrating both players and local businesses into the game was an important part of achieving the final design in order to maintain a sense of purpose and community. As such, the game can be discussed from both the perspective of the player and the perspective of the business taking part in the game to show how the fluidity of the game’s location can change through each interaction.

In the last decade we have witnessed large sections of society spending increasing amounts of time socialising online through sensor rich mobile devices. This phenomenon is primarily driven through popular social networks such as Facebook, Twitter and Foursquare. Each of these platforms maintains a slightly different focus depending on the social network from the grouping of friends to posting photos. Furthermore, services like “friending”, “tagging”, “following”, “check-ins” and “hashtags” have all impacted the way we make these quick and convenient real time communications with one another. With the advent of Location Based Services (LBSs) for mobile phones these “status updates” were extended to incorporate location. This extension was adopted by early LBS’s such as Dodgeball (Crowley and Rainert 2000), which popularised the term ‘check-in’ (Humphreys 2007) to describe such an activity. However, it is arguably the service Foursquare that has brought the activity into common understanding and use. Although many other social networks such as Facebook and Google+ have now incorporated such functionality, the rise in popularity of this activity has led some venues to embrace the concept and actively encourage customers to check-in by offering physical and virtual offers through advertisements often offered through the social networks. Many venues are already embracing the Foursquare community by enticing customers to ‘check-in’ achieved through many social mediums and also by the inclusion of such advertisements in window displays. However, one important aspect to this phenomenon is what service Foursquare is actually offering. In its early days those discussing Foursquare would refer to the application as a Location Based Game
(LBG), as it actively embraced the use of leaderboards, mayorships, rewards and badges. As McGonigal (2011, 166) notes, “…it’s not a game that rewards you for what you’re already doing. It’s a game that rewards you for doing new things, and making a better effort to be social.”

However, the location based social network has undergone an obvious clear shift from what could have once been considered a game to now a very service driven approach with gameful designed elements. The use of badges and leaderboards are still present in the latest offering, however they are not as prominent in the design of the system (albeit they are still part of the service). Discussions, search, recommendation systems with independent incentives have taken centre stage of the application. This has been achieved in an attempt to encourage further participation through other activities, such as deals, specials and other monetary promotions (by synchronising users credit cards such as American Express, where users receive certain deals if they use their credit card and check into the venue). Furthermore, in their latest offering, Foursquare have introduced functionalities to visualise a users’ past through an online mapping technology that flows the user through time and space, highlighting the places they have visited since they became a Foursquare user.

Similarly, QR codes and NFC tags litter our social worlds, from ways of purchasing goods to ways of promoting or augmenting our buying habits. As such the places around us are marked with layers of sign systems created by these physical and virtual tags, and are only brought to life by the accessibility and portability of mobile phones along with the users that understand how to read them. Instead of relying on GPS positions that allow users to check-in to a range of nearby listed locations, as is the case in Foursquare, that has its advantages in scalability but disadvantages within accuracy (for example a user on Foursquare can check-in to venues without being at said location). By employing an implied approach for determining location such as NFC tags, QR code markers and now even iBeacons, the user has to physically engage with the place they are in. The
materiality of the marker becomes embedded within the place and thus associated with it for as long as it remains there.

Finding a solution: designing LPT

The design of Local Property Trader (LPT) draws upon many of the original interactions observed in the board game Monopoly, such as buying and selling (negotiating) properties, paying rent and collecting additional funds from ‘passing go’ or collecting cards, with a modern day element of ubiquitous technologies. In a decade focused around constant communications on the move, through popular social services like Twitter, Facebook and Foursquare, we are all sharing information about our whereabouts, what we are doing and what we like/dislike all from our mobile devices which we carry around inside our pockets. These devices with all their sensors and connectivity methods provide game designers the ability to develop games to use greater levels of information including location. Along with the social media content one of the other rationales of LPT was to draw the player’s attention to the places around them in their local area. The decision to use NFC or QR codes was made in order to make the player connect with the place they were standing in. Much like placing a marker on the board of the Monopoly game, the physical location of the player is one part of the new mechanic offered by this iteration of the game.

It’s easier to split the game up into two tiers, the players and the physical properties. The players of the game interact with physical properties around the city, by simply checking in. However, the check-in element of the game is not the sole mechanic. The game highlights social issues such as political and economical factors by linking the physicality of checking in with drawing inspiration from the traditional all time classic board game ‘Monopoly’. The underlying goals of the game are to get players to engage with their city and neighbouring cities, to seek out places they wouldn’t usually visit such as independent venues that do not usually have big budget for marketing and advertising plans.
Business and player registration

As we can see from Figure 1, a player registers their participation with LPT by authenticating with Facebook. Businesses on the other hand join by registering directly with the game (supplying all required pieces of information). Once a business has registered, in order for game data to be present, a cronjob (a running process for a specified time that can execute comments at specific periods – in the case
of LPT a cronjob calls a script on the server) is performed daily retrieving all business related twitter data (such as number of posts, followers, retweets etc.). This data is then passed through a game algorithm to calculate that businesses Social Capital (SC). The change of the SC is calculated daily, similar to the stock market (X).

**Property Status**

![Diagram of Game Processes](image)

*Figure 2. A diagram to show the basic game processes*

The basics of the game can be summarised by the following statements and Figure 2:

- Only one check-in per property per day is permitted.
• Players can only purchase a property once they have checked into it.
• A check-in is worth a relative number of credits based on the properties social score.
• Each check-in earns the player a chance card (this can be something negative or positive such as extra credits, offers or pay tax and bills).
• Rent is calculated based on the social score of the property.
• The rent is taken out of the players’ check-in credits.
• Insurance for properties can be purchased (the incremental prices of this is based on the social capital of the property).
• Owners can buy insurance for 2, 5, 10, 15 and 20 days.
• Players can only see if a property is insured (they do not know the level of insurance).

Everyone knows that New York City is the city that never sleeps. But what actually happens to a city when we go to sleep? People tend to congregate in pubs/bars/clubs socialising in groups, they navigate around the city often visiting place after place. Nowadays social media allows us to interact with people/businesses at any time of the day. Just like the real time aspect of these interactions, social data can be collected in real-time at any time of the day. LPT embeds social data directly into the game, unlike the game of Monopoly whereby the prices are fixed. Instead, just like the real world prices for land and properties increase and decrease in value. LPT uses the social data and more importantly the social change to determine the price of properties. In order for the game to provide variable property prices, Twitter accounts for each property are scraped and parsed each day generating a social score or ‘social capital’ for each property. The price is set for each property at 8am every day, and the change is determined on the previous day’s social capital. It is this change that is revealed to players in order for them to make an assessment
on the properties value and possible increase in value. The social capital is calculated by observing the most influential aspects of a Twitter account which are to gain new followers, increases tweet count, favourite a tweet, be added to lists and follow other users (these are all considered as positive impacts to the social capital) whereas losing a follower, having your favourites decrease, being removed from lists and unfollow some users are negative aspects of Twitter. These metrics are calculated and compared to the previous days.

The physical properties in and around the city form the focal point of the game. LPT gives these businesses another way of representing themselves in a different manner. Unlike Google’s ‘Places for Business’, which lists companies on Google, TripAdvisor, Twitter, Facebook and Foursquare, LPT represents this data in a different way. The properties engagement with Twitter as represented in LPT has the ability to influence the game by increasing their value within the game. As previously mentioned, this is achieved by increasing the social score, in essence by improving, maintaining and interacting with their own Twitter account, by tweeting, getting new followers and generally interacting with their audiences. Furthermore, this gives the business an opportunity to engage with the players of the game, encouraging them to check-in by applying a discount within the business or via by simply understanding the customer demographics. In doing so, the aim is to create a closer relationship between the company and the customer, through the playing of the game, and in doing so, start to construct a more unified town, city or high street through these interactions.

A basic example of this can be understood from the following pieces of information and the Figure 3: Manchester Museum of Science (MOSI)

- day 1 score: 30,122
- day 2 score: 30,170
Daily calculation of social capital

1. get twitter results
2. query twitter's search API for account activity
3. perform game algorithm on received data
4. Produce social capital
5. Compare previous day to today
6. Calculate difference
7. store difference as change

Figure 3. A diagram to show the process of calculating the social capital from the data collected from Twitter.
This has a positive 48 value. This means that the property has increased its value by 48, and this is represented within the game as a green up arrow. If the property had not improved it would reveal a blue flat line, whereas a red down arrow would represent a negative value. The increase in value means the players of the game earn more check-in credits and rent. Rent is paid out of the check-in credits earned for the check-in and this is based on a percentage of the credits.

![Figure 4. Screenshot of the LPT web interface and notification system.](image)

If a business is engaging with social media on a frequent basis, and has a high amount of followers, then their property value in the game will be much higher. Players will aim to buy properties based on how much they are worth (much like in the game of Monopoly), except in LPT this price is changing daily depending on the business’ real life upkeep of their social media outlets. This score is then compared to its previous days score and this determines the property’s forecast (Figure 4). The decision to fluctuate the property prices is linked with actual land, stock and share prices, which occur daily. In the game, the change in price is depicted by a green ‘up’ arrow, a red ‘down’ arrow and a blue ‘flat line’, this allows players to determine if the property is worth purchasing, as it gives the player an insight into how
the business handles their social media account. If the property has a low social capital then the property is lower in price. However, if the property has a high social capital then the rent rates are higher. Essentially players want to purchase properties by observing their forecasts to see if the social capital will increase, thus earning the player a high rent score. It is all about buying at the right time.

Furthermore, keeping inline with the UK’s property tax procedures (assigning properties to different tax bands, starting with the lowest band A) and colour coding properties in Monopoly, LPT uses these bands/colours to categorise properties into groups to determine the percentage of rent and check-in credits distributed against that property’s social capital (Figure 4). As LPT has been designed as a centralised system, only one property can be purchased at one time. This means that two people cannot own the same property. To avoid players earning large numbers of credits from checking in, a single player can only check into the same property once a day, and a purchase offer/transaction can only take place upon tapping their mobile phone against the properties NFC tag or scanning the QR code (Figure 6).

Additionally, as a physical city’s transportation system is critical to keeping the city moving and creating a healthy and balanced economy, the same applies to LPT. These properties within the game, such as transportation systems (rail, bus, tram and underground) and public services (town hall, police, fire, hospital etc) are places players cannot actually purchase. These properties however act as places to earn kudos points within the game. If a player regularly visits and supports them (and contributes credits towards maintenance costs) they are looked upon supporting the city and this data is considered when making a deal/bid to purchase the highest valued properties within the game (these are currently properties worth £2.5m, which have high social capitals, thus high rents and checkin credits distributed). A player can not simply earn the credits to purchase the property alone, other gaming benefactors are considered such as their property portfolio, check-in history and their local support
(kudos points for supporting the public sector industries) therefore contributing to the wider community of the game.

Furthermore, to keep the game like its original boardgame counterpart, ‘passing go’ is represented daily through the opening of the mobile app and a simple poll of one of the main headlines of the city. For the example of the game in Manchester, the Manchester Evening News newspaper headlines are downloaded and selected at random and sent to the mobile client upon login. Players vote on the headline as to if they agree, disagree or are unsure on the topic to be then given a city wide poll as to how other players feel towards their city, represented in the form of a pie chart. This is achieved once a player has registered using their Facebook account and has chosen their LPT game character (Figure 5). The mixture of using Facebook for player identification and Twitter for properties was adopted due to both social networks nature of interactions between people. For example Twitter with its followers and Facebook with its connections. Additionally, chance cards are provided upon check-in. These are random cards which are generated from the central server, relating to real world topics and inline with current affairs such as, if you check-in around the time of ‘Children in Need’ (a UK annually charity event broadcasted over the BBC to raise money for children), you may be expected to pay some credits towards this charity (this would also come out of your check-in credits).
Figure 5. Screenshot of the LPT mobile interface: registration and player avatar screens
Although the original game of Monopoly was designed to essentially get a monopoly of the city, LPT differs completely from this analogy.
A player in LPT, who gains a monopoly of the city, will be punished by higher taxation rates on the number of properties they own (and have to maintain these properties by checking in more regularly). A monopoly is determined by the number of high band properties owned, for example; a player who owns 5 high band properties will be highly taxed and require extra maintenance, whereas a player who owns 2 high valued properties and 8 low band properties is considered as an ideal player contributing to the wider community wealth of the city. The idea of the game is to trade with other players and support the local economy. Furthermore, the game is about building up the property’s value (thus increasing the company’s social impact) and not player’s worth. Players need to play the game by exploring other areas of the virtual gameboard. The majority of the game is based around the idea of being a ‘good citizen’ in amongst the wider community (not just individually checking in and individual wealth) emphasising wider social consequences of play.
Figure 7. Screenshot of the LPT mobile interface: checking into a property displaying details and the social score of a property, with the option to buy where possible.
As a great deal of inspiration was taken from traditional boardgames, the designers of LPT also curated a novel way to influence the game with real-time dynamic data to add context to the digital game and the real world. This data results in a player’s social capital where the price of a property is determined by how well the player utilises social media, in particular Twitter. This was a key factor in balancing the game and defining the rules. One of the disadvantages of using contextual awareness within games is handling the ambiguities and unknowns. Take for example a game that uses real weather data to change the gameplay (Lund. K., 2011), in this instance all weather conditions need to be mapped and categorised to a particular action.

Unfortunately LPT’s contextual information cannot be pre-mapped due to its varied and sparse information collected from Twitter. However, what was apparent early in the design and prototyping stage was how the Twitter accounts of some venues were owned as a global brand, rather than that particular location. This was clear with some train stations, whereby the national brand of the company as opposed to the location of the station itself ran the Twitter account. This was also clear for the football teams in Manchester (arguably global brands in themselves) having a greater pull on the city’s property scape. Ultimately the game creator for that city/area has the choice to allow a business into the game or not. Furthermore, this is when the concept of mirroring the real world further became clear by categorising the properties into tax bands and any calculations were based on this band (similar to the rates one pays in certain housing/business locations in the UK). To reemphasise, the purpose of LPT is to get people engaging with their high street in an attempt to spend money locally, the game’s mechanics and rules have been designed and set out to constantly reiterate encouragement. This progressed into new gameplay mechanics to keep in line with current developments in terms of the economic state of towns and cities in the UK.

Much like the game of Monopoly, players can build houses and hotels
to increase rent, but also in order for the game to balance and create a sense of longevity the idea of a singular property owned by one person throughout its entirety lead to the game designers looking for additional inspiration to forbid such action happening. This is where encouraging players to check-in even when they don’t own the property becomes a viable option. As previously mentioned, the main aim of the game is to get people to explore their city and ideally rejuvenate the high street, thus actions like these are rewarded. This is when the idea of squatting becomes appealing to owners and visitors. A squatter is someone who wants to steal away the ownership from the owner, he/she becomes a squatter whenever they check-in, and if done regularly and consecutively they can change the ownership of such property. This is only permitted if the owner hasn’t checked-in thus interrupting the check-in chain. Furthermore, the idea of squatting is again linked to the real world and its current affaires. Additionally, to re-balance the game, property owners in LPT can also protect their properties with insurance levels to deter the ability of explorers to squat. As previously mentioned, varying levels of insurance can be applied to such properties. This could be used in a scenario where the owner may go on holiday and has no ability to check-into their properties but still wants to keep ownership; he/she will add insurance so that when they are able to once again check-in, the property still belongs to them. During said time some information isn’t revealed to all players in order to encourage players to keep engaging with the game. The players that have checked in can see if a property has insurance but they cannot see when this is likely to expire (thus its level of protection), whereas the owner can see when their insurance is to expire. The number of check-ins before a property can be stolen is based on its colour/band, the higher the band the greater the need to self check-in to prevent squatters and also the higher the insurance protection. It is also through negotiating the relationship between the player and the business that the city streets start to change into the gameboard.

As well a marking locations within the LPT mobile application, a web-based map of the game was also presented as a further idea to allow for another sense of community amongst players and those
interested in following the game action but not necessarily playing it (Figure 4). The traditional Monopoly board acts as a mapped representation of place, with the original British version focusing on key landmark streets and stations in London. The colours of the board separate out areas of commonality through location and community, as a way of representing parts of the city (while recognizing the vast expanse that the city actually is). By contrast, the game map of LPT also marks out locations, but this time through checking into new places.

In discussing the growth of networks, in relation to perceived global and local access, Eric Gordon (2009, 23) comments that, “[t]he ubiquity of digital networks has altered the form and function of space. Distances between things and people have changed: physical space has become less of a barrier to interpersonal, social, cultural and political communication”. Through location-based media, our social networks can in some ways change the way we view the spaces between each of our connected user’s check-ins, even if we are not in the same vicinity as them. We are given a snapshot into other people’s locations and social spheres through the information they choose to share with us through the network. Location has become another status update, a way of conveying how people move about, and whom they might be there with. Locations frequently checked into by others starting to become ‘placed’ in our social networks as we see familiar names crop up time and time again, even if we haven’t been to those locations ourselves. This bridges the gap between spaces that physical transport networks cannot provide as instantly. In many ways this is changing how we access the landscape and view the places around us.

It is through locating our actions, through locating our bodies within the landscape that the map becomes vital in our understanding of both known and unknown spaces. In discussing the connectivity of online spaces, Dodge and Kitchin (2001, 72) distinguish between four different modes of mapping that exist in digital environments, including “static, animated, interactive and dynamic”. We can start to see more and more “dynamic maps” popping up on the Internet “where the mapping automatically updates as the information used
in its construction is updated”. In terms of LPT the locations within the database are fixed in order to define the structure of the game, much like the traditional Monopoly game board fixes a sense of place for users to navigate around. By fixing place, the goals of the game become apparent (although players then have to find those real world places, navigating real space, and potentially navigating real maps). By players locating themselves within the game, a map of connections starts to form, drawing attention to real world places and a representation of the places via the linked game website (Figure 4 and Figure 5). Here, both players and viewers of the website can track the progress of particular properties and locate their possible next move. The game becomes as much about negotiating the real world city as it does about checking in to the virtual equivalent via an NFC or QR code (Figure 6 and Figure 7). The social elements of play become vital in order for players to adapt and understand their motivations for entering into as well as maintaining a level of interest in the game. It is this connection to a map, a virtual boardgame of interactions that allows for a social connectivity of play as so important in both the original game of Monopoly and the newly developed idea of LPT.

Conclusions

The findings and work presented thus far deriving inspiration from traditional boardgames and translating such interactions into a mobile game, alongside the creation of novel concepts such as adding in game context (Twitter), tax bands and squatting, were conceived from paper prototyping the game and initial playtesting. Although the current designs for the game are still in their infancy, playtesting and paper prototyping enabled the game designers to understand if such concept could be developed into the wild, to create further research linking to social and economic studies to understand if people of a city or town are willing to engage further with their local businesses in a more playful manner. Furthermore, the disjoint between the web and mobile platforms needs to be further studied to observe if non-players of the game find the web platform interesting enough to either
participate in the game and become a player or if the information provided helps them understand their local community.

The characteristics of many LBGs mean that they are often based on movements rather than unveiling the location. This requires constant player attention, which has lead to the conclusion; what extent and context of location is used within LBGs. In contrast to the term ‘location’ applied to many LBGs, where in such games the players’ location and surroundings are independent from the actual game (Lund K. C., 2011; Lund K. L., 2012) as the players’ actual locations are not contextualised within these games. Designing LBGs to be more than simply moving through space to actually permit players to interact with their surroundings can unlock greater depth of gameplay. Some LBG designers employ location independence deliberately, as it allows these games to be more scalable, in the sense of being able to play it at any location. However, this can also be seen as the negative aspect of designing LBGs in this way as the scalability leads to a generic output that does not take into consideration how players might use individual cities and particular locations in certain ways. This is something that LPT aims to explore in more detail.

By checking into LPT, the player is broadcasting to others within their social network (and the game network), allowing other people to see the new place they have started to mark as their own territory. This is much the same as moving the boardgame piece in the physical version of Monopoly, with the claiming of space being an apparent theme across both platforms. In both instances the place is named and therefore, takes on some sense of location as other users can view the location and get a sense of its positioning from this data. If this place is in the other player’s possible vicinity, it may encourage them to seek it out and they too may decide to check-in the next time it comes up on their location list of possibilities. In writing about various examples of locative media, Peacock (2005, 129) notes that, “they are performative in the sense that the participant is bought into a role (as traveller, seeker, author, witness) and in carrying out that role they bring-into-being the work...through their actions, their utterances”. It
is through these performances that the places within the networked
database start to emerge.

The fluidity of the data transfer in networked location-based social
media systems, such as LPT allows for the player to negotiate the city
in different ways. As much as the player may be aware of the rules of
Monopoly, they also have to shift their frames of reference to play the
game when out and about on the city streets. This shifting between
frames (Goffman 1974, Stenros Montola Mäyrä 2009) allows players
to dip in and out of play as they go about their daily lives. It also
acts as a reminder of the benefits of play, in terms of seeking to keep
the virtual community alive (and hopefully these actions flowing back
into the real world community). As such players learn to “upkey”
and “downkey” (Goffman 1974) between frames, as Stenros, Montola
and Mäyrä note (2009, 269), “shifting the focus between ludic and
ordinary changes the frame, but also looking at the same event from
the point of view of an individual, the community (of, say, players),
and the society may require keying”. Therefore, the businesses
involved need to be as aware of the ludic content they are potentially
creating by maintaining their social media capital in the hope that
players will continue to engage and want to keep the properties
they have accumulated in the game. It is these factors that draw on
how players recreate and response to the rhythms of the boardgame
of Monopoly that start to become translated into the location-base
version of LPT.

As much as LPT is based around the mechanics, meanings and rules
of Monopoly, by converting a boardgame to a real life space, some
of these aspects also had to be adapted. The evolving structures of
a city, such as Manchester do not lend itself to a fixed grid of a
traditional Monopoly board. Instead, properties are spread out, but
this in itself creates a movement of players between places. The
player has to physically be present on the point on the virtual game
board, much like the piece has to wait on the square of the Monopoly
location. However, unlike Monopoly, there is no roll of the dice to
move on. Instead there are incentives to Pass Go, collect Chance
cards and collect Railway stations through interaction with places,
rather than the numbers depicted on the dice. The player takes their position into their own hands, but as with Monopoly, their property-buying portfolio (Figure 6) involves taking risks and working out the lie of the land in terms of other player’s interests. The social space of both games remains as a vital aspect of being part of the playing community. But now the location of the places becomes a vital part of the player’s need to interact with places as real world consequences of social media engagement affect play. This in turn, allows player types of change and evolves to suit different modes and models of play through a common gamespace of shifting frames. By rethinking the underlying values of Monopoly, the game is now able to be adapted and updated for 21st Century play, not only in terms of the technologies involved but the underlying principles of integrating players with the community, showing the value of community to local businesses and hopefully re-invigorating towns and cities to create “new experiences”.

Bibliography


SimCity and the Creative Class

Happiness, Place, and the Pursuit of Urban Planning

Frederika Eilers

Abstract

Used habitually in educational settings, SimCity has been drawing many young people to design by highlighting popular aspects of urban planning. The 2007 version of the game mimics popular planning theories that resemble the controversial work of Richard Florida and his use of the creative class. Florida’s writings are in this article interlinked with texts produced by Will Wright, creator of SimCity, as well as the game’s websites, manuals, in order to track these similarities. It is my understanding that both Florida’s and Wright’s work share and emphasize certain cultural values, including cities’ personalities. The analysis reveals how significantly the existence of happiness is linked to place in contemporary cultural setting, although Florida and Wright seem to disagree on how exactly they may relate. Furthermore, critiques of Florida also evoke criticism of the game’s suppositions. Through interpreting SimCity’s application in pedagogy, its educational value is tied to discussions of in-game assumptions which promote academic critical inquiry. The conclusion frames the game as a simulation or model in game and play theory and problematizes Wright’s intention to build elaborate models based on assumptions, which players as potential urban planners absorb and emulate.

Keywords

Models, Pedagogy, Richard Florida, Simulation, Social Engineering, Urban Planning, Will Wright
Introduction

Maps, of course, are a type of model. Computer models contain the same levels of assumptions as the road map. —Will Wright

*SimCity* creator Will Wright wrote in one of his notebooks that much like a road map, computer models reflect simplified versions of reality.1 Cartographers, like game designers, foreground certain aspects of geography, or culture, while other aspects move to the background. Wright found inspiration for the game from maps: while he worked as a game designer for *Raid on Bungling Bay* (Brøderbund 1985), an aerial shooting game where the player flew a helicopter over a map and targeted buildings, rather than the shooting, he preferred designing maps.

This game poses unique challenges for artifact study because its designer is cognizant that the game distorts the culture it represents. In this paper, E. McClung Fleming’s Artifact Study method (1982) is applied to a new media. The *SimCity* game and its paratexts, such as online resources, game manuals, and the game itself are studied as an artifact. In the first section, *SimCity*’s various versions and how they follow trends in urban planning are identified. Secondly, I compare *SimCity Societies* to ideas credited to famed urban theorist Richard Florida. Adapting Fleming’s method, my evaluation frames or contextualizes by comparing social engineering in game to that in urban planning. This leads to a cultural analysis in the third section that unveils the importance of place for happiness. In the fourth section, I interpret these findings in the context of a spectrum of user groups to explore the educational value of using *SimCityEDU* as a teaching aid. My conclusion situates the game as simulation or model in game and play theory, and questions the creator’s intention with reference to Wright’s keynote address.

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1. In 2010 The Strong National Museum of Play (Rochester, New York) acquired nine of Wright's design notebooks, which convey his ideas and thought processes while developing other games based on SimCity. The notebooks were created while developing The Sims, SimCopter (Electronic Arts 1996), and Spore (Electronic Arts 2008). They are in the “Will Wright Collection” and the epigraph is from Object ID: 110.1633.
Methodology

Scholars have defined diverse methods to study artifacts. One consistent endeavor is to outline “material culture as a process whereby we attempt to see through objects (not just the objects themselves) to the cultural meaning to which they relate or which they might mediate” (Schlereth 1991, 240). My investigation utilizes Fleming’s four steps: identification, evaluation, cultural analysis, and interpretation (1982). Folklorist Henry Glassie promotes three different types of contextual framing for artifacts: personal, conceptual (paratexts), and physical (1991, 256). In this study, conceptual framing is used. Moreover, artifacts manifest multiple identities, such as maker and user. Glassie conjectures that artifacts are more accurate portrayals of the maker; meanwhile, architectural historian Dell Upton sees “the object as a mediator between creator and perceiver” (1991, 263; 1991, 158). Therefore, in addition to Fleming’s four-step analysis, I describe the different user types in the interpretation section and the maker’s intentions in the discussion.

Despite a recent push to develop a unified method to study video and massively multiplayer online games, methodological tool boxes for this type of research are fragmented. For instance, games like The Sims (Maxis 2000) can be studied as cultural “texts” that can be analyzed through the lenses of “Object Inventory, Interface Study, Interaction Map, and Gameplay Log” (Consalvo and Dutton 2006). One gap in existing research, according to Ioanna Iacovides and coauthors, is “investigating both how and what people learn through their involvement with games” (Iacovides et al. 2013, 2). While their research focuses on the mental and physiological breakthroughs and breakdowns of how through lab observations and diaries participants internalize informal educational goals, in comparison, I strive to understand what a videogame says in a formal educational context. Another trend in game studies is to treat videogames as either realistic or fantastic. Alternately, Alexander Galloway promotes a hybrid viewing of games as representations of reality, akin to an artwork (Galloway 2004). Synthesizing these approaches, my argument treats
these virtual artifacts like artworks which mediate cultural meanings between makers and users.

Research on physical games and toys is often subjected to material culture methodology. Observe that using this method to study physical toys like dolls is well-established by scholars, such as Attfield (1996). Surely, Wright knew of other types of toys as he grew up in the 1960s in Atlanta Georgia. He often relates his games to “fundamental paradigms of play [like] role-play, constructing miniature towns, [and] ‘playing house’” by comparing them with physical toys, and sometimes calling them toys in sources like his keynote or in his notebooks (Pearce 2002, 116 qtd. in Lauwaert 2009, 75; Wright 2010, 110; Wright). While designing The Sims he wrote the word dollhouse several times in his notebook. This was the major inspiration for the game, but a problematic one: Jeff Braun, Maxis’ other co-founder, explains that using the dollhouse paradigm made it initially difficult to attract investors (Lew 1989). The dollhouse is also a popular metaphor used to dissect The Sims (as in the work of Martey and Stromer-Galley 2007; Consalvo 2007; Reid-Walsh 2011). Given that SimCity combines physical games like spatial toys such as construction blocks, simulation toys such as dollhouses, and strategy games such as Risk or Monopoly, I believe it is reasonable to apply material culture methods. Digital games may not be physical, but they do contribute to popular and visual culture, to which this method readily applies.

Identification: SimCity as Artifact

In Fleming’s first step, called identification, the basic properties of an artifact are history, function, design, material, and construction (1982). Several themes from the profession of urban planning, like sustainability, gentrification, social engineering, and the desire to make the profession more accessible to women, are highlighted in various versions. Functionally, players of the original SimCity (Maxis 1989) used their budgets to build basic services, such as residences, police stations, fire stations, parks, and entertainment and work places, while working within zoning (based on water and electricity
infrastructure), budgetary, and population requirements. Tax revenue was generated by attracting citizens, which consequently generates more finances for the player to expand his or her city. Residents were deterred by crime, traffic, and pollution. In the sequel, SimCity 2000 (Maxis 1994), the interface shifted from pure plan to isometric and the object inventory increased by adding new programmatic building types, like schools and prisons. New features included a newspaper (later a news ticker), a query tool, and neighbor cities, while improved graphics showed buildings that were under construction, in use, and unoccupied. The next version SimCity 3000 (Electronic Arts 1999) introduced even more complex cities with waste management, agriculture, agreements with neighbors, and more emphasis on pollution and its effects.\(^2\) Again graphics improved; this time maps took on different climate characteristics with different vegetation types.

SimCity was related to urban planning from the beginning, and early packaging reinforced this relationship. In the user’s manual for SimCity 2000 the 1996 collector’s edition, the bibliography cited a score of spatial scholars; among them were Le Corbusier, Jane Jacobs, and Christopher Alexander (Bremer 1996, 139). Le Corbusier was an influential modern architect practicing after The First World War known early in his career for grand urban designs and continued to practice until his death in 1965. Jane Jacobs was a highly respected activist-journalist who criticized Le Corbusier’s urban plans in the early 1960s, and whose ideas like “eyes on the street” have influenced many planners. A decade and a half later, Christopher Alexander reacted against sterile modernist environments preferring ground-up design; although he was trained in architecture and math, he is best known today among computer scientists. The bibliography was comprised of urban theories from the mid 1960s to the late 1980s. Wright most likely learned of them when he spent two years studying architecture (Yi 2003; digital kids con 2013). Their inclusion

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contextualizes the product within architectural and urban planning disciplines.

In the 2000s, *SimCity* mirrored developments in the urban planning profession by taking a decisive turn away from technical and toward social concerns, like gentrification. Rather than the user managing technical aspects like placing the streets and utilities, in *SimCity 4* (Electronic Arts 2003) zoning could determine the grid patterns of the roads and accelerate the layout process. In earlier versions residences merely evolved due to density, this version introduced residential building phases categorized by the economic class of the occupants, called sims. Sim’s educational quotient was inherited by their parents, and corresponded to their wealth (Kramer 2002, 252). Housing desirability was based on nearby public amenities like recreational areas and schools (Kramer 2002, 274). Upper class sims generated more tax income that many users strived to achieve. Gentrification, an issue popularized by sociologist Ruth Glass continues to be discussed with vigor in urban planning (Glass 1964).

Among the most prominent urban planning theorists in the mid-2000s was Florida, who popularized “the creative class”, a demographic group often associated with gentrification. Perhaps in response to trends in urban planning or because *SimCity* was developed by a different company, *SimCity Societies* (Electronic Arts 2007) departed from previous versions;³ this enraged fans such that it did not achieve the success of previous versions. The game focused less on utilities and infrastructure than previous versions and more on social engineering through mixing building types without zoning regulations. This mixture led to cities with personalities, such as the fun city.

In the following decade, *SimCity* (Electronic Arts 2013) was a Massively Multiplayer Online game and, due to internet connection issues, is available offline. It included more aesthetic choices (like curved roads), and simplified infrastructure, insofar as the road

³. Maxis outsourced the development to Tilted Mill Entertainment the designers of Caesar IV (Sierra Entertainment 2006).
simultaneously supplied water and electricity to buildings. Since individual cities and players interacted with each other through the internet, designers of cities were encouraged to focus on certain niche markets, like an industrial port city or a high-tech region. The game no longer included the unpopular city archetypes from SimCity Societies, but instead focuses on interactions between players acting as megaregions; megaregions have been a focus of contemporary urban theorists like Edward Soja (2013).

In 2013 Electronic Arts partnered with GlassLab to make an educational adaptation focusing on climate change; it is considered a science, technology, engineering, and mathematics (STEM) “game-based learning and assessment tool” called SimCityEDU (“SimCityEDU” 2014). This platform is a basic version with many variables removed so that the user focuses on the objective, yet it still allows micro and macro views of the city. The integration of STEM and Common Core Standards in the United States educational system induced a heated public debate on the best way to encourage women and minorities to develop these skills. Urban planning is among the STEM professions, yet as a newer profession, the Town Planning Institute of Canada formed in 1922, it has attracted women since the mid-1940s (Adams and Tancred 2000, 70–71).

Over the past twenty-five years, SimCity has enjoyed phenomenal success. Materially, over the years the game has come in boxes or jewel CD or DVD cases, containing manuals and the CD or DVD itself. Recently, the game came as a digital download. The game has had a variety of platforms including Amiga, PC or MAC, and the game’s price is mid-level. However, the original version, Micropolis (Electronic Arts 2008), can be freely acquired as it was designed for the company’s participation in One Laptop Per Child where children from developing countries were given it preinstalled on their own laptop). There are also free fan-created homages, like LinCity (1999) or OpenCity (2008). These are testaments to its status as a cultural phenomenon.
Evaluation: Cities have Personality

According to Fleming, the second step is evaluation which is a comparison between the artifact and a similar object which “provides the essential building blocks for conceptual generalization” (1982, 169). SimCity was the first of many games in the city building genre. On a larger scale is Civilizations (MicroProse 1991) and Age of Empires (Microsoft Studios 1997); on a smaller scale is Wright’s other hit game The Sims. These games stress the relationship between the built environment and humanity. The similar object in this discussion is the theory of Richard Florida. They share notoriety, the belief that cities have personalities, their focus on creativity, their attempt to measure creativity, and their assumption that high-tech industry is based on creativity.

Florida is what many consider a superstar academic who has breached the boundary into mainstream discourse. His books have graced bestseller lists because his writing style is relaxed and readily accessible to the general public. Primarily his books The Rise of the Creative Class: And How It’s Transforming Work, Leisure and Everyday Life (2002)4 and Who’s Your City? (2008) are compared with SimCity Societies (2007). Florida’s influence is broad and his popular lectures have influenced a “generation of leftist policy-makers and urban planners” (Malanga 2004, 36 qtd. in Peck 2005, 740). SimCity 4 may also influence policy; for instance, an article claims that a politician had gotten his tax rate the game. The Electronic Arts representative responded: “We encourage politicians to continue to look to innovative games like SimCity for inspiration for social and economic change” (Terkel 2011). While a sardonic response, it captures SimCity as progressive change.

“Cities have Personality too,” asserts Florida because people with similar personality types cluster in certain regions; therefore, these regions have their own personalities. In short, like-minded people tend to congregate in the same city or cities. Florida’s categories are based on five personality types from psychologist Lewis Goldberg:

4. Note that John Howkin’s termed the creative economy.
extroverted, agreeable, neurotic, conscientious, and open to experience (2008, 194). These types overlap, just as many people have combinations of personality types so can cities and Florida closely links these city traits to professions, as does SimCity Societies.

SimCity Societies presents six “societal values” which determine what archetype your city will reflect. The six societal values are authority, creativity, knowledge, productivity, prosperity, and spirituality, and these social values lead to the city characters authoritarian, capitalistic, industrial, fun city, and contemplative. The player does not choose the character of the city at the outset; rather it is based on the city’s composition of different structures. Points in each societal value are generated and consumed by buildings and the balance visually transforms the city and shapes the city’s character. Like Florida’s types, there are also more complex city profiles that consist of more than one societal value; they are cyberpunk, haunted town (hidden), normal, romantic, and small town.

Florida’s experimental region and SimCity Societies’ fun city both privilege creativity. Florida writes whole books on the creative class (the denizens of experimental cities), and the game bases its tutorial on this type of highly creative city. Florida’s experimental city is filled with “Open types [who] have a tendency to enjoy new experiences, especially intellectual experiences, the arts, fantasies, and anything that exposes them to new ideas. Open people tend to be curious, artistic, and creative” and are “people who do not need to be around other people, who question authority, and who quest after intense experiences” (2008, 190, 200). Openness, to Florida, is the major trait linked to economic development (2008, 210). Like the experimental city, the fun city in SimCity Societies relies on the societal value of creativity and is hindered by authority (Kramer 2007, 17).

Both Florida and SimCity Societies attempt to measure creativity, yet do so very differently. SimCity Societies’ tutorial declares,

5. Florida also cites two studies: Goldberg 1990 and Gosling and Rentfrow’s “The Geography of Personality”.
“Decorations are a great way to generate Creativity.” In this system, a decorative fountain earns five creativity points, the societal value that determines a fun city. There are options to put sims in creative housing, to build schools that encourage creativity like drama schools, to entertain them creatively by providing city botanical garden or theaters, and to have sims active in creative fields like playing in a garage band. Fun cities generate at least one-hundred creativity points. As the city produces more creativity, up to one-thousand points, the city takes on more characteristics of the fun city. Alternately, Florida’s creative index is formed by four factors; they are the proportion of the population in creative careers, the number of patents per capita measuring innovation, the high-tech index, and the gay index (2002, 244). Although through different means, Florida and *SimCity Societies* both quantify creativity.

High-tech industries are the economic center of both cities. In Florida’s earlier book these open individuals, which populate the experimental region, are part of the creative class and share the values of individuality, meritocracy, diversity, and openness (2002, 77–79). Florida links the creative class to high-tech industries, while in *SimCity Societies* high-tech industries, like game developer, use creativity and knowledge. Entertainment venues, such as art museums, drama schools, and ice cream shops, produce creativity, whereas haunted houses and corporate offices consume creativity. Some assumptions in the game are realistic, such as carbon levels influencing the frequency of natural disasters, while other assumptions are unrelated, like haunted houses depending on creativity. In earlier versions, even assumptions are made for fictitious species; for instance in *SimCity 3000* aliens attack landmarks first and then the most expensive buildings (Kramer 2000, 45). It is evident that the game is a rich tapestry woven with both real and imagined societal beliefs.

6. The gay index is one of the more heated arguments against Florida (Florida 2004). Note, that Wright's games are considered quite liberal. The Sims, as author Stephen Kline points out, is one of the most liberal games regarding homosexuality (Kline, Dyer-Witheford, and Peuter 2003, 269–293).
Fleming argues that in cultural analysis “the artifact functions as a vehicle of communication conveying status, ideas, values, feelings, and meaning” (1982, 169). SimCity and Florida communicate that cities have personalities and this affects the happiness of the population. Although both deal extensively with happiness, they differ on how place affects happiness. This section explores these connections in three ways. First, while Florida frames the problem as an individual choice, SimCity takes the viewpoint of a politician or city planner that endeavors to attract sims. Second, happiness equates to a temporal and financial resource in the game. Third, since there is no established goal many users infer that the goal is to make sims happy. Lastly, given that several scholars question Florida’s accuracy and because Florida and SimCity Societies have so many points of correspondence, the accuracy of social engineering that SimCity Societies depicts should be questioned.

Florida explains how to pick a place, while SimCity encourages players to mold the place to retain and gain city dwellers. Who’s your City? was written to “help you pick the place that is right for you” and is based on an extensive twenty eight-thousand person survey Florida conducted called the “Place and Happiness Survey” (2008, 12–13). He stresses the importance of location for one’s life as it affects educational, professional, and love pursuits (2008, 6). Florida focuses on a single city type and makes few allowances for other types of cities to provide happiness, for example he writes “that place affects happiness, that the happiest communities tend to be open-minded, vibrant places where people feel free to express themselves and cultivate their identities, and that these communities tend to foster creativity” (2008, 187).

Conversely, in SimCity the player cannot chose where to play or affect the sims’ happiness directly, but place-making is his or her responsibility. In SimCity 3000 the easiest way to maximize happiness is to create “a nice, ordered city, with low crime, low pollution, plenty of water, great health care, thriving business, and
lots of good recreation. In short, they want it all. SO, you know what to do. … places that say, ‘This city isn’t just efficient, it’s fun too’”(DeMaria 1999, 294)! Later, SimCity Societies skips directly to specific buildings affecting the mood of sims (Kramer 2007, 16). The player must attract dwellers by providing a happy place, which is attributed to “Home, Visiting Venues, Accessories and Enhancements, Special Sims, Building Actions [... and] An especially nice home minimizes a Sim’s daily loss of happiness” (Kramer 2007, 22). Thus, while game players actively shape their city in ways to promote sims’ happiness, happiness for Florida is dependent on selecting the right place.

Happiness is one resource in the game. Sims require time to accumulate happiness, and consequently their happiness provides tax revenue which gives the player more money and allows them to build more. One change in SimCity Societies is that the player could not set the tax rate; the manual explains: “the revenue your city collects is a function of the buildings you choose and how happy their workers are” (Kramer 2007, 5). Previously, if sims did not or could not travel to their workplaces, they would soon lose their jobs. In this version, sims will always go to work, however time spent traveling decreases their free time, so they have less time for entertainment to increase their happiness. Yet it is important to place their homes away from workplaces, which the game manual tends to conflate with industrial zones, because these buildings cause pollution that decreases sims’ happiness (Kramer 2007, 6). In a city with many productivity structures leading to an industrial society, unhappy citizens become rogue, the status of sims when they are unhappy enough to shut down a workplace (Kramer 2007, 26). The run-down townhouses called “slum apartments” that produce productivity have a negative effect on sims’ happiness. This sets up an assumption that industrial workers are not happy, which follows the game’s logic where happiness is largely based on free time and income. Indeed, if you click on apartment buildings, like “Wood Trim Apts”, the inhabitants will evaluate their city with economically based assessments, such as “What makes me Happy? There are great places to shop!” (GlassLabs 2014). Do sims represent the consumer citizen?
The fact that Wright’s game did not have a goal in itself was one of the revolutionary aspects of the game. Despite the lack of a clear goal, most people believe “the object is to make the citizens of the simulated city happy by creating an optimal environment”(Lew 1989). However, according to the game manual, SimCity Societies “isn’t about maximizing happiness. It’s about controlling it” (Kramer 2007, 21). Yet, there is a constant bar graph indicating how happy the sims are and a happiness filter to see face bubbles above the sims’ heads. The SimCity 3000 guidebook says, “It’s an educational product disguised as a really cool game. It’s an urban development simulation that rises to reproduce with reasonable faithfulness the actual conditions and problems faced by real-world cities” (Kramer 2000, 4). This reasonable faithfulness belies the fact that SimCity is based on popular assumptions concerning societal values.

SimCity is heralded as educational, yet it may not portray accurate theories. Florida’s theories are criticized by scholars, particularly for its neoliberal tendencies. Geographer Jamie Peck describes The Rise of the Creative Class as “cosmopolitan elitism and pop universalism, hedonism and responsibility, cultural radicalism and economic conservatism, casual and causal inference, and social libertarianism and business realism” (Peck 2005, 741). Another geographer, Stefan Krätke, points out Florida’s overly affirmative approval of the creative class and suggests an alternative approach, which the author applies to a German test case to show that Florida mistakenly relates economic growth to his creative class rather than other occupations which are co-located (Krätke 2010). Because Florida discusses happiness extensively and has been criticized as being a hedonist, it seems reasonable to understand happiness as his implicit quest. Comparing social engineering aspects found in Florida’s theories and in SimCity Societies facilitates critically questioning the goals of games.

Interpretation: Teaching Space

Fleming’s next step “focuses on the relation between some fact learned about the artifact and some key aspect of our current value
system” (1982, 172). This section studies how different user groups’ play, sometimes subversively, with the sims’ happiness. To understand how this occurs, it is critical to understand how and to what degree users play with norms, either by absorbing or reacting to cultural assumptions. First anecdotal information about its use in primary schools shows the game facilitated learning computer skills. Then, the interpretation considers how a recent adaptation of the game called SimCityEDU and its web-based community promote critical thought through discussions on embedded cultural assumptions. These are similar teaching goals when using the game at college level. Lastly, advanced users, like Vincent Ocasla, play with these assumptions as well, especially happiness.

The first type of user is school children. Many people remember playing the game in elementary school. One journalist remembered “technology lessons that consisted of us sitting two to a computer, playing the original SimCity; presumably to stop us fighting each other for one hour a day” (Sterry 2010). The game may be more about the skills of concentrating, reading, and learning to use a mouse than applicable skills for architecture or planning. Play theorist Brian Sutton-Smith writes that videogames develop concentration and solo play (1986 24, 61, 69). In addition to learning these skills, there was an educational descriptive in the initial SimCity; namely, missions with historical backgrounds were incorporated.

SimCity also offers an interactive tool to develop skills like critical thought. Since February 1993, the National Engineering Week sponsored by the Institute of Electrical and Electronic Engineers (IEEE) has held “The Future City Competition” for 7th and 8th grade students where a SimCity layout, a descriptive essay, and a physical model are judged. Many of the lesson plans featured on the polished GlassLabs’ website for SimCityEDU also include the virtual city and descriptive essay. Several of the lesson plans on the website ask the students to compare their virtual cities to real life ones. Critical thinking and understanding “basic causal relationships” on which the game is built are 21st century learning objectives of the GlassLab lesson plans. The website explains that this adaptation
“provides formative assessment information about students’ ability to problem solve, explain the relationships in complex systems, and read informational texts and diagrams” (“SimCityEDU” 2014). The game only tracks a couple variables, such as time to complete the mission, air quality, and city funds. The teacher’s interface displays statistics for each student called a report, and if the student affected several variables they receive a higher level. However, the report accesses a limited number of variables in the complex system and obviously does not show the amount of thought or creativity.

In higher education, *SimCity* is hesitantly incorporated. A journalist for the New York Times, Julie Lew, interviewed various design professionals and university professors who extolled the realism and academic value of the game (Lew 1989). More recently, An architecture student recounted how interest in the game was considered too hackneyed a justification for attending architecture school on a Museum of Modern Art (MoMA) website (Arida 2014). Yet, planning professor John Gaber used the game at college level (2007). He examined the instructional possibilities of the game, noted that the designers’ assumptions are imbedded into the game, and explained how these assumptions can be uncovered in a classroom debate (2007). Interestingly, for Gaber and *SimCityEDU* the most educational aspect is the discussion.

One user who engages the cultural assumptions of the game in a subversive way is Vincent Ocasla who manipulates happiness to produce desired effects like maximum population. His *SimCity 3000* city Magnasanti surpassed six-million and the city itself is 50,000 years old (Sterry 2010). The city consists of repetitious mid-rise residential buildings, and there are no public amenities like schools, fire stations, or hospitals; however there are abundant police stations. So while it follows some advice in the *SimCity 3000* guide like striving for low crime and high organization, it ignores citizen’s health and education (DeMaria 1999, 294). Unsurprisingly, he was an

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7. These goals are expressed according to the language of educational standards; namely, English Language Arts (ELA) Common Core and Next Generation Science educational standards.
architecture student at the time and says he views *SimCity* as a “tool or medium for artistic self-expression” (Sterry 2010). Furthermore, for him it is a political statement inspired by the Bhavacakra in Buddhism as well as *Koyaanisqatsi* (1982), a film by Godfrey Reggio with composer Phillip Glass. The title is translated from Hopi to mean “Life out of Balance” and the Bhavacakra without the symbolism of the moon denotes a cyclic existence with ignorance, hatred, and greed as poisons which propel the cycle. Ocasla’s city is considered art, most likely due to these references and has been acquired by the MoMA (Arida 2014). In Magnasanti, Ocasla carefully regulates happiness to maximize population. In addition to Oscala, other players manipulate happiness; in fact, it is anticipated by *SimCity Societies* which incentivizes subversive behavior by awarding trophies, such as the “fat cat” trophy which requires angry or furious citizens.

**Conclusion: Models Simulating Space**

The name of the game comes from simulation, which cultural theorists Roger Caillois, Brian Sutton-Smith, and Jean Baudrillard define differently. Roger Caillois classifies play into four categories, one of which is simulation. He describes two conflicting types of simulation play. Many times, simulation is just as we assume “nothing more than theater” (1958, 77). The second definition allows for transformation of the performer to character, “the corruption of mimicry [... is] when the one who is disguised believes that his role, travesty, or mask is real” (1958, 49). In the early years of videogames, Brian Sutton-Smith remarked on videogames as perfect models and automations (1986, 61–62). Galloway notes that the more real a videogame is, the more it acts like a simulation or model (2004). However, instead of the predominantly positivist way of viewing simulation games Patrick Crogan problematizes simulation by analyzing philosopher Jean Baudrillard (2007). Baudrillard illustrated his theory with Jorge-Luis Borges’s story “On Exactitude”, where the map makers are so absorbed in their work, they make full scale maps (Crogan 2007). Baudrillard defines simulation relative to simulacra. In his description, simulacra destroy or replace reality, whereas
Simulations run parallel to the real (1981, 47). In a later definition he describes a “total simulacrum an automated nature” (1968, 125). While Wright may or may not have been familiar with authors like Baudrillard, they capture cultural connotations of simulation.

This artifact study linking *SimCity* with urban planning has provided insight into the design of the game and how it teaches space. By closely examining *SimCity Societies* and the urban theories of Richard Florida together, their emphasis on place, personality, and happiness emerged. The cultural value of happiness became the emphasis of many players too. The game’s imperfect reality is an educational asset since it is discussions surrounding the verisimilitude, which engages critical thought. Wright, however, points to a few sources of inspiration that problematize how we interpret this artifact, such as a short story and his own background in models.

Wright often cites science-fiction writer Stanisław Lem’s “The Seventh Sally” as inspiration for *SimCity*. In it, the main character Trurl returns from giving a model city to a barbaric despot named Excelsius, who now lives on a planet by himself. Trurl and his friend Klapaucius argue whether the inhabitants feel pain. They return to Excelsius’ planet and the civilization had spread out of its box to the entire planet, and Excelsius is shot into space (1967). Simulation goes too far, because as we know from the story’s alternate title, “How Trurl’s Own Perfection Led to No Good”, perfectly simulated miniature cities are bad for both the inhabitants and the king.

This story highlights Wright’s wariness of models. Wright spoke about the relationship between models and imagination in his keynote address at “Engage Expo”. He loved building models as a boy and tested the validity of the models with his imagination through narrative or simulation play. He explained: “play and story […] are both fundamentally educational technologies [that] we use to supplant our limited experiences to build more elaborate models of the world” (2010, 4). He related these models to videogames.
Models are educational aids to understanding complex systems or objects. Models can also be a tool to imagine a prototype. If potential urban planners, who inspired by Wright’s games or models, overemphasize happiness, then we know what assumptions the roadmap might contain.

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'That’s Not a Secure Area'

Physical-Digital Sound Links in Commercial Locative Games

Inger Ekman

Abstract

Pervasive games break the boundary between digital and physical to make use of elements in the real world as part of the game. One form of pervasive games are locative mobile games, which utilize physical movement as game control. To facilitate eyes-free interaction during play, these games benefit from exploring sound-based content. However, it is currently unclear what type of sound-based interaction is feasible to the general audience. Another consideration is which sound design strategies best support the goal of situated experiences, and how to design sound that supports game experiences drawing upon location-awareness, and intermixing virtual content with physical reality.

A first generation of locative mobile games is already commercially available. The present contribution analyzes seven commercially available locative games (Ingress; Shadow Cities; Zombies, Run!; Inception the App; The Dark Knight Rises Z+; CodeRunner) and summarizes the sound design strategies employed to contextualize game content in real-world. Comparison to current themes in contextualized audio research indicates similarities but also challenges some assumptions regarding audio-heavy gameplay. The findings illustrate the need for simplicity regarding audio challenges, but generally confirm the view of audio-based gameplay as a facilitator of mobility. Sound is also centrally involved in shaping contextualized experiences, forging links between the physical and digital world, and indexing game content to context through functionality, verbal references, spatialization, and remediation. The
article discusses two complementary strategies to systematically manipulate the physical-digital relationship, and to promote strongly situated experiences.

Keywords

Game sound, audio, sound design, locative games, pervasive games, mobile context, contextual experience, situated experience, indexicality.

Introduction

Locative games (or location-based games) use the player’s geographical position (derived via combinations of GPS, WiFi and cell positioning) to map game content to physical locations. Locative games are typically included under the umbrella of pervasive games, which refers to a family of games that break the traditional boundaries of games (Montola 2012). This boundary-breaking accounts for the unique attractiveness of pervasive gaming, but the strategies for combining digital and physical content also constitute a central design challenge to pervasive game designers (Waern et al. 2009). The open questions fall under what Benford and colleagues (2005) have referred to as ”hefting domains”: (1) where to use virtual content, (2) where to use physical content, and (3) how to tie the two domains together in a meaningful way.

Sound is of particular interest to pervasive games for many reasons. In terms of practical usability, audio offers a solution for overcoming the functional limitations of mobile interfaces, in particular by providing an alternative for screen-based information (Brewster 2002). Audio meets many of the demanding usability requirements of a mobile user, sometimes conceptualized as situationally-induced impairments and disabilities (Sears et al. 2003). For example, sound is the modality of choice for facilitating a blended focus of attention, allowing players to attend to game content alongside other ongoing tasks such as driving (Gustafsson et al. 2006). In game design in general, sound has been strongly indicted as triggering user
imagination (Liljedahl 2011), and the high temporal resolution of human auditory perception makes sound exceptionally suitable for real-time feedback (Collins 2013). Explorations of sound in mobile computing generally confirm these sentiments. Sound-based interfaces have been successfully employed in location-aware games (Paterson et al. 2010; 2011; Ekman et al. 2005; Herbst et al. 2008), mobile sound art (see the extensive overview by Behrendt 2010), and many other types of playful location-based experiences (e.g. Kurczak et al. 2011; Rowland et al. 2009; Stahl 2007; McGookin et al. 2009; Bichard et al. 2006).

However, practical field experiments also point to new aesthetic challenges that arise from a design setting which intends to draw simultaneously upon both digital and physical content (i.e. Rowland et al. 2009; Paterson et al. 2010; Behrendt 2012; Ekman 2013). Even as many locative sound designs seek added value specifically in situating content and bringing it into the players’ physical everyday surroundings, it is not clear how to approach the design of such situated experiences. How can designers orchestrate outcomes that depend not only on the content designed into the system, but intentionally draw upon the matches and mismatches mobile sound creates in different contextual settings (Behrendt 2012; Paterson et al. 2010; Rowland et al. 2009; Ekman 2007)?

Prior sound design literature provides little insight for the design of sound in such situations. For example, to assess the overall quality of game sound, designers of mobile sound now need to factor in the experiential impact of contextual elements, such as the physical environment, social situations, and other ongoing tasks, and consider how the experience responds in various contextual settings. Such complex balancing acts have been unnecessary in previous design, and demand significant adaptations both to design and evaluation processes (e.g. for a discussion on authoring tools, see Woo et al. 2005). Another question concerns the transferability of design goals derived for sound in PC/console gaming into the mobile context, in particular the suitability of immersion-driven design paradigms for mobile contexts (Knowlton 2008; Ekman 2013). In particular,
many immersive sound design techniques operate by suppressing players’ awareness of their physical surroundings, which makes them incompatible with a mobile scenario (Ekman 2013).

The present work contributes to the discussion regarding the aesthetic goals, purposes and design directions in locative game sound. To this end, the study systematically analyzes a handful of commercial games with locative functionality, that have recently emerged onto the consumer market. The study investigates how a locative sound design connects, refers, or responds to contextual factors and how situated experiences can be intentionally promoted through design.

The specific research questions can be formulated as follows:

Q1: How do current commercial locative games use sound to create situated experiences, which convey a sense that the virtual content is related to the players’ current context?

Q2: How do these strategies align with the way situated sound is employed in research on locative sound, and where does the commercial practice indicate new directions for research?

The work proceeds as follows: Next comes an overview of how related work on sound in locative media has dealt with the situated experience. The section thereafter considers the motivations for looking at commercially published games as part of design research. After that, the material and method of analysis are presented, followed by the results of the study. The discussion covers separately ways in which applications are functionally employing detected/sensed real-world contextual data, and how situated dependencies are expressed and communicated through sound. The work concludes with a summary of promising future directions for design and development of situated sound experiences.

Previous work on locative and situated sound

In the research literature, a number of interactive systems describe sound mapped to physical locations or bound to and influenced by
other contextual factors (such as social situations or time). This section will focus on summarizing how prior work in this area has addressed the user experience, and in particular how it has approached the aesthetic impact of context in the design of situated sound experiences.

Only a relatively small number of locative or augmented reality systems with locative audio content are actually games (Ekman 2007; Stahl 2007; Kurczak et al. 2011; Paterson et al. 2010). However, many game-relevant elements (exploration, playful interaction, goal-directed interaction) can also be found in location-based sound installations (Rozier et al. 2000; Goudeseune and Kaczmariski 2001; Rowland et al. 2009; Reid et al. 2005; Woo et al. 2005; Vazquez-Alvarez et al. 2010). Other projects have used locative sound for functions with imminent applicability in games, such as navigation (McGookin et al. 2009; Holland et al. 2002; Stahl 2007), or personalized mobile music experiences (Gaye and Holmquist 2004; Sawhney and Schmandt 1999). Finally, several publications address the technical aspects of mobile binaural rendering and augmented reality audio (e.g. Brock et al. 2003; Peltola et al. 2009; Albrecht et al. 2011; Mariette 2011).

As a result of the various different research perspectives, the understanding of what constitutes relevant context varies significantly between publications. Some areas and topics—particularly work seeking to establish an augmented reality environment (Cohen et al. 2004; Kurczak et al. 2011; Paterson et al. 2010; 2011; Brock et al. 2003; Mariette 2011; Albrecht et al. 2011; Woo et al. 2005) define context primarily as the properties of the physical environment (for example, nearby objects, background noise levels), additionally also incorporating sensor data about the user’s orientation within the environment, such as head position or gaze direction. On the other hand, context may also extend to include considerations such as the social environment (Stahl 2007; Rozier et al. 2000; Ekman et al. 2005), ongoing task and temporality (Rowland et al. 2009; Gaye and Holmquist 2004), and even physiological and psychological user state (Fagerlönn 2005). Broadening to the scope of mobile computing
in general (not specific to sound, nor games), Jumisko-Pyykkö and Vainio (2010) reviewed the way ‘context’ was used in recent mobile literature, and found as many as five different contextual categories, spanning technical, social, physical, temporal, and task factors.

The literature on mobile sound covers a range of products and applications. In most cases, situational factors are so central to the design that the services would be rendered meaningless if context was removed. However, whereas the explicated intent of many of these efforts is to create novel forms of contextualized content, the way sound is perceived, evaluated and experienced in context and the added value of presenting sound as situated experiences has gained remarkably little attention. Designs are typically described in technical detail, but only provide hints regarding how designers perceive the flow of information and how represented content is linked to the current context. The audio material may consist of designer-edited content—quite often with a historical perspective (e.g. Reid et al. 2005; Rowland et al. 2009; Herbst et al. 2008; Paterson et al. 2010; 2011)—or offer a platform for visitors to share and annotate spaces with their personal stories and collected sound materials, creating a form of audio social commentary (Rozier et al. 2000; Rowland et al. 2009).

By the descriptions available, it appears most designs consider audio as an one-directional augmentation of physical location. Only a few authors point to the transformative effect of combining space with sound, and the novel interpretations that arise e.g. when a certain form of content is experienced in juxtaposition to a certain real-world context (e.g. Paterson et al. 2010; Ekman 2007; Rowland et al. 2009; Behrendt 2012). However, it is clear that in some serendipitous cases, the contextualized experience creates emergent experiences where the sum is more than its parts. For example, Paterson and colleagues (2010) as well as Behrendt (2012) discuss cases where aesthetic impact arises from specific and unique combinations of place and sound. Ekman (2007) points out the impact of the environment on semantically making sense of and interpreting game sound. And finally, Rowland and colleagues (2009) discuss a rare case of
intentional design when they describe how they placed locative content on the top of a steep hill in order to ensure that the participants would be out of breath (from climbing the hillside) simultaneously to experiencing the audio material.

Taxonomy of Locative Sound Art

As is evident from the previous section, a multitude of design cases have explored locative sound, yet the aesthetics of locative mobile sound has been rather poorly conceptualized. A notable exception is Behrendt’s taxonomy of mobile sound art (Behrendt 2010), which has its primary focus in the aesthetic properties of contextualized sound. Her work is based on an extensive analysis of (over one hundred) mobile sound art projects, and offers a classification of the design approaches coupling mobile interactions with sounding interfaces. The taxonomy identifies four main design strategies for combining mobile interaction with audio material: The act of (1) placing sounds binds sound to specific physical locations. In contrast, by (2) sonifying movement, sound is connected to certain ways or patterns of moving, rather than any individual locations. Designers may also establish spatially defined areas for more complex sound-related activities. These (3) sound platforms offer stages for (often multi-user) sound crafting and manipulation through mobile interaction. Finally, the approach can also focus on the mobile device as a (4) musical instrument, turning the physical device and its sensors into an interface for musical expression.

The taxonomy is not specific to games, and it focuses on mobility which covers only a subset of the contextual factors we are interested in (as discussed in the previous section). Nevertheless, it provides an example of how aesthetic function can be dissected and analyzed thematically, in order to reveal common design strategies for specific aesthetic pursuits. Applying Behrendt’s taxonomy, the location-based game-like interfaces in current research mostly fall into the category of placed sound, with some added elements of sonified mobility. For example, navigation-style interfaces such as AudioBubbles (McGookin et al. 2009), The Roaring Navigator (Stahl 2007), and
Growl Patrol (Kurczak et al. 2011) all use place-bound audio cues to playfully guide users towards set targets. Placed sound also forms the basis for the game-like explorations of the city in Rider Spoke (Rowland et al. 2009), and even if many installation-type games differ in the technology they apply to locate players (e.g. using Bluetooth instead of GPS), placed sound remains an underlying idea in games such as Pirates! (Björk et al. 2001) or Syren (Woo et al. 2005). In addition to placed sound, various gestural game interfaces have appropriated elements of the sonified movement category. These games may additionally connect experiences to specific locations, as in Backseat Playground (Bichard et al. 2006), or they may simply create the illusion of location-bound sound as movement establishes a spatial frame of reference, as in AudioFlashlight (Valente et al. 2008).

The work of Behrendt offers an excellent example of looking beyond the technological realization of mobile systems, to focus on the aesthetic design strategies of mapping sound and movement. However, the taxonomy falls short in categorizing more complex game-based interaction with sound, in particular interaction that takes place within an augmented-reality style audio setting, which easily ends up using elements from all four categories (e.g. Cohen et al. 2004; Ekman et al. 2005; Moustakas et al. 2009; Paterson et al. 2010; Paterson et al. 2011). Moreover, since the taxonomy puts sound in focus, it applies best to audio-only or audio-mostly concepts and the supportive function that sound plays in most audiovisual contexts falls outside the framework. As a consequence, the taxonomy is less helpful for analyzing audio in cases where interaction is primarily visually-driven, such as in the augmented-reality audiovisual game TimeWarp (Herbst et al. 2008).

Indexicality and the Contextualization of Information

To examine the contextualization of sound elements, we can apply another concept. Within mobile computing, Kjeldskov and Paay (2010) have suggested using indexicality as a conceptual tool for exploring and describing the flow of information between user-
interface representation and use context. Indexicality traces the ways in which the user interface points to information implicit in the current context. For example, when the service communicates that a restaurant is close to the user’s present location, indexes are the pointers by which the service establishes that relationship, linking the represented information (restaurant) with user context (current location). The way contextual knowledge is communicated, and how these links are shaped, argue Kjeldskov and Paay, is the essential core design task of contextualized information design.

While Kjeldskov and Paay concentrate on the contextualization of (user-actionable) information, indexicality could be equally useful to understand the contextualization of meaning from an aesthetic perspective and also applied to less utility-focussed products such as games. Interestingly where the core design question Kjeldskov and Paay considers is how to establish the links between context and content, this question—what prompts users to perceive a connection between audio content and space—has been relatively absent in work on locative game sound. The lack of critical discussion might be taken as an indication that the contextualization of audio is unproblematic and situational dependencies are intuitively grasped. However, such an assumption has been questioned by Ekman et al. (2005), who found that without prior briefing, players of a locative game would not spontaneously discover the connection between place and game audio. It is difficult to assess how significant the impact of briefing has been in establishing the location-dependency of sound in prior studies.

Whereas Kjeldskov and Paay demonstrate how to use indexicality as an analytical concept, their examples only address visual interface elements. Even if indexicality appears to be very promising for describing contextualized gaming experiences, it is not straightforward to determine how the idea of indexical information applies to the audio modality; indeed, how does one point with sound? This question will require some further development. It would appear that apart from subject briefing prior to experiments, and seeking a certain thematic likeness between sound and location (e.g.
Bichard et al. 2006; Stahl 2007) the primary cue to contextual dependency is how the system’s sound output responds to user movement (placed sound and sonified mobility). If indexing relies only on this strategy, it would follow that technical constraints such as temporal resolution and location accuracy are central in establishing a connection between location and sound. Such indices would also leave the system very vulnerable to positioning and orientation errors. As would be expected in such a case, positioning errors have been found to lead to significant confusion, to the point of making functions incomprehensible (Kurzcak et al. 2011; Ekman et al. 2005; Holland et al. 2002). Furthermore, considering the wide variation in location accuracy of current devices\(^1\), in the absence of proper briefing, the locative nature of sound might fail to become apparent to the user. Finally, successfully communicating contextualization through sound is likely to become more challenging in systems that (1) combine visual and auditory components, leading most users to expect visual-dominant interaction, (2) are used simultaneously by multiple users and autonomous game entities, which decreases the direct impact of the user’s own actions, and (3) respond to input from several information sensors/sources at once (again, confounding the direct and observable impact of any single control action).

Commercial games as artifacts—exploring design strategies through Formal game analysis

This work looks for inspiration on how locative game sound could communicate across the digital-physical divide by exploring designs and strategies adopted in current commercially available locative and mobility gaming. I approach commercial games as artifacts that document and embody tacit design knowledge about the design ideas with value within the current product ecology. While it will be impossible to trace the precise reasons a design has materialized in

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1. Studies show that the iPhones A-GPS has a median error of only 8m (compared to 1,5m on a dedicated GPS device), it is notable that whenever GPS is unavailable the error grows significantly; in areas with GPS shadow, the median error for WiFi was 74m and 600m for Cellular positioning (Zandbergen 2009). Similar results seem to apply for other smartphone models as well (Zandbergen and Barbeau 2011).
a particular way, commercial products nevertheless give a unique perspective on design expertise that pertains to the current consumer market, weighing in the various factors that impact design on a level rarely accessible by research projects conducted in a purely academic environment. This includes considerations such as technological penetration and feasibility (including infrastructure), production realities and workflow, target audience expectations, legal concerns, marketing strategies, branding and product identity etc. Analyzes of commercial games provide an angle for examining the types of design decisions that survive or even flourish in a true project ecology.

Moreover, the practical limitations that come from relying on off-the-shelf technology implies that added value must be sought solely through design. This provides a counterpart to constructive design research, which is often published in technical forums, and hence tends to favor new technological development over pure content design. Not only can this provide new insight about design solutions for overcoming technical obstacles; as pioneering products, these games may also set consumer expectations for future products, and determine the type of content strategies the general audience will find familiar and palatable in the future.

Game Material used in the Study

Games and game-like applications were sought for analysis by perusing the App store and Google play, as well as by following industry news. The games for analysis were selected using the following criteria: (1) they offer game-like interaction, (2) they contain non-trivial sound design elements (3) the game uses location information as game input, and (4) the game was available in the app market for iPhone or Android in Sweden during January 2012-January 2013.

The above selection criteria exclude a number of games that either had very trivial game sound or no sound at all, for example Gbanga Famiglia (Milliform Ltd., 2012). Moreover, apps that use a “check-in” style location paradigm have been excluded from the analysis.
(e.g. games built on the Foursquare API). Local multiplayer games which cannot be played in single-player mode, such as MobileWar (Upright Media Concepts, 2012), were also intentionally left outside the analysis.

The resulting collection included the following seven games, available for the iPhone and Android platform:

- **Shadow Cities** (Grey Area, 2011)\(^2\)
- **Ingress** (NianticLabs/Google, 2012)
- **CodeRunner** (RocketChicken Interactive, 2012)
- **Zombies, Run!** (Six to start and Alderman, 2011).
  Henceforth referred to as ZR.
- **Inception the App** (RjDj, 2010). Henceforth referred to as ItA.
- **Dimensions** (RjDj, 2011)
- **The Dark Knight Rises Z+** (RjDj, 2012). Henceforth referred to as TDKRZ+.

### Method and Data Collection

Within game research, perhaps the most popular strategy for producing design knowledge from analyzing commercial games is to generalize over a large body of artifacts, identifying design patterns (Björk and Holopainen 2005). However, seven games provide limited material for pattern construction (by definition, a pattern is a recurring design solution). Whereas pattern-harvesting has been applied separately to game sound (Alves 2012) and locative games (Will 2013), there is little overlap between the two sets of patterns to provide a basis for investigating locative sound. Therefore, the present work applies formal analysis to systematically examine and collect the variety of approaches employed within this particular niche of game sound design. The theoretical framework of

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2. As of 20.9.2013, Grey Area has announced Shadow Cities will be discontinued.
indexicality (Kjeldskov and Paay 2010) was chosen for this purpose. The analysis looks at the precise means by which games create contextualized sound experiences and tracks how the games are (a) using sound in order to (b) point at the current context. As a starting point, the work adopts the five index categories of Jumisko-Pyykö and Vainio (2010), but the full set of index categories are allowed to evolve based on the encountered game material.

For analysis, all applications were played by the author, on a mobile smartphone (iPhone 4 for iOS applications, Samsung Galaxy S2 for Android applications), using the standard in-ear headphones provided with the devices. Playing styles were varied to gauge the aesthetics of the game, and to analyze the applications’ detailed sonic behavior in various situations. As material was collected over a longer period of play, the games received a number of updates during the duration of the analysis. In the rare case where a client update had a noticeable difference to locative sound behavior, I have indicated the specific version it applies to in the footnote.

The analysis procedure for each game commenced with a period of free-form play to get a general feel for the game, to level up, and to gain access to game features that were locked at the beginning of the game. The length of this phase varied by game, from approximately 5 hours (The Dark Knight Rises Z+, which has no locked features or character development) to well over 20 hours of active play. This phase was followed by a period of more systematic research-play\(^3\), exploring the game in different contexts, analyzing functional dependencies behind various sound designs, and cataloguing contextual references. Again, the duration of active play varied significantly between applications, from very briefly replaying certain events to engaging in over 40 hours of systematic play and replay (story-heavy games CodeRunner and Zombies, Run!).

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3. For analysis, play has been in compliance with the guides or instruction provided by the application, and no intentional subversive action or cheating has been explored; this was made to ensure analysis focuses on the uses designed into the system. When in doubt about the intended use, the author has referred to official instructions and guides about how to proceed with game action.
Game analyses were complemented with additional information on the applications gained through online sources, such as game reviews, designer texts and interviews, game forums and Twitter channels. This material was primarily used as a way of ensuring that no significant content or relevant playing context was left out of the analysis. Any use of complementary data in analysis is indicated by direct references to the source material.

*Shadow Cities* is a massively-multiplayer online roleplaying game. SC overlays a persistent game world on a map representation of the physical world. Players banish spirits, and harness energy from virtual structures built at hot-spots in the game world. SC divides its player base into two factions, and gameplay is driven by a competition between factions, both in player-to-player combat, area domination, and on a point-based basis in weekly campaigns.

*Ingress*, similarly to SC, is a multi-player game with persistent game worlds connected to a map-layout of the physical environment. Players are split into two factions, competing to take control over the world by conquering and linking in-game portal locations with the help of items collected from the game world. The locative gameplay additionally provides material which feeds into an alternate reality game, played on other platforms.
**CodeRunner** utilizes a semi-permanent game world over a map display, offering an espionage-themed interactive experience fueled by location-based quests. The player performs missions consisting of visiting locations marked on the map, or following moving targets. At in-game locations, players also solve visual riddles to discover the information they need to break into systems. The experience is primarily single-player, even if the game draws on its (multi)player base for content creation.

**Zombies, Run!** is a zombie-themed fitness application, offering an audio narrative that progresses in bite size chunks, designed to accompany physical exercise such as walking, jogging and running. Zombies, Run! complements regular run tracker application features with a game-like interface that visualizes overall training progress. It also features zombie chases as a (optional) mini-game for interval training.

**Inception the App** (top left), **Dimensions** (middle left), and **The Dark Knight Rises Z+** (bottom left), are three different variations of contextually responsive personal music applications. The applications offer contextually responsive music tracks that respond to a range of sensor and derived data: movement, sound, touch, date, time of day, and weather.
While all three applications afford distinctly playful use, *Dimensions* is most decidedly a game, with players advancing along an explicit progression line (tracked on the Apple Game Center) by collecting gemstone-like artifacts and fighting off adversaries.

The playfulness in *Inceptions the App* and *The Dark Knight Rises Z+* revolves more around exploring the full extent of the musical experience with content based on the soundtracks of the movies *Inception* and *The Dark Knight Rises*. All three applications are primarily solitary experiences, but incorporate a mode for co-use amongst a select number of friends.

**Table 1: Description of the general style and content of the seven analyzed games**

Results of game analysis

The applications analyzed for this work approach locative sound from different perspectives, but they also share some similarities. In order to focus on generalizable design strategies rather than surface thematics, the detailed analysis will primarily look beyond choices of genre and style, and instead focus on how the systems approach locative content and mobility. However, as a way of contextualizing the analysis, Table 1 provides a brief summary of the content style of each application. The remainder of this work will discuss the formal design strategies in more detail, and examine separately how sound
is involved functionally in the context of gameplay, as well as what sound-based indices are used to link virtual content to real-world context.

Gameplay Interaction, and Utilization of Locative Data

In the distribution channels, all but one of the applications (*TDKRZ+*) are classed as games. Active gameplay provides the core content in four of the apps (*Ingress, SC, CodeRunner, Dimensions*). *ItA* and *TDKRZ+*, while both offering playful interaction, lack explicit goals or a system for tracking individual progress and are more accurately described as augmented sound experiences. In contrast, *ZR* introduces gameplay elements in the form of zombie chases, but they occur only sporadically (and can be turned off completely) among otherwise linearly progressing content.

Locative data is also used to varying degrees. Physical movement is in a primary role for using *Ingress* and *CodeRunner*, and the games offer no progress for the stationary player. *Ingress* requires that players move around both to gather energy, which is spread around in the environment, and to find game content. Since interacting with portals necessitates proximity to specific geographical locations, this limits the amount of active play in areas with no portals and benefits players who travel actively. Depending on the density of the map, players may need to cover significant distances, or simply walk the short distance between closely positioned portals (portals have a 35m radius, and do not overlap). *CodeRunner* is slightly more flexible in terms of specific locations and the game will always generate a number of randomly location-mapped targets around the player, regardless of how populated the location-specific map happens to be. However, missions will require significant physical activity (automatically generated targets will generally be at least some hundred meters away) and the game explicitly rewards the player for covering longer distances (accumulated distance up to 1000km, or 50km in one step).

In contrast, movement is less of a necessity for enjoying *SC*,
TDKRZ+, ItA, and Dimensions. The applications use GPS data, but while location-based features add to the experience, they do so without removing the option for stationary use. ZR uses GPS data to track run metrics, and provides an option to upload runs to an online map view. However, GPS is not required and there is a treadmill mode that uses accelerometer data. Moreover, detected movement is not required; the story will progress and item pickups will occur regardless of (any) player movement. The single element in which progress is tied to detected physical movement are the (optional) zombie chases.4

SC offers some benefits for physically located players (harvesting energy from in-game structures requires physical proximity), however, the game is fully playable without moving. Moreover, players can use in-game beacons to gain (and provide) access to game areas mapped to other physical locations freeing exploration from ties to actual mobility. Likewise, the music applications TDKRZ+, ItA and Dimensions all three derive some information based on location data, but the impact of location is optional. All three offer basic functionality (reactive music) regardless of specific location and are therefore fully enjoyable also in stationary mode.

Sound Design Strategies and Sound-based Functionality

Since audio was one of the selection criteria, all titles involve game sound. Many of the game titles are also audio-heavy, and sound forms the main content in ZR, ItA and TDKRZ+ and remains indispensable in CodeRunner and Dimensions. The designs combine sounds from four categories: embellishing/interface sounds, spoken commands, radio play style narratives, and music. Ingress and SC use audio only sparingly, with simple sound effects (fire, electricity) set against a sonic background of winds and musical drones. Unlike the other applications, the sound design offers no unique content and the information design of the user experience is visually-oriented. ZR and

4. Early versions of Z,R! offered zombie chases only when GPS was activated. Accelerometer-based zombie chases were introduced as an experimental feature in version 1.2., released in April 2012.
*CodeRunner* are more audio heavy, developing stories in the style of radio plays. The player is connected to the base of operations over a radio/phone connection, and the narrative progresses primarily in the dialogue that is conveyed over this channel: overheard conversations, spoken instructions and recordings. In *CodeRunner*, the player can also examine found media clips, and operate remote connections (command-line interfaces) to break into data repositories. Finally, music drives *TDKRZ+, ItA* and *Dimensions* (the latter also involves a limited number of spoken instruction and interface sounds). These apps feature unique contextually responsive music. They also take input from the device microphone, and captured environmental sounds are elaborately processed and incorporated into the musical mix in different ways, playing sounds stretched or backward, or turning recorded samples into rhythmical patterns or virtual sound elements that swoosh past the listener.

The primarily sound based experiences in *ZR, CodeRunner, TDKRZ+, ItA* and *Dimensions* facilitate mobility by allowing a greater portion of visual attention to the environment. Moreover, the type of audio we find in these games is meticulously tailored to integrate with the everyday. Even if most of the games aim for dedicated use scenarios, high levels of flexibility is achieved either by distinctly episodic progress, or by casual and therefore easily interruptible play. *CodeRunner* and *ZR* offer mission-based play where the temporal structure of missions demands a dedicated time slot set aside for gaming. To add some flexibility, *CodeRunner* will let users choose between several simultaneous missions, whereas *ZR* will let users tailor the length of episodes (choosing between 30 or 60 minutes workout) and missions can be paused. *Ingress, SC* and *Dimensions* split play into yet shorter, bite-sized engagements with immediate returns, which increases casual play alongside other activities.

The high demands for integration is also reflected in how external audio content is handled. Both *ZR* and *CodeRunner* will encourage players to listen to their own music while playing, and include this as a fundamental part of the end user experience by flexibly alternating
between the playlist and game-based alerts; ZR will even schedule its main content to fit between songs to minimize the disruption. Ingress allows music playing in the background during use but SC, Dimensions, TDKRZ+ and ItA will stop other ongoing sound players upon start. While Dimensions mixes gameplay functionality and music, TDKRZ+ and ItA frames the experience as background, rather than a foreground playing activity.

Sound-based Gameplay

While the significant shift towards using audio for main content is well in line with how research has envisioned sound in mobile computing, the precise design strategies for shaping audio-based gameplay and situated experiences differ somewhat from those typically seen in research prototypes. Despite generally audio-heavy designs, the games use sound cautiously when shaping gameplay challenges. For example, instead of capitalizing on challenges inherent in listening (cues, directions, recognition), these efforts are minimized in the commercial designs. Whenever possible, game-relevant information is provided primarily, and sometimes only, in visual form. In the few cases where player action is based on audio information alone, the information design avoids ambiguity at all cost. This is achieved by combining identifiable alerts with clear verbal instructions. For example, ZR zombie chases are announced with audio only. The fact that zombies are on one’s tail is communicated by introducing as many as three new sounds: spoken instructions, zombie growls, and a geiger-style beeping signal, which all serve the sole purpose of informing the player of a need to speed up. Additional spoken confirmation will signal when the mob has been evaded. In a similar manner, CodeRunner and Dimensions back up all non-speech audio cues with clear and unambiguous spoken prompts; all the player needs to do is obey the instructions.

In addition to audio-only information, some of the games also use more complex audio information designs, but only in accompaniment with visual information. For example, Ingress provides a spatialized audio navigation beacon as a directional cue to targeted portals.
However, the sound beacon will disappear when the phone is in an upright position, and be misplaced if the phone is pointed sideways to the user’s line of sight. Thus, the beacon will only display (correctly) in the exact same situations as the player has access to the visual map. Neither is navigating by ear very feasible in practice: sound localization is not very accurate and additionally quite sensitive to compass interference.

The unambiguity of audio design is particularly interesting to take notice of, and it gives some indication about the type of audio challenges that are feasible for pervasive and mobile use in the mainstream market. Unlike typical\(^5\) audio-based games—where the player, for example, navigates by ear, detects specific sound cues, or times their actions to the beat of the music—the analyzed games avoid making listening a challenge. Even in audio-heavy designs there is nothing to listen for only listen to. This is a clear divergence from the functionality-driven approach adopted in audio-based gaming (e.g. Rovithis 2012; Friberg and Gärdenfors 2004). Notably, also previous research within locative sound (e.g. Kurczak et al. 2011; Stahl 2007; Vazquez-Alvarez et al. 2010; Cohen et al. 2004) has featured far more complex listening tasks than found in the analyzed games.

Playful Music and Unlocking Sonic Content

The three musical applications ItA, Dimensions and TDKRZ+ are special in the sense that while they do not appropriate audio to make a traditional game, they are nevertheless very playful. Of the three, Dimensions actually offers a bona fide game, however, the main content in all these applications is in the contextually reactive music experience. Additionally, all three applications promote a very active stance towards context and operate solely by audio, offering a musical background that changes in response to small elements in a whole range of contextual factors (making maximum use of the phone’s sensors). By making sound immediately responsive to so many factors at once, the design offers something of a musical puzzle-toy,
prompting the player to try out the application in new environments and seek new ways of triggering novel musical material. At the same time, by not strictly demanding that the player engages in any specific listening task, the score-like reactive soundscape is allowed to latch onto any other activities (regardless of how demanding they are). This way, the application seamlessly shifts between its two roles as either reactive background music or interactive musical toy.

*ItA* and *Dimensions* further develop the reactivity into a new form of contextual sound game, by inviting players to explore new contexts more generally to unlock novel musical material. This becomes an active pursuit; the applications openly describe the relevant contexts required to gain access to the new content. For example, the player is instructed to log into the app late at night to get into the ‘Ghost dimension’ (*Dimensions*). By making context relevant in such an explicit fashion, players are further encouraged to pay attention to details in their context, seeking clues or signs that will qualify as criteria to unlock the new experience (Oh, is it a full moon tonight? How can I convince the app it is sunny?). Some contexts define rare or very special situations, which makes fulfilling the contextual demands something of an achievement in itself. For example, one level in *ItA* is only made available upon visiting Africa (yes, the continent). *TDKRZ+* does not use contextual elements as a way for unlocking new sonic material, nevertheless it promotes the same very active stance to context, and also allows the user to navigate the sonic material they possess (a few scenes are available for free, more can be purchased) through this similar approach.

Discussion

**Sonic contextualized experiences**

The previous section reviewed how sound is functionally employed in the analyzed games. Applying the notion of indexicality, we can also identify a number of pointers which direct players to associate game

6. While *TDKRZ+* uses contextual exploration as a way to interact with the content, additional tracks are available only through purchase.
elements to the environment. The sound-based indexes reveal several different approaches to make the actions of the service appear to have a meaning that is specific or connected to the current use context, be it physical, technical, social, temporal or task-based.

Indexing with Sound

As noted previously, making elements functionally responsive to context is one way to make contextual connections apparent to the user and signaling contextualized meaning. Functional dependency—such as the audio beacon in Ingress or the playful soundscapes in ItA, Dimensions and TDKRZ+—provide the user both with an incentive to explore use in various contexts, and also turn attention to the context as part of framing the system response. However, only tracking the ways in which context is made necessary or required for interaction overlooks the many subtler design aspects that go into shaping and invoking a sense of contextualized experience. A comprehensive look at all the pointers provides a more complex picture of how the service shapes connections with the current use context. Despite not requiring location data to function several other design techniques are utilized, both to invite and guide the contextualization of the overall experience.

CodeRunner and ZR make frequent verbal references to the player’s current context—the environment, use situation, time, equipment, and task. By pointing to contextual factors and claiming them as game-relevant, the player is invited to seek elements in the current context that match what is described. Even if some references are based on observed sensor data, others are more or less arbitrary. Some of the references by CodeRunner are functionally backed up, such as relative target directions (“north of your location”), or when the game chides a stationary player who fails to obey instructions (“ok, I’m serious here—get walking”). However, other references connect story content to environmental features that are rather based on plausibility than actual checked facts, or they are simply vague or general enough to accept almost any target (“people”). Likewise, ZR will index liberally to contextual factors without any concern
for factual accuracy, including not only physical structures, but also including time (“it’s getting late”), physical effort (“you’re doing great”), and relative direction (“twelve o’clock”). The game even incorporates references to the user’s pre-selected playlist (“a special song”).

There are also certain purely auditory cues that can be used as ways of indexing sound to contextual factors. By using spatialized audio, it is possible to perceptually place sound sources so that they draw attention to a specific direction, or even a specific point in the environment. The analyzed applications use spatialized audio sparingly and only Ingress features a navigation beacon that combines physical location and directional cues (from the phone, i.e. not head position) with sound spatialization.

Another sound design technique which is found in the material and used for indexing is remediation, which refers to the practice of masking mediated content as another type of media (Bolter and Grusin 2000). In the case of these games, game content (game audio) is remediated by presenting it as on-line communication and audio recordings heard over an (unreliable) radio channel. This is a way of indexing that points to the technological context, whereby the experience involves listening at sound context through headphones. Notably, while many of the games (Ingress, ZR, CodeRunner, Dimensions and ItA) offer some form of general explanation for using headphones in the game instructions, the audio realization of many seeks to dissolve the technological interface. In contrast, ZR and CodeRunner use the sound design to further strengthen the sense of interface, but remediate it to fit the game’s version of the story and thus extend the fiction to cover also the physical technological equipment that is being used to play the game. By using a crackling radio signal, the sound material points to the real-world fact that the player is carrying a phone and wearing headphones, but simultaneously also provides a good in-game reason for carrying that technology.

Strategies for Shaping Situated Experiences In particular, the liberal
indexing to non-factual contextual parameters suggests that from an experiential perspective, only focusing on the functional dependencies is a gross oversimplification of the design techniques that contextualize play experiences. Rather, the design of situated experiences can be thought of in terms of two separate functions. The first function subjects the service to certain contexts, either by making the service dependent on certain contextual data (e.g. requiring movement as input, demanding the player visit Africa), or alternatively by softer means, by selectively promoting and facilitating targeted use contexts. When a service is in the target context, situated experiences can be created by various different strategies that index game content to the current context, establishing it as an integral part of the overall experience. A summary of indices is presented in Table 2.

The strategy of facilitation and indexing as a way of creating situated experiences has a number of implications for design. A common feature to many of the examined applications is that context is viewed proactively. It is not something that the game is passively dropped into. Rather, context is either adopted as a part of the control mechanism for using the device, or contextual references are considered malleable and open-ended. The reviewed material shows that the link goes both ways; it invites players to consider the impact of environment on the game, but the game also lends something magical to the everyday. This interaction has previously been discussed as the three-sixty illusion (Waern et al. 2009), and the reviewed material helps identify tools in the design arsenal for strengthening this two-way interchange through sound.

7. Neither are contextualized experiences restricted to designed aspects of the service. However for the purpose of looking at how such experiences can be shaped by design, this work will limit the discussion to ways in which the applications do this by actively calling upon the user to pay attention to such connections.
<table>
<thead>
<tr>
<th>Context</th>
<th>Shadow</th>
<th>Ingress</th>
<th>Code</th>
<th>Zombies</th>
<th>Inception</th>
<th>Dimen</th>
<th>TDKR</th>
</tr>
</thead>
<tbody>
<tr>
<td>specific physical location</td>
<td>F</td>
<td></td>
<td></td>
<td>F</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>relative location</td>
<td>F</td>
<td>F</td>
<td>(F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>objects in physical environment</td>
<td>X</td>
<td>X</td>
<td>(F)</td>
<td>(F)</td>
<td>(F)</td>
<td></td>
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<tr>
<td>environmental sound</td>
<td></td>
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<td></td>
<td>F</td>
<td>F</td>
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</tr>
<tr>
<td>other environmental factors</td>
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<tr>
<td>current time</td>
<td></td>
<td></td>
<td>X</td>
<td>F</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ongoing task</td>
<td>F</td>
<td>F/X</td>
<td>(F)/X</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>social context</td>
<td></td>
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<td></td>
<td>X</td>
<td></td>
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</tr>
<tr>
<td>simultaneously playing music</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>mobile device</td>
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<td>X</td>
<td>F</td>
<td>F</td>
<td>F</td>
</tr>
</tbody>
</table>

Table 2: Contextual sound indices. F indicates functional dependence. (F) points to derived functional dependencies in which the contextualization uses functional dependencies, but in a different form from how they are being represented to the player. X indicates a non-functional reference where contextualization is implied, but no functional dependence exists between context and representation.

Technically, the malleability identified in the analyzed games
suggests a more forgiving design scenario exists alongside rigorous context-detection. For example, while using sensors to determine the exact context of use is typically very challenging to get right, the proactive approach turns the challenge of contextual matching into a game where the user is tasked with actively searching contexts that would qualify for purposes of the game. As demonstrated by ItA, TDKRZ+ and Dimensions, this form of situational play can be quite enjoyable if it is coupled with the right kind of sound. Furthermore, some games within the collection (Ingress and CodeRunner) employ user-created content to define physical spots as game-relevant places. CodeRunner and ZR are both tapping into the players’ personal music reserve which is potentially very valuable material for sound designers. While ZR is the only game to also explicitly index to this type of user-selected content, simply allowing players to use their own music in the background (ZR, CodeRunner) is a way of drawing on the emotional significance of user-selected musical content. By tagging selected physical structures in their environment (CodeRunner, Ingress), players are also providing the service with specific information of meaningful contextual elements in their surroundings.

Moreover, verbal indexing suggests that potent situated interpretations can arise even if contextual matching is not backed up by functionality. While some of the contextualizations may lack factual accuracy, this type of contextualization nevertheless seems to acknowledge and explain the user’s environment by reconciling the reality of play within the fictive frame of the game. What appears most important to the success of indexes is not the factual accuracy, but precisely the reconciliation between the physical and digital representations. From cognitive science, we know that the human mind shows a preference for “good stories” over accurate content (Kahneman 2012). Interestingly, as especially the verbal references in ZR and CodeRunner demonstrate, even slightly mismatching information can seem quite palatable; the author’s experience was that it was only upon clearly contradictory information that the mind protests. For example, the locative audio beacon that Ingress uses to point towards target portals is very sensitive to errors because any
shift in position will cause the target to appear to jump from one place to another. Such jumping is inherently irreconcilable with how places behave in physical reality and completely destroys the perception of a stationary beacon. On the other hand, when open-ended references actually match to the environment (be it through sheer coincidence), it was very memorable.

Comparing to prior work again, at its core, the proactive stance to context is not uniquely novel. Many prior locative sound prototypes also come with the explicit purpose to somehow manipulate user context, most typically by promoting spatial exploration (McGookin et al. 2009; Rowland et al. 2009; Paterson et al. 2010; 2011; Kurczak et al. 2011; Stahl 2007). Interlinked with this vision, is also the idea—popular within alternate reality gaming—of using game design to cause very tangible change, in McGonigal’s (2011) words, to “fix what’s wrong with reality”. To this end, the analyzed games show practical techniques for how the combined use of indexes and functional response can be employed to establish a stronger two-way connection between the virtual and physical domains. Furthermore, the present analysis points to the possibility of using open-ended indexing techniques in the interface to strengthen situated experiences regardless of function. The natural ambiguity of sound indexes appear uniquely suited to this purpose, leaving the user room for selectively picking matches from the environment which satisfy the indexing functions of the game and riding on coincidental matches for experiential effect. Whereas the intentional designing for coincidence has been addressed before, the strategies for this have focused on increasing the potential for serendipitous matches by selectively picking highly plausible contextual targets (Reid 2008). The work here shows a way of manipulating the representational aspects instead, which provides significantly more flexibility for designers.

Conclusions

The aim of the present work was to (Q1) identify how current commercial locative games use sound to create situated experiences, and to (Q2) compare how commercially explored ideas align with
prior research perspectives into locative sound aesthetics. The specific novel contribution of this work is a detailed analysis of the sound strategies employed in seven commercial locative games for current generation handheld devices. This work provides an overview of how situated sound is used presently within locative and mobility game/entertainment, and summarizes the design solutions that industry developers have considered most promising, feasible or interesting to pursue in this early stage of locative gaming. Moreover, the analysis also looks into how well the goals and strategies of sound design align with current research directions for locative sound, offering a comparison between research and industry design.

To investigate the involvement of contextual factors in experience design, formal game analysis is used to explore how designs actively invite the player to actively attend to elements within their current physical, technological, social, temporal and task context. The analyzed collection suggests a two-step strategy is particularly promising for promoting frequent and meaningful contextualizations: a) The game can proactively push the players into experientially desired contexts to influence play experience. Additionally, b) the game can invite contextual elements to become part of the experience by indexes, which draw in external information to game content. The work identifies four types of sound-based indices that can be used to tie virtual content to the user’s current content: 1) functionally responsive audio, 2) verbal references, 3) spatialized audio, and 4) remediation.

Regarding sound functionality, adopting a proactive stance towards contextual matching helps push the player towards desired situations. Making gameplay location-dependent is a natural way to steer action, however the cautious approach to using location data observed in the analyzed collection is telling: Only two games (out of 7 location-aware titles) necessitate movement, and only one game ties gameplay

8. Other possibilities are available as well, which are less applicable to the mobile domain. For example, film typically uses synchronicity to attach a sound to a concurrent visual event. Sound material can also semantically attach to objects, such as a female voice will connect to a female speaker, or a lullaby will be associated with a crib.
to fixed physical locations. On the other hand, several of the games facilitate playing while actually on the move, increasing the likeliness that players will experience the service in different contexts: Five of the games achieve this turning to audio-heavy content designs. The musical games ItA and Dimensions offer the player sonic rewards for seeking out new contexts and turn contextual matching into a kind of puzzle activity.

Of particular practical interest, however, is the finding that many games rely on techniques for situating experience that depends on no functional verification or context-sensing technology at all. Instead, following the idea of indexicality, open-ended references to context are frequently created to suggest contextual dependency even when none exists. Such incomplete references become anchored to contextual elements only in the user’s mind, where contextual elements can be selectively attended to in order to satisfy the qualities indicated as targets. While such indexes will fail at times, inaccurate or incomplete references seem to behave in relatively unproblematic ways. The most critical failures arise with overt contradictions, when the information clashes with observable physical reality.

Comparison to current themes in contextualized audio research indicates similarities but also challenges some assumptions regarding locative audio experiences. While the observed material generally confirms the view of audio-based gameplay as a facilitator of mobility, the games contain only extremely clear and simple audio-based gameplay and no perceptually challenging tasks whatsoever. Sound is centrally involved in shaping contextualized experiences, forging links between the physical and digital world, but the techniques to achieve this are both novel and surprising. Whereas previous work on contextual audio has sought to create contextualized experiences primarily with functional contextualization, the present analysis suggests that it is equally interesting to look at how this connection can be constructed regardless of function, or by alternative ways of representing detected dependencies. Moreover, between functionally verified and completely arbitrary contextual indexes exists an area of probability
that depends both on the available context and the flexibility and adaptability of the applied indexes. This could be a sweet spot for contextual design as the use of open-ended contextual indices increases the chance of serendipitous matches.

Among the open questions from this study is to find out what types of contexts would be most desirable to catch by such open-ended indexing, and also how to most effectively use proactive contextual design in combination with open indexes, to lure/push/guide the player towards the contextual hooks embedded in the design. A particularly promising area of making memorable references could be the greater utilization of user-created or user-tagged content. While some games already involve player-generated content, this material is used sparsely as the end point of indexes. For sound design in particular, the increased use of preselected playlists as part of the game experience offers a potent source for tapping into audio material which is both generally considered emotionally significant, as well as highly personalized.

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The Case for Computer-Augmented Games

Using computers to support and not dictate gameplay

Karl Bergström and Staffan Björk

Abstract

In this article we introduce and explore the concept of Computer-Augmented Games – the use of computer technology to provide support or tools for gaming activities rather than use the technology as the complete mediating platform. Several examples of these games are presented and placed in a design space using a multi-dimensional typology of games approach. Based on this, possible future directions for using computers to support gameplay are discussed.

Keywords

Computer-Augmented Games, Game Design, Multi-dimensional Typology of Games

Introduction

Computers have become an integral part of many people’s lives, including to shape their leisure and entertainment. Nowhere is this perhaps more obvious than in the case of games; computers and gaming consoles let millions of people play in a multitude of forms, often with each other over networks and in many cases exploring large detailed fictional worlds.

That computers are so often used to encase or mediate games has a long history. The early computer pioneers have documented research interests in games, and the first computers were often used for games (Björk 2013). While the motivation for this often was to try and create AI players for particular games – which allowed them to be
played alone – the introduction of computational power brought other advantages. Rules could be enacted and enforced by the computer, and this allowed players to adopt a trial-and-error style of learning games. By maintaining the game state, the computer could make it easier to setup and store away ongoing game instances, and with the development of computer networks people could play and game with people at far off locations. With the development of computer graphics and sound, virtual worlds could be visualized in high fidelity.

With all these advantages, one could almost believe that the use of traditional games would have declined. However, even if today the video game industry is the commercially strongest game industry, it is easy to find thriving examples of other types of games. The hobby-game site boardgamegeek lists over 1000 board games and expansions released in 2012 alone (www.boardgamegeek.com). While below their peak in the 1980s, Tabletop Roleplaying Games (TRPGs – see e.g. Fine 1983 or Bowman 2010) continue to be published in new editions (see Peterson 2012 for the history of this type of games). Live Action Role-Playing (LARPs – see e.g. Stenros & Montola 2010) is becoming a more and more established form of gaming and several large scale crossmedia events have used this as part of the interaction offered (e.g. Waern & Denward 2009; Stenros et al. 2011). Further, the recent popularity of mimetic interfaces (Juul 2010) provided by the Wii, Kinect, and PlayStation Move show that people are interested in game experiences other than those provided by the “standard” platform provided by video games. Evidently, people still play and enjoy a wide variety of games. Looking closer at the advantages offered by computers for gaming, several of these seem to come with limitations that can be seen as disadvantages. That the computer can enforce rules lessens the workload for players in updating the game state but at the same time makes it difficult to change or add rules to suit the social context, or quickly create example game states to explain the game for novice players. Scripted narration and well-crafted visual and audio material can effectively be presented by computers but make it more difficult for players to be creative within these areas.
In this article we argue that there exists a larger design space for harnessing the potential affordances of computers for games. While we would argue that computers are today mostly used to encase and mediate games, we describe the concept of *Computer-Augmented Games (CAGs)*; games that utilize computational power to provide support or tools for the gaming activity rather than use it as the complete mediating platform.

First we look at a number of different cases that we believe straddle the divide between the traditional video game and the traditional “non-video” game; usually by augmenting one or more existing games, but also some which are more like hybrids. We then describe six CAGs whose design, implementation, and deployment we have been involved in. From these cases – as well as from archetypical board-, computer, role-playing, and live-action role-playing games – we extrapolate a number of design features that are available to game designers. Using the method suggested by the *multi-dimensional typology of games model* (Elverdam & Aarseth 2007), these are used to describe a novel part of the design space of games. Concluding, we make some observations regarding CAGs and other types of games and the different use niches they can occupy.

Related Work

While this paper builds upon the design experience gained during several game design projects, the CAGs presented later have been informed by many earlier research contributions in the intersection between games and computer technology. Two examples that clearly fit within our definition of CAGs is *False Prophets* (Mandryk et al. 2002) and the *Stars platform* (Magerkurth et al. 2004). Both of these introduce new computer systems to support gameplay and provide new functionality to support the face-to-face context of board games. The designers of *Stars* also explicitly mention potential pitfalls of moving “a lot of game elements into the virtual domain” (p. 76) and do not create computerized die to maintain the social dimension of die rolling (Fine 1983). However, to provide a fuller understanding of CAGs, we in the following position them with examples that use
computers for novel gameplay but are neither CAGs nor “ordinary” video games.

Many of the early computer pioneers did explore the playing of traditional games such as Tic-Tac-Toe, Nim, and Chess (Björk 2013). However, access to the game states were only available through interfaces that ensured following the formal rules either because they were intended for commercial use or because this made the actual practical construction easier from an engineering perspective. We regard these types of games as Computer-Mediated Games (CMGs) in that a computer system encases the game state and acts as a gatekeeper for which actions are possible, only allowing actions that are part of the formal rules of the game. As such, most current video games are CMGs.

A noteworthy step towards moving the focus and control of games from being within the computer was taken by Ishii et al. (1999) through the concept of Computer-Supported Cooperative Play (CSCP). They saw the use of computers together with various input and output technologies as a way not to mediate an activity but instead to “encompass both the augmentation and transformation of sports and games” (Ishii et al., 1999). Using the dimensions of augmentation|transformation and competition|collaboration, they presented a two-dimensional design space for CSCP together with seven applications (including the “application” of unmodified ping-pong). While CSCP has been used to understand online gaming (Wadley et al. 2003), Ishii et al. saw the term as a way of exploring “athletic-tangible interfaces” (1999) and this aspect has been carried on by later work on exertion interfaces that support “sports over a distance” (Mueller et al. 2007). Although our concept of CAGs overlaps with CSCP and exertion interfaces, it is significantly more inclusive in the types of games it considers, as there is no requirement that players’ physical prowess affect the activity (c.f. Ishii et al. 1999).

Another relevant approach is pervasive games (Magerkurth et al. 2005). Taking the basis in the ideas of ubiquitous computing (Weiser
1991) and pervasive computing (Dordick 1998), these types of games use computers together with sensors and actuators to create gameplay that is “no longer confined to the virtual domain of the computer, but integrate the physical and social aspects of the real world.” (p. 2). Many of these make use of augmented reality (Mackay 1998), e.g. MIND-WARPING (Starner et al. 2000), the Touch-Space system (Cheok et al. 2002), AR Tankwar (Nilsen & Looser 2005), and TARBoard (Lee et al. 2005). While these point towards intriguing new gameplay possibilities, all but TARBoard fall within the category of CMGs since the systems mediate all gameplay.

From the perspective of how games can provide play in a multitude of locations, McGonigal introduces a categorization that redefines ubicomp games, pervasive games, and ubiquitous games (McGonigal 2006). Montola (2005) and Montola et al. (2009) gives a different meaning to pervasive games that is closer to McGonigal’s ubiquitous games, stating that the defining characteristic is that they expand when one can play from a social, spatial or temporal perspective. While many of the games mentioned in this section make use of computers, Montola (2005) uses the game Killer: The Game of Assassination to show that pervasive games do not need to use computers at all. McGonigal’s categories rely more clearly on technology in that they all describe approaches that make it possible to play games in different kinds of situations. Although this can be a result of augmenting a game with computers, it is not the defining characteristic, and in this sense CAGs can be seen as a more inclusive term.

Cases

Our understanding of CAGs has been developed over several years of experimental game design research. In the following, we provide descriptions of some of these projects. While some of the games described in the previous section could have been used as examples, we use games where we have either been directly involved in the design or worked in a supervisory capacity, and therefore have detailed insight into the underlying design processes and goals.
The design goal behind *Wizard’s Apprentice* (Peitz et al. 2006) was to explore how computer technology could support two distinctly different target audiences in playing a board game together. The two audiences were a) people interested in playing the game but in need of some help to play, and b) single individuals who were perhaps not that interested in playing but rather in providing said help. The typical user case being a group of children and a supervising parent. The game starts with gameplay being directed for the most part by the single individual, but as gameplay progresses this individual is needed less and less. This is themed as a wizard trying to save a fantasy kingdom by sending his or her apprentices to solve quests which become progressively more difficult and require longer journeys. The physical components needed to play *Wizard’s Apprentice* consisted of a sensor-augmented board, a laptop, and several custom-made tokens (a die, miniatures, and control markers) with embedded RFID-tags.

*Wizard’s Apprentice* does not check that any of the players are following the rules even if the system can detect when players move to story locations and has a sensor for detecting the result of die rolls. Instead players have to jointly enforce the rules and decide when and if exceptions can be made. This allows for rerolls and simply deciding what result one wants as long as all those present agree. An added bonus of this is that setting up game state examples and events is simplified.
Case: M.I.G.

*Mobile Intelligence Game (M.I.G.)* is a commercial quiz game similar to *Trivial Pursuit* (Haney & Abbot 1979). The iPhone version of the game was developed as a master thesis (Göransson & Landin 2009) and has since then also been released on Android Market (*M.I.G.* will in the text refer to these versions unless stated otherwise). Based on observations of people playing the original *M.I.G.*, the designers of the computerized version explored the possibilities of automating bookkeeping and rule enactment, compared to letting players do these things manually. While some advantages to automation were found, primarily less more seamless interaction, many disadvantages were also found. First, the automatic approach was vulnerable to unintentional interactions and needed a manual mode to correct the effects of these. Second, a big social disadvantage was found in that interaction “takes place between the user and the device instead of between user and user” (p. 30). In contrast, the manual allowed...
freedom in the social interaction of explaining the game in that one person could “teach the other players to play the game by freely showing the different parts of the game, exactly as when explaining the physical game in the real world” (p. 30). Given these arguments, the iPhone version was implemented with the manual approach as this put “[t]he user, and not the device, is in control of the game and the flow.” (p. 30)

Figure 2: The main interface for the computerized version of M.I.G.

The M.I.G. application provides a simulated environment that contains all game components needed to play the game. Players can freely move between rolling the dice, marking score, and interacting with the deck of questions. The players are free to ignore rules in the same fashion one could do with a physical copy of the game (e.g. to avoid having questions one has already used), and themselves decide if an answer is correct.

Case: Undercurrents

Undercurrents (Bergström et al. 2010) is a web-based tool that augments TRPGs. The GM and all players use individual laptops or tablet computers to send messages and images. This replaces the hand-written notes normally used, which come with several inherent
weaknesses, such as writing time, legibility, and that it is visible who is sending a message to whom. The system also gave the players the ability to take notes and access a wiki with information about the game world.

The design goals of Undercurrents was to make peripheral and secondary tasks of TRPGs easier. None are strictly necessary but done without Undercurrents or other aids they are likely to cause some disruption or inconsistent role-playing. However, introducing computers could easily be distracting, so care was taken to make the interface subtle and not support activities that would disrupt the role-playing focus.

Figure 3: Players and game master engaged in tabletop role-playing using the Undercurrents system.

Case: Tisch

Tisch is an application developed for the Microsoft Pixelsense table¹ to provide support for board and role-playing games (Hartelius et al. 2012). Based upon an analysis of the general challenges to these

1. The table version used during the development of Tisch was named Microsoft Surface,
activities, the *Tisch* system was designed to reduce excise (Cooper and Reimann, 2003) while allowing house rules and support both improvisation and advance preparation. Further, the principle of *Calm Technology* (Weiser & Brown 1996) was a design goal in order to avoid distractions from the main gaming activity, and as a corollary of this came the objectives of having *Social Adaptability* (Björk *et al*. 2007) and low *Social Weight* (Toney *et al*. 2002).

The basic functionality of *Tisch* is to provide an interactive map which several people can use simultaneously with their fingers and custom tokens. While a game master (GM) can prepare maps in advance, redrawing parts or adding details can be done on-the-fly. The system supports both rapid transitions between scenes as well as gradual exploration. The state can be saved between game sessions to help and special modes provide tools to measure distances or determine line of sight. In addition, the system can help keep track of the order in which characters act as well as some visual features such as lighting and day|night cycles.

but has since changed as the trademark Surface has been transferred to Microsoft’s tablet computers.
Case: Monitor Celestra

Monitor Celestra (Berättelsefrämjandet 2013) was an ambitious three-day LARP taking place in early 2013 with a Swedish museum-destroyer standing in as the spaceship Celestra. The game was enhanced with a plethora of computer systems and custom-built hardware, providing communication between the players and between the players and the GMs, a soundscape, and the means of controlling the ship in a virtual space. Real-time game masters provided some of the game’s logic and coordinated the players.

While the system calculated ship and torpedo movement, sensor signatures and set off some sounds automatically, the state of the support system could be manipulated by the GMs at will, and they provided the majority of the content and logic in real time. Thus, the GMs were free to change events “behind the scenes” to better suit the
game’s narrative and enter new elements to the ongoing story based on the players’ actions.

Figure 5: Helm console aboard the Celestra. Image: John-Paul Bichard.

Case: Voidship Concordia Pilot

The Voidship Concordia Pilot (VCP) LARP (Bergström et. al. 2013) was the precursor for a planned later game and tested methods and design concepts. Just like in Monitor Celestra, technological systems were used hand in hand with traditional LARP to enrich the experience and develop a sense of a wider (fictional) world stretching beyond the stage, as well as providing the players with affordances generally unavailable in a traditional LARP. The game system generally built on what was learned during work with Monitor Celestra, but scaled back on many levels; replacing custom-built hardware with commercial-off-the-shelf solutions and reducing automation. Instead, gameplay was developed further, with even greater emphasis on making it possible to add content in real-time.

Just like in Monitor Celestra, the player characters were in command
of a ship, but this time only the command centre was “on stage”, and the rest of the ship simulated virtually. From there, the players controlled the ship using voice commands instead of consoles. The computer-augmented part of the game consisted of two parts – one that kept track of the movement of the ship and other objects in the fictional space (but left all other logic to the GM, such as object collisions, damage, etc), and one used to control entities within the ship, such as the players’ troops and agents. An additional computer was used to control the soundscape, providing sound effects and ambience. This setup meant more work for the GMs (there was almost as many GMs and support personnel as there were players), but greatly increased flexibility.
Figure 6: Players from VCP discussing strategy in front of the plotting table – one of the game’s display screens can be seen in the background.

Dimensions of Computer-Augmented Games

While the games and systems we have described above provide examples of what CAGs can be, they do not in themselves point out other possible support computers could lend to a game. To do this some form of framework is needed where the examples can be positioned, but even more importantly, where the spaces in between (and beyond) them can be made explicit. This has been done earlier
by game researchers wanting to understand the structural forms of games; specifically through defining dimensions that attribute the presence or absence of specific game elements in games (Aarseth et al. 2003; Elverdam & Aarseth 2007). In this context game elements should be understood not only as tangible elements but also abstract features, e.g., pace, representation, and teleology. Further, elements do not have to do directly with what is being interacted with during gameplay but can be any part of the game artifact that one wishes to study, so an alternative descriptor may be “design features”. Through using these dimensions, a multi-dimensional typology of games is possible, which defines a design space with the extreme points of all dimensions as the outer bounds. Examined games occupy specific places in this space based on what values they have for each dimension, and this allows them to be compared to each other easily – close proximity indicate more similarities. That dimensions can be added, removed, or changed is argued to be an advantage since parts can be used to explore specific aspects of games without compromising the general model. The Game Ontology Project (Zagal et al. 2005) has a similar perspective, even saying “[o]ur goal is not to classify games according to their characteristics and/or mechanics [...], but to describe the design space of games” (p. 2), but does not elaborate on this further.

During the work with the cases described above, we identified several game elements related to CAGs. Through a brainstorming session several of these were flagged for possible use in this context, and further reduced by discarding those that did not look interesting for more than one game, or produced a (more or less) clear-cut dimension. This reduced batch was then applied to the aforementioned games, and presented to several other researchers for feedback and commentary. After said feedback had been applied, we felt that the remaining dimensions were adequate enough for our purposes.

In line with the methodology of the multi-dimensional typology of games, we below outline these dimensions which can serve as expansions to the original typology. These are then used in the next
section to analyze the cases described above as well as relate to archetypical examples of several types of games. The reason for aligning more with the multi-dimensional typology rather than the game ontology project was its flexibility; the identified dimensions can be used without regards to an existing hierarchy which would not have been possible using the game ontology project. This allowed for an iterative, explorative approach where candidates could be added to test their viability without causing inconsistencies or conflicts with other identified game elements. Many of the dimensions we identify overlap at least in part with each other, and in some cases the dimensions have been perceived to be non-orthogonal, i.e. where movement in one dimension likely will cause movement in another.

Note that for games with human GMs, e.g. TRPGs and some LARPs (including both LARPs presented in this article), we view these GMs as players, since our perspective is primarily related to how computers or humans handle various aspects of games. Also, when we talk about changing aspects of the game, we do so from a perspective of doing so from “outside” the game, i.e. not as part of regular gameplay.

"Player-agreed" vs. "Artefact-encased" game logic

In this dimension we find the difference between games where the game logic is held in collective agreement between the players, and where it is held by the game artefact itself. On the extreme end of the spectrum we have child’s play, both “free” and more formalized (blind man’s bluff, hide-and-seek, see e.g. Hughes 1983), then board games where the artefact provides the explicit rules but they are held collectively by the players during play (e.g. Agricola, Rosenberg 2007), and at the other end of the spectrum, traditional video games where the artefact takes care of all game logic for the player (e.g. Grand Theft Auto V, Benzies & Sarwar 2013).

"Limited" vs. "Rich" audiovisual content

One thing that differentiates different types of games is the ability
to access audiovisual content, which can help visualize aspects of the game such as the game state and/or the game world, further the narrative of the game, or simply improve the audiovisual aesthetical experience. On one end we find games where the game world is held entirely in the participants imagination (e.g. tabletop role-playing without props or visual aids), on the other end immersive virtual environments such as the CAVE (Cruz & Neira 1992) and LARPs. Somewhere in the middle are board games with added AV content, such as Space Alert (Chvátil 2008).

“Fluid” vs. “Fixed” game content

The ease with which game content is added; both during play and between sessions, comprise a dimension. On one end of this scale we find collaborative storytelling games (Universalis, Holmes & Mazza 2002), where a player is relatively free to come up with new content during play, after which comes “creative” board games (e.g. Dixit, Roubira 2010). “Sandbox-style” games (e.g. Minecraft, Person 2009), where players create content but are restricted in which elements to use, come somewhere in the middle and traditional video games are placed in the other end.

“Manual” vs. “Automatized” excise

Excise denotes the amount of work required by the players to maintain and update the game state. At one end of this dimension we find high excise board games such as The Campaign for North Africa (Berg 1979), low-excise board games such as Settlers of Catan (Teuber 1995) can be found in the middle, and games where computers perform large amounts of updates as part of simulations, e.g. Europa Universalis IV (Andersson, 2013), are found in the other end. Note that this dimension relates to several others – more work done by the computer often means more logic controlled by the computer, for example.
“Low-effort” vs. “High-effort” modification of rules

How easy it is to modify the game rules, both during games and between games, make up another dimension. This takes into account both the amount of modification possible and how easy it is to perform the modification. Storytelling games such as Universalis are on one end (usually requiring only a change of the common agreement), followed by most board games such as Space Alert and Dixit (which also might require an adjustment of the game materials), then “mod-ready” video games such as Europa Universalis IV and Sid Meier’s Civilization IV (Johnson 2005), followed by video games which lets you change game rules via options (e.g. Silent Hunter III, Lazar 2005) and arcade games on the other end.

“Low-effort” vs. “High-effort” modification of game state

The possibility of modifying the game state is viewed as a separate design feature from the modifying rules or game content because it points to different use scenarios; e.g. when the game state can be modified to let someone “take back” a bad move, explain the game by providing examples, or correcting an error made earlier. On one end we have board games such as Space Alert and Dixit which lets you modify the game state at will, usually because it is necessary for you as a player to update the game-state as well (i.e., being in the manual part of the excise dimension), somewhere in the middle are video games with a “god mode” editor (such as Sim Earth, Wright 1990) and on the other end arcade games.

“Unlimited” vs. “Constrained” action space

Games differ greatly when it comes to the number of actions players can perform. On one hand we have storytelling games where only the players’ imaginations are the limit (e.g. most tabletop role-playing games), then comes live-action role-playing games (LARPs), where the players’ character basically can do as much as the players; on the other end of the spectrum we have “open world” video games (e.g. Fallout: New Vegas, Sawyer et al. 2010) next to more restricted
“follow the path” video games (e.g. *Leisure Suit Larry*, Lowe & Crowe 1987). Tabletop miniature games, wargames, and “eurostyle” board games are all in the middle, but clearly distinguishable as separate points.

“Low” vs. “High” Tangibility

With tangible interfaces we mean the number, quality and scope of tangible objects players can interact with as part of gameplay. This differs greatly between games, and has been researched before, see e.g. (Ullmer & Ishii 2000). The spectrum has the traditional video game on one end and LARPs on the other, games with tangible interfaces such as *Dance Dance Revolution*, (Wada & Yoshida 2001), board games (e.g. Campaign for North Africa), and miniature games (e.g. *Warhammer 40.000*, Priestley et. al. 1998) in the middle. While one does not necessarily consider traditional video games as having tangible interfaces, the use of a game controller or a mouse and keyboard do provide tangible experiences even if they are the same for all games using those interfaces. Note also that traditional pen-and-paper role-playing games belong on the “video game end” of the scale, unless augmented with tangible props such as miniatures and handouts.

Exploring the Design Space of CAGs

The diagram below illustrates where the CAGs mentioned in this article fall on the above spectrums, as well as “archetypical” examples for modern video games (aVG), board games (aBG), tabletop role-playing games (aTRPG) and live-action role-playing games (aLARP). These were chosen to provide additional data points and comparisons. *Grand Theft Auto V* was chosen as aVG to represent the open world freedom found in many current video games. *Agricola* serves as an example of modern mechanics-driven board games. *Call of Cthulhu* (Petersen 1981) serves as an example of TRPGs that have a strong GM role and is representative for many other systems. *Krigshjärta* (Föreningen Krigshjärta 2013) is a prototypical example of an immersive and inclusive LARP that takes place over several
days in a rural fantasy setting. It is however important to stress that these were chosen to represent categories of games; while this could have been done by adding several examples from each category this would have cluttered the diagram and decreased its readability without adding much in terms of information.

Unlike both the multi-dimensional typology and game ontology project, we considered the dimensions to be continuous. This avoids having a requirement to create hard dichotomies or enumerations of possible values and instead be able to focus on the relative differences. While this is similar to the synthesized dimensions Aarseth produced using correspondence analysis in the work that informed the multi-dimensional typology (1997, p. 67-75), our choice of focusing on relative positions rather than exact values make our values less suitable for clustering analysis (besides Aarseth’s original work, see Peitz & Björk 2007, and Dahlskog et al. 2009 for examples of this related to games). We present these games using *parallel coordinates*. This visualization technique was original developed in the 19th century (Maurice d’Ocagne 1885) but popularized by Inselberg (1985).

We do not want to suggest that positions given for the games should be taken too literally. This is due to several reasons. First, the extreme points of each dimension are typically difficult to exactly or meaningfully pinpoint, making the possible range imprecise. Second, providing a deterministic way to measure the game features for the different game types presented here is non-trivial. Even so, we argue that judging the games positions to each other can be done reliably and these suggested positions serve a useful purpose in that they allow relative comparisons.
To avoid possible misrepresentations it is important to note that the polarities of the scale have been selected so that the archetypical TRPG, *Call of Cthulhu*, is along the bottom of the diagram. This creates a rather uniform line for this game but also for the aVG, *GTA V* except for the two last dimensions. The presented polarities were chosen since they minimized intersections between the most extreme examples (the archetypical TRPG, *Undercurrents*, and the archetypical CG) and other examples, thereby making the diagram somewhat easier to read. The line for *Tisch* deserves an extra note since it bifurcates for the action space and tangibility dimensions; this is simply because *Tisch* can support both board games and role-playing games. Since *Tisch* does not change the number of gameplay actions available, using it means that players have the same action space as the supported game and the tangibility is only slightly affected if used with the aBG *Agricola*. Beyond these basic comments, the diagram help points out a number of observations regarding how CAGs influence gameplay.

First, looking at the board games examples one can see that the lines for *Agricola*, *M.I.G.*, and *Wizard’s Apprentice* closely follow each other. As a system using RFID-tags and a computer to keep track of
a hidden game state as well as player progress, it is not surprising that *Wizard’s Apprentice* is closer to the video game example than *Agricola* is; the exception being that it has as limited actions for players as other board games. The design intention of *M.I.G.* to put players in control can be seen in that it follows closely to *Agricola*; it retains the flexibility of board games while reducing excise since setting up and storing away the game is trivial. That shuffling the card deck is done simply by shaking the phone also reduces excise but reduces the possibility to change the game state since one cannot rearrange the deck (one can however freely browse through it). Naturally, having all game components represented on a screen lowers tangibility but since the smartphone needs to be passed between players *M.I.G.* still retains some tangible aspect.

Second, looking at the role-playing games, *Tisch* and *Undercurrents* also closely follow the chosen example of a TRPG. *Undercurrents* adds some possibilities for audiovisual content and makes some actions less cumbersome but otherwise doesn’t affect the role-playing activity it is used with. *Tisch* is more blatantly a computer system which can be seen in how it positions closer to video games (and *Wizard’s Apprentice*), the exception being action space and tangibility which it does not affect at all. That *Tisch* positions itself between the board game and TRPG example regarding game content is not a compromise value; adding content requires more effort than for TRPGs since in these they can simply be announced through performative utterances, while expanding the playable area or making it detailed is simplified by the drawing functionality of *Tisch* compared to a traditional board game. *Tisch* helps both board games and TRPG in setting up and taking down game states between sessions as well as providing measuring tools; this gives it the lower excise value than the games it supports.

Finally, looking at the systems supporting LARPs, both *Monitor Celestra* and *VCP* introduced whole new features compared to traditional LARPs, which is reflected in the greater discrepancies between their respective scales. *Monitor Celestra* was significantly more automated than *VCP*, leading both to less excise and flexibility.
It also had more dedicated hardware for changing the game state (buttons, levers and switches instead of verbal commands), increasing tangibility.

Generalizing, the CAGs that have automated excise have made it more difficult to add game content or modify rules. *M.I.G.* is an exception to this, arguably due to the quiz game not being complex in terms of game element manipulation. In contrast, *Monitor Celestra* and *VCP* increased the possibilities for GMs at the expense of more excise compared to the archetypical LARP. This may be an indication that designs need to consider the level of excise and the possibility of game content and modification together, but can also be a challenge for future research on CAGs. Similarly, increasing the possibility for visualization seems to be related to difficulties of adding new content. Besides these comments about CAGs, the diagram does point to the somewhat unintuitive point that regarding the explored dimensions, LARPs have more in common with videogames than with TRPGs. The basic reason for this is that LARPs for many purposes make use of reality as the “game engine” and this causes similar limitations to changing the game rules and -state as for most video games.

Discussion

The design space introduced above aims at helping in the understanding of what possibilities computational technologies offers for games beyond that which players can access currently. On a whole, CAGs and the dimensions presented in this article are not intended as normative guidelines for design. Instead, they allow the mapping of a design space where a multitude of gameplay experiences are possible in the interplay between different points on the scales, which can be used to more precisely define and describe design goals. So far, CAGs have mostly been about reducing excise, or providing additional capabilities without increasing excise to unreasonable levels; it is however not difficult to imagine other types of games. As a thought-experiment, the “perfect” CAG would push against the endpoints of the scales by having automatically executed but entirely modifiable rules, rich visualization capabilities, the
ability to add content on-the-fly, an unlimited action space, and complete tactility. While such a game may seem a farfetched fantasy, this has already been conceptualized in Murray’s *Hamlet on the Holodeck* (1997).

Even if the positions can be read literally, one can also find some open spaces in the presented diagram. These can be seen as potential area for future explorations of novel ways of using computers for gameplay purposes. How this can be done is rather straightforward for CAGs supporting board games, TRPGs, and LARPs given the cases presented, but the same approach can be applied to video games. For example, the dimensions regarding control of game logic and the possibility of modifying rules or game states have most examples near the extremes (*Monitor Celestra* and *Voidship Concordia Pilot* being the exceptions). Video games can rather easily move towards the middle areas by either simply avoid protecting data or implementing a “simulation layer” that allows manipulation of game elements as if they were physical elements (as *M.I.G.* does for a quiz game). While this may not suit all video games, the concept of CAGs and the diagram help make possible design features explicit so they can be included in design discussions. As another example, the tangibility dimension makes visible the lower level of tactile interaction in video games compared to board games, LARPs and CAGs that support these. *Skylanders: Spyro’s Adventure* (*Toys for Bob* 2011) can be seen as a step in adding tangibility to video games but the diagram shows that many more steps can be taken in this direction.

We believe that the dimensions presented here are not the final set of dimensions to be used to understand CAGs but should rather be seen as a starting point for more detailed studies of the topic. Like Aarseth and his collaborators have updated which dimensions they use (c.f. Aarseth *et al.* 2007 and Elverdam & Aarseth, 2007), we believe that further research on CAGs will suggest new dimensions and modifications to those suggested in this text. In fact, several dimensions were discarded in the process of formulating those presented in this article, mainly because none of the presented cases
addressed these dimensions in any significant manner. One of these was whether one could learn the game in a “trial-and-error” manner while playing the game, as is possible with most typical video games, but impossible with most board games (i.e. you have to know at least the core rules before play begins). Another was rules transparency – if it is possible to see and understand the underlying mechanics of the game, as in a typical board game, or if these are opaque, as in a video game with a physics engine, for example. The latter dimension is also complicated by the fact that rules transparency is not always a design goal. A dimension that was suggested during the process is whether the game can visualize possible future game-states based on a proposed move, in order to facilitate mastering of the game. Combined with the “trial-and-error learning” dimension suggested above, it is possible that future CAG projects can operate on a scale where they will help players learn and master complicated games quicker, through this making them available to a wider audience.

Finally, we believe that the dimensions presented here have feasibility for game research more generally. They provide a perspective of how games are presented, enforced, and encased through their materiality. The expanded the multi-dimensional topology can for example help distinguish between various forms of LARPs; e.g. examine the hypothesis that vampire-based LARPs (e.g. *Minds Eye Theatre*, Woodworth 2005) are more similar to TRGPs than other LARPs are because of their need to have rules for supernatural powers.

Conclusions

In this paper we have introduced the concept of *Computer-Augmented Games* and given several examples of how this allows computer technology to support gaming and playing activities without dictating exactly how they should be done or encasing the rules or content. Through a number of identified dimensions, we have presented a design space which points out new technology-based possibilities for all types of games as well as offering to be a theoretical tool for game research.
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Ludography


The Roll of the Dice in Warhammer 40,000

Marcus Carter, Mitchell Harrop & Martin Gibbs

Abstract

In this article we discuss the role that the physicality of dice has in the experience of the non-digital tabletop strategy game Warhammer 40,000. Numerous previous approaches towards the digital augmentation of non-digital games have considered dice rolling a menial or tedious computational task to be designed away. We disagree. In this article we argue that the physicality of dice has a positive effect on players’ experience and enjoyment of the game. This occurs through their tangibility, their role as a representational object (situationally, imaginatively and audibly), and through enabling shared experiences. Thus, while digital augmentation of physical games has the potential to make strong contributions to game play experiences, more careful consideration should be given to what might be lost through such efforts.

Keywords

Warhammer 40,000, tabletop, war-game, non-digital, dice, game design.

Introduction

Warhammer 40,000 (W40K) is the most popular tabletop war game worldwide. First released in 1986 as the sci-fi, Dungeons and Dragons-esque, strategy system Rouge Trader, W40K and its fictional universe have been continually developed and expanded. Much like games in the real-time strategy (RTS) genre (e.g., Starcraft or Age of Empires), W40K involves the tactical maneuvering of an army, composed of differently abled units, in an attempt to destroy an opposing player’s army. Though the number of players of W40K
would be eclipsed by most digital games, and even many non-digital games (e.g., *Settlers of Catan*), the cost to play *W40K* is uniquely high; both in terms of financial cost and time cost. Each individual soldier or unit in a player’s army has to be carefully assembled and painted – a process which can take several hours – and many armies necessitate hundreds of soldiers. Further, due to the material cost and detail, an individual soldier can cost almost USD$10 and some larger models are priced at over USD$100. Given the increasing ‘casualisation’ of games – in the sense of the reduction of barriers to entry and moving towards freemium payment models (see Juul 2009; Kultima 2009) – *W40K* is a remarkable phenomenon. Players will literally spend thousands of dollars on small figurines, paint and player manuals and devote hundreds of hours assembling and painting their models in preparation to engage in the occasional 1-2 hour tabletop battles.

Despite the pervasiveness and ubiquity of computing technologies, *W40K* has strongly resisted digitisation. Our research set out to study the attraction of *W40K* given its prominence and the enormous competition from the digital games market for the leisure time of players, seeking to find lessons for the broader study and understanding of digital games. In this article, we report results from interviews (n=36) at numerous *W40K* tournaments (large amateur competitive gaming and social events, not dissimilar to computer game LANs; see Jansz & Martens 2005) on the role that the physicality of *W40K* plays in its enjoyment and experience.

Though its physicality has many impacts, in this article we focus specifically on the role of dice in the *W40K* experience. Dice are pervasive in the tabletop and board game genres; they are an essential computational tool ubiquitous in games involving chance or luck. In *W40K*, they are used throughout the game play to determine the results of nearly all in-game actions. To date, however, there has been no focused study or consideration of the role that this omnipresent tangible tool has on the game play experience. Expanding our understanding of the role of dice has significant wider relevance in regards to recent focus on the relationships between the material and immaterial in all kinds of game play (see Apperley & Jayemane
2012). In addition to contributing to our understanding of physical play, this analysis thus also contributes to the body of work seeking to better understand the relationship between specific design choices and the holistic player experience (see Klastrup 2008).

Dice have been chosen in particular as the focus of this research because, while numerous smart phone applications are available which allow for the virtual rolling of dice (seeking to alleviate players the ‘burden’ of this ‘arduous’ form of computation), we never observed players using these applications and when questioned, their use was always denied and strongly objected against. As we are interested in the way that *W40K* has so strongly resisted digitisation, and in the context of a body of academic research preoccupied with digitising non-digital games, we felt that furthering our understanding of the impact of dice on the *W40K* experience would glean novel insight into the complex interplay and differences between physical and digital play.

Literature Review

Within modern game studies, the beginning of the 21st century is often taken as being the beginning of the discipline of game studies (Aarseth 2001). Although problematic, this view does capture the way in which the discipline has principally emerged in tandem with the rise of computer games as one of the chief entertainment mediums in the developed world. Accordingly, the interdisciplinary game studies predominantly focuses on digital game experiences, which has resulted in a dominant paradigm of “treating digital games as the standard of games” (Stenros & Waern 2011). It is worth considering how this history has impacted the development of theories and research, and in particular, what may have been overlooked. Jaakko Stenros and Annika Waern refer to this dominance of digital games in game studies as the *digital fallacy* (Stenros & Waern 2011).

While many important and frequently cited works in game studies are ‘B.C’ to this notion (Huizinga 1938; Caillois 1961; Suits 1978; Fine 1983), overwhelmingly non-digital games¹ as subjects of study are
nearly entirely overlooked in the modern discipline of game studies. This is despite tabletop games (encompassing board and strategy games) having had an essential, fundamental influence on the development of the modern digital game (see Crogan 2011). Stewart Woods, whose research focuses on Eurogames (a genre of board game), argues that this is “perhaps due to the inaccurate perception of the genre as a niche in decline” (Woods 2009). The economic and cultural reality of modern gaming illustrates that tabletop games in the modern era are not just an established game form that has resisted obsolescence, but one continuing to grow. Take, for example, the pervasive descriptive term ‘traditional’ game, implying not modern. The latest version of W40K was released in 2013. The widely popular Eurogame genre of board game has only emerged in the past decade. Through rhetoric like this, the study of non-digital games is often marginalised as outdated – rhetoric troublesome in modern academia. A result of this inaccurate perception is few examples of modern research which engage solely with non-digital games as artifacts worthy of study in their own regard (some exceptions being Crogan 2011; Woods 2009; 2012, Xu et. al. 2011).

Indeed, much of the research which does engage with non-digital games reinforces this implicit assumption that ‘traditional’ tabletop games are inferior or unequal to modern digital games. For example, previous work which has dealt with Warhammer 40,000 specifically has focused on the digital augmentation of W40K battles (Hinske & Langheinrich 2008; 2009). In this research, Hinske & Langheinrich have experimented with the use of RFID chips to determine the position, and orientation, of figurines in battle. Though valuable, this research channels a tradition in modern game studies involving non-digital games, research which principally attempts to improve them through digital augmentation of the non-digital experience, without first considering their unaugmented appeal.

1. Though technically all games with dice are ‘digital’ games; dice are digital tool. However, in this article we use the phrase ‘non-digital’ to refer to games which do not involve electronic computer technologies in their play, which is its most common usage. This has been criticised as presenting problems for game studies because of the ambiguities it creates (see Björk, 2013).
For example, Peitz et. al. (2005) explores the genre of augmented board games, auspiciously taking into consideration the “possibilities and limitations put on game design by technology and the social environment in which the games are played”. In their digitally augmented board game, *Augmented Kingdom*, this entails “automating the numerous additions and multiplications required to calculate score after each round”; practices they understand do “not provide interesting choices, or produce interesting experiences” (2005). Similarly, Leitner et. al. (2009) presents the implementation of an augmented tabletop game, *Comino*, arguing that it is “the logical consequence” to merge the real and virtual to create (ostensibly) better gaming experiences. Indeed, Leitner et. al. (2009) make an implicit assumption found quite frequently in academic research involving non-digital games which seemingly reduces the advantages of non-digital games to their increased capacity for social interaction, ostensibly as a result of the collocation of players (e.g., Björk et. al 2001; Magerkurth et. al. 2004; 2005; Mandryk 2002; Lundgren 2002; 2006).

A larger proportion of research is more mindful in its consideration and application of non-digital elements in gaming experiences, although still somewhat being proprietors of the digital fallacy. For example, in *Electronic Augmentation of Traditional Board Games*, Clim deBoer and Maarten Lamers (2004) explored “what value modern technology can add to the social-interactive character, the excitement and/or entertainment value, and also to the useability and flexibility of boardgames” (p. 441). They argue that “innovations should have a clear added value to the game concept and introduce new elements” (p. 442), and that “the existing physical elements of the game [should be] preserved as much as possible” (p. 442). Echoing Berland et. al. (2007) and Xu et. al. (2011), de Boer and Lamers also argued that the transparency of the rules of non-digital games is an important element of their enjoyment. So while de Boer et. al. approach ‘traditional’ board games with the potential of being improved by digital elements, they are attributed with some advantages over ‘modern’ digital games.
Similarly, in some significant depth, Sus Lundgren (2002; 2006) has explored the design possibilities for the digital augmentation of non-digital games. Like Mandryk et. al. (2002), Lundgren considers the benefits of non-digital games more broadly, expanding them to include their interactivity, mobility, flexibility and proclivity to social interaction. Meanwhile digital games are attributed with enabling more complex simulations, evolving environments, interacting and reacting parts, impartial judging, increased immersion (also see Watts 2007) and the ability to easily save the state of the game. However, the contributions of simple simulations, static environments, partial judging etcetera to the experience of digital games is left ignored. Further, Lundgren categorises the computation of in-game events (using dice or other counters) as being “tedious” (2006, p. 70) and prone to game-ruining mistakes and suggests (like Peitz et. al 2005) that game mechanics “suitable for computer augmentation are the ones that are information-related” (2006, p. 111). As we will demonstrate, we believe this to be incorrect in the case of W40K.

In contrast to this, Yan Xu et. al. (2011) closely examine how non-digital games afford social play before designing an augmented experience; a deep consideration and analysis missing from many of the papers discussed earlier in this literature review. Based on a series of observations of board game play sessions, Xu et. al. (2011) identify five categories of social interactions based on how the social interactions are initiated; chores, reflecting, strategising, non-game and reacting to the game itself. Of these, the categorisation of chores – interactions arising from “bookkeeping activities” – is worth particular note. They argue that chores “which at first appear to be merely functional” are “critical” for supporting social interaction and encouraging enjoyable experiences (p. 1). The maintenance of these physical items “(e.g., dice, tiles and score keeping tokens) direct player’s attention to other’s current action and status” (p. 14), and through doing so “increase player’s awareness of each other, assist their communications, and help players engage with each other” (p. 14). Xu et. al. conclude that while “most of these chores can be automated using technology … this is often not the best choice when designing social interactions with digital media” (p. 1). The
turn-based structure of non-digital games (a “techno-historical limit” (Hutchison 2008) due to the limited computational abilities of players) has the effect of creating “time and space for players to synchronize with each other’s game play and emotional experience, which is universally important for digital and non-digital games.” (Xu et. al. 2011, p. 13). Downs et. al. have made similar findings with turn taking in co-located console gaming and levels of engagement, enjoyment and anticipation of turns (Downs, Vetere, & Howard 2013; Downs, Vetere, Howard, Loughnan & Smith 2014).

We argue that Yan Xu’s approach, beginning with non-digital games and their distinct experience as worthy of study in their own right, is an important step necessary when conducting research involving the design of augmented games. This is not to discredit the research discussed so far in this literature review; it is of excellent quality and contribution. Rather, it is to suggest the possibility that elements of the game experience may have been overlooked. The limited number of studies which solely focus on the attraction and experience of non-digital games presents the possibility that without a firm foundational understanding of the non-digital game experience, and the role that the physicality of this experience plays in the enjoyment of the game (highlighted as being important), essential elements of the experience may be overlooked or diminished in digital augmentation. Consequently, our research attempts to fill this gap.

Along with this contribution, we also believe that concerned study of individual elements of the experience of games is a worthy focus of study in its own right. Numerous game studies scholars, such as Lisbeth Klastrup (2008), have argued that game studies should place more emphasis on analysing “particular and salient elements of game world experiences in order to better comprehend the relationship between design choices, a specific game world culture and the player’s world experience” (2008, p. 144). This has been well illustrated as fruitful in the context of non-digital games (see Bakker et. al. 2007; Heijboer & van den Hoven 2008), and argued as being facilitated by the increased transparency of game mechanics (Zagal et. al. 2006). As such, in this article we narrowly focus on the impact
of one physical element of the *W40K* experience – dice – in order to understand this specific element of the game’s design in more detail. Though holistic understandings of player experience are often fruitful, we felt this specific analysis was a more keen contribution to the literature, particularly due to the numerous instances in the literature where dice have been denigrated to menial or tedious task, eager for digitisation (e.g., Leitner et. al. 2009; Mandryk & Maranan 2002; Lundgren 2002; 2006; Peitz et. al. 2005).

Method

This research emerged from an ethnographic investigation of competitive *W40K* tournament play (see also, Carter, Gibbs & Harrop 2014). We followed (and played with) a small hobby group in their preparation for Australia’s largest competitive *W40K* tournament – Arcanacon – and conducted over 40 semi-structured interviews prior, during and after the event. Though these tournaments are competitive, they are primarily social and leisurely activities; e.g., the core goal for most players is an enjoyable game experience rather than winning. A common phrase used to describe *W40K* tournaments is as ‘festivals of the hobby’, as all dimensions of the *W40K* pastime (painting, modelling, the fiction) are involved in the event. See Carter et. al. (2014) for a thorough account of a *W40K* tournament experience and Harrop et. al. (2013) for a discussion of how players who lost tournament matches rationalised their failures into narratives of success by emphasizing their previous decisions and tournament preparation. Due to the number and variety of attendees, tournaments consequently present an excellent opportunity for investigating the player experience of *W40K*.

The majority of participants in this study were male (only two participants were female), reflecting the demographics of *W40K*. Audio recorded interviews were transcribed manually by the researchers. Informed by Glaser and Strauss’ (1967) grounded theory techniques, these interview transcripts were then coded for relevant themes. These themes were used and refined in the analysis of subsequent interview responses. The themes that emerged around the
The Roll of the Dice in Warhammer 40,000

use of dice form the structure of this report having provided the basis for conceptual development.

Warhammer 40,000

Typically involving two players (though it is possible to play with more), a *W40K* battle involves the deployment of two armies (each belonging to one player) on one side of a 6’ by 4’ (1.82m x 1.22m) tabletop covered in ‘terrain’; buildings, hills, trenches, exploded tanks, rivers and bridges around which a player must attack their opponent. Though modern play is most similar to historical and strategic wargaming, *W40k* first emerged out of the role-playing movement of the 1970’s and 80’s (see Carter et. al. 2014, p. 127). The objective of a *W40K* battle can vary; some involve the complete obliteration of the opponent while others involve capturing the majority of battle objectives (typically a location in the map) before the end of the battle. Each player takes turns manoeuvring and attacking with their army, and the game ends after 5-7 rounds.²

The size and composition of a player’s army is limited by ‘points’; each unit is given a points value in the rule books based on its comparative power. A weak foot soldier may only be worth 6 points, while the powerful tank it fights beside may be worth 200. Armies are typically limited to between 1000 and 2000 points. At a tournament (where a player must fight each new opponent with the same army) selected armies tend to be adequately balanced to be able to deal with potential range of compositions their opponent can bring. Each unit has a different stat-line (numerical values representing their strength, toughness, ballistic skill etc). As a result, the selection of what units to include is a complicated, in-depth tactical and strategic decision (for an in-depth discussion on this process, see Carter et. al. 2014).

We will now briefly (and simplistically), for the benefit of the reader

2. At the end of the 5th round, a dice is rolled, and on the roll of a 5 or 6, the game ends. On a 4 or below the game continues for another round, at the end of which a dice is rolled again, but this time needing higher than a 3. If a 1 or 2 is rolled, the game continues for a 7th round, at which point it must end.
who has not played *W40K*, describe a clash between two units – a squad of Ork Boyz and a troop of Space Marines – and the processes of play. Any single turn could involve half a dozen or more similar encounters, and their outcome is overwhelmingly determined by the roll of 6 sided die.

The Ork player, having completed the movement and shooting phase of their turn, declares that his squad of 19 Ork Boyz (with an Ork Nob leader) will attempt to charge his opponent’s squad of Space Marines. The Space Marine player is able to declare ‘Overwatch’, allowing her squad to fire at the Orks as they charge. This particular Space Marine unit has 10 models; 8 Space Marines with ‘Boltguns’, 1 with a ‘Missile Launcher’ and the Sergeant who carries a Pistol and ‘Chain Sword’ (a powerful and iconic close-combat weapon). As the Ork figurines are within 12 inches of the Space Marines, the rapid-fire Bolters can shoot twice. To determine if this volley of shots hits any of the charging Orkz, the Space Marine player rolls 18 dice; 16 blue Boltgun shots, a red pistol shot and a white dice from the missile launcher. The use of different colored dice is a common practice by players to differentiate these different strength weapons and roll all dice at once. Overwatch shooting is under a ‘snap fire rule’; gunfire quickly unloaded in the face of a charging enemy is unlikely to be accurate, so shots are only considered to have hit if the dice rolls a 6. She rolls, and picks out the dice showing less than a 6; only 2 remain. These two dice are picked up and re-rolled to determine if these two shots that hit ‘wound’ the Orkz, a calculation contingent on the strength of the Boltgun (4) and the toughness of the Orkz (4) – a result of 4 or more (‘4+’) is required. Luckily, both shots wound the Orkz, and the dice are passed to the Ork player who rolls a ‘save throw’, needing a 6+ to ‘save’ the unit. Both fail and two Ork Boyz are removed from the table to indicate their demise.
The remaining 17 Boyz and Ork Nob continue to charge at the unit of Space Marines, depicted by the models being put into ‘base contact’ with the Space Marine squad (i.e., with their bases touching, see Figure 1). The assault phase proceeds in accordance with the ‘initiative stats'; the higher a unit’s initiative, the quicker they can strike in close combat. In this example, the Space Marines have an initiative of 4, the Boyz 2 and the Ork Nob 1, thus the Space Marines attack first. Each Marine has 1 close combat attack, while the Sergeant has 3. The Marines’ player correspondingly selects 9 blue dice and 3 black dice, and calculates they need a 4+ to hit the Orkz. Again, the marine player picks out all the rolled dice showing a 1, 2 or 3 and discards them. This leaves 6 blue dice; 6 Marines hit the Orkz but the Sergeant missed all 3 of his hits. Once again needing 4+ in order to wound, these 6 dice are rolled again, with 4 wounds caused on the Ork Boyz, only one of which the Ork player successfully saves against; 3 more Orkz are removed from the table.

The surviving 15 Ork Boyz strike; they have 3 close combat attacks each and an additional attack as a result of charging; 60 dice are collected and rolled at once, covering a large section of the table in dice. Similar to the Marines, his Orkz need 4+ to hit, and after picking out all the 1s, 2s and 3s, approximately 3 dozen remain. Due
to the higher toughness of the Marines, a 5+ is needed to wound; the successful dice from the previous round are scooped up and rolled again, with failures once again discarded and successes collected and passed to the Space Marine player, who now needs to roll 13 save throws to determine how many Space Marines survive the brutal assault.

In this example of 15 Ork Boyz striking at the hardy Space Marines, 60 dice are required to determine the outcome of the first round of this combat. 60 dice is a lot of dice; approximately enough to fill two cupped hands (see Figure 2). Oftentimes, an in-game action can require over 100 dice be rolled all at once. Each time a unit engages an enemy unit, these dice have to be rolled up to three times (to find out if the shots hit, if they wound and if they are saved). This ‘arduous’ process takes up a significant portion of the time a player spends playing W40K. Finding space on which to roll these dice can also be frustrating; stray dice may knock over models or be lost underfoot. At the peak of engagement, where each turn may involve the rolling of literally hundreds of dice, this ‘laborious’ computational process can slow down the game. Further, humans are fallible (and sometimes dishonest); often making mistakes in counting dice (potentially on purpose) that have huge impact on the outcome of actions. Consequently, numerous Smartphone applications and computer programs exist tasked with removing this roadblock to an enjoyable experience. However, in our ethnography of W40K tournaments and in our collective years of playing we have never met a player who actively used these applications. Why?

We argue that the physicality of these dice play an important, enhancing role in the experience of W40K. In the following section we will tease out the multiplicity of ways that dice, as physical tools, impact the play experience in manners that a virtual application could not satisfactorily mimic. In the subsequent section, on the basis of this discussion, we will argue that this exemplifies how focused study of individual elements of games are necessary for better comprehending the relationship between design choices and the player’s experience,
an understanding which makes essential contributions to further research on the future relationships between physical and digital play.

Results

Driven by interviews and participant observations, we have identified three key ways in which dice impact the player experience of *W40K* players; through their tangibility, their role as a representational object, and through enabling shared experiences. We further explicate their role as a representational object into situational representation, imaginative representation and audible representation. We now present these results, combining interview quotes with our observations of common player practices to illustrate their importance.

Tangibility

Recall again the Ork Boyz and their flurry of attacks against the Space Marine troops. To resolve these 60 attacks, 60 dice are used *at once*. The sheer volume of 60 dice replicates the volume of attacks in a meaningful, tangible and relatable way, and the player’s clumsy interaction with this overflowing handful of dice reinforces perceptions of the power of a particular action in the game. The Space Marine player turned to using specific colors for each shot of different strength in order to also be able to roll all dice at once. This common (nearly universal in our sample) practice ensures this tangibility is still present in the experience, despite it potentially being easier to roll dice separately. If the players were to replace this dice rolling with a Smartphone application the meaningful feedback given through the tangibility of this computational tool would be lost.

A typical unit in a race like the Orkz (which deploy hundreds of weaker troops) may have 3 attacks per turn in close combat, an additional attack if they charged and the units can be up to 30 Boyz. It is therefore typical to have a single attack involving the roll of over 100 dice. One interview participant whose Ork armies featured many of this type of unit said,
It’s just ridiculous how much dice you can roll. Like if I can hit with a full squad of boys and they get all their attacks, I think it’s upwards of 100 dice or die or whatever it is. So to me that’s a lot of fun.

Figure 2: A handful of approximately 50 dice.

For this participant, the comically large volume of attacks (though they are weaker) is also a source of amusement and enjoyment; something translated and made real through the tangibility of the dice.

Representational

As outlined in the literature review, dice are often considered simple computational tools. However, we noted several ways in which they became representational objects and subsequently impacted the experience in ways difficult to recreate through a smartphone dice rolling application.

Imaginative Representation

An impact of dice in *W40K* emerges through a common ‘best practice’ by *W40K* players employed when counting the results of their actions. The rule book from the ‘Assault on Black Reach’ (AoBR), a boxed game that acts as a starter kit for many players, makes the following suggestion in the face of the computational complexities of the game:
Speed rolling

You’ll soon get used to the system of rolling to hit, wound and to save. We find it quickest to pick up the dice that rolled a successful result at each stage and roll them again. (Games Workshop 2009, p. 19).

Through employing this practice, each dice that is rolled to ‘wound’ was also a dice which had successfully rolled a ‘hit’. The ‘best practice’ we observed in most instances of tournament play was slightly different to that recommended by the AoBR rule book. Typically, the player would pick out the unsuccessful dice, (i.e., those with 1 or 2 facing on a 3+ roll) rather than picking out the successful dice. Those dice which had been unsuccessful would then be cast aside, and the dice remaining (those that hit) rolled again to find out if they wounded the Space Marines. One of the advantages of this practice is that it gives both players the opportunity to see the dice, however one participant explained that by picking out the unsuccessful dice, “if you were to be making a mistake, then you would have taken away an attack of yours, not giving yourself an extra attack, so that’s a fairer way of doing it”.

While players can never be as accurate as a computer application, this exemplifies the ways that players have developed strategies to minimise the potential impact of human fallibilities. Many competitive tournaments also allow players to score each other on ‘sportmanship’ and being able to audit the actions of an opponent is one part of this. Participant Kyle, noted good dice practices as being important when asked about sportsmanship scoring:

Yeah, you know, were they friendly? Did they introduce themselves? Did they talk me through their [army] list? Did they let me know things? You know. Did they let me look at dice before they removed them, those sorts of things. Did I have fun? All those sorts of things

What both of these practices ensure is that a significant, physical
association between the fictional actions of the attack and the physical dice is developed. The same dice that ‘hits’ is re-rolled to ‘wound’; these dice do not simply replicate the complex statistical capacity of machines, but each dice becomes imagined as a physical representation of the fictional action it seeks to resolve; each dice represents a bullet, and the result of the roll represents that bullet’s performance. The bullets which miss are discarded, and those which hit are re-rolled to determine if they wound. Those that wound are then again pulled from the field, and those same dice are handed to the Space Marine player, who rolls the physical dice which both hit and wounded, attempting to see if his units successfully shrug off the attack that has been represented by that dice through each round of dice rolling.

Andrew Hutchison has introduced to game studies the notion of techno-historic limits; “the technical limits at the time of a game’s production” (2008). He argues that these limitations have enormous impact on the aesthetic and consequent experience of digital games. If we extend the concept of techno-historical limits to not just the technological limits present at the time of production, but also the limits of the game medium, these ‘best practices’ identified can be understood as emergent responses to a techno-medium limit of the tabletop genre. It is through this emergent response that dice rolling becomes more meaningful; through being a physical representation of an in-game action, the fictional undertaking are embodied in our own realm, which enhances the player experience. In addition to making more meaningful the tangibility of dice overviewed earlier,

3. At the end of the 5th round, a dice is rolled, and on the roll of a 5 or 6, the game ends. On a 4 or below the game continues for another round, at the end of which a dice is rolled again, but this time needing higher than a 3. If a 1 or 2 is rolled, the game continues for a 7th round, at which point it must end.

4. As the latest edition of W40k was released in 2013, it would not be fair to say that the limitations of dice rolling are something present at the time of production. Thus, an extension to Hutchison’s original definition (2008) is required. However, it can be understood as a techno-historical limit of the first edition of W40k which supports Hutchison’s original argument regarding the impact that techno-historical limits can have on subsequent games un-restricted by those same limitations.
this facilitates player imaginations of the fictional conflict. This reiterates how the dice are more than just a computational tool, but physical representations integral to the play experience.

**Situational Representation**

In observing players, we also noted another practice that suggests the existence of a meaningful relationship between player and die, which was player’s preferred surface upon which to roll their dice. Again, 60 dice is a lot of dice, and when rolled they take up a large surface area. However, rather than rolling in a contained box next to the tabletop, dice are almost always rolled on the tabletop itself, in flat areas as clear of troops as possible. This despite suggestions from the rule book, which states;

> Of course, if your gaming surface is very textured and results in a lot of cocked dice (or simply if you prefer a tidy battlefield) you can make all your rolls in a tray or box lid. (Games Workshop 2009, p. 19).

When pressed why they always rolled on the tabletop, an interview participant simply said “it’d have to be a very special circumstance where there wasn’t space on the table to roll that many dice”; it wasn’t conceivable to this player that dice would be rolled away from ‘the action’, as it were. This is despite us observing numerous occasions where stray dice were missed, or hit and moved the static figurines further disrupting play.

What further indicates the existence of a meaningful representational relationship between player and die, however, is where on the tabletop they choose to roll. Regulated by the practicality of doing so, if a unit was shooting at another unit, the players would almost certainly roll those dice between two units; the dice would fill the gulf between units like the fictional volley of shots would. As noted, this practice can have its causalities; stray dice frequently knock over the units they are being intentionally rolled near. However, this physical reality is often playfully re-appropriated – players will often
remove those models (‘real’ casualties of the dice) before removing any others, after all, they were actually hit!

Players act similarly when their units are in close combat; one participant stated, “I try generally to roll as close to the combat as I can if there is space.” Note in Figure 1 the proximity of the dice to the units engaged in close combat. However, they did not articulate this (as can be expected) as being due to a meaningful relationship between in-game attacks and the dice, but due to the practicality of rolling the dice as near as possible to the action,

Because that way, it’s kind of, your results are right next to the battle and it makes it a lot clearer both to me and the opponent, uhm, so you can see what’s happened. And the same thing goes whenever you roll movement for a character. I always try and do it as close to the character as I can just for a matter of clarity just in case you do get distracted by something else in the room and it’s there next to your characters and you’re aware what’s going on.

So, similar to the practice of ‘counting’ successful rolls, players’ emergent strategies in their dice rolling – to minimize the impact of human fallibilities – reinforce the way in which dice become tangible representations of in-game actions in a fashion difficult to mimic with a computer application.

Audible Representation

A participant in our interviews also drew our attention to something we had initially overlooked; the noise that a large number of dice create when rolled at once. One of the central squads in this participant’s army could potentially have close to 100 attacks when they charge into an enemy unit in close combat. To this participant, the rolling of this many dice creates a cacophony of clattering sounds which mimic the “clash” of two units meeting for close combat. The audible difference between this roll and the roll of say, 2-3 shots from an elite sniper unit, similarly makes real and perceptible the
fictional undertakings. This is also an element of the game experience lost if using a smartphone application. In our ethnographic study of W40K tournaments, we also felt that the way in which the background noise of chatting and laughter in tournament halls was permeated by the sound of dice rolls was an important immersive element of the tournament, indicating the carnage going on around each player.

Shared Experiences

Were it not for some meaningful physicality of the practice, players might simplify this computation. Rather than having to collect and count out 100 dice (it can take some time), a player could roll 50 dice twice, or extrapolate based on the statistics of large dice rolls (for example, 10 die, representing 10 attacks each). Emphasizing how it would be inaccurate to characterize dice rolls as arduous or simply computational, we never observed a player doing this.

We suspect that one of the reasons for this is that player’s participation in the computation as a shared experience was also important. The following quote from an interview captures this sentiment well,

Interviewer: There are a lot of apps for resolving dice rolls. Do ever use one of those?

Participant: No. I like to roll the dice. I think it’s fun. For me.

Interviewer: What makes it fun for you?

Participant: Oh I don’t know! like I guess, just to be told a number and then you’re like, oh okay, ... so for me actually rolling the dice, actually doing the math, and counting out the ones (not really that much math) but you know just actually looking and... that’s a big part of what came to be the game for me like as much as it is moving my models around and thinking tactically it’s also, you know, about rolling the dice and see what happens. It’s a bit of an
experience between the two of youse because you’re both looking over, seeing what the dice rolled, working out what it meant, constantly adjusting your strategy but if it’s just kind of like this, you press a button and ‘oh that’s the number’ and you’re kind of like, aww, okay.

So while rolling of large numbers of dice could be conceived as being arduous or time-consuming, for the majority of players whom we spoke with reiterated this sentiment; by involving players in the computational process, the experience becomes more meaningful both socially and tactically. Dice are rolled together, in that one player watches while the other does their rolling. Consequently, dice enable shared experiences as players work together to determine the results of game events. This is similar to Xu et. al.’s (2011) finding that the turn-based structure of non-digital games allows players to synchronize with each other’s game play and emotional experiences (p. 13). Often these shared experiences can be humorous, particularly when a player rolls a hilariously unsuccessful turn.

This hesitance towards changing the dice rolling in W40K even extended to the use of physical dice rolling contraptions, which help manage large numbers of dice. One participant explained;

Participant: I’d never use a machine because that’s half the fun, you do it yourself. But sometimes I am tempted to build myself a dice tower. Just to help so you don’t have to actually roll a lot of dice.

Interviewer: A what?

Participant: Dice tower. It’s like this towery shape which has got several slants in it and you put the dice in and it just bounces it and it helps with a lot of dice.

Interviewer: To make sure they don’t go everywhere?

Participant: Yeah. But never really [got around to] making a model myself because it takes too much of the personality
out of it. Which I find is a lot about Warhammer. It’s personality, it’s doing it yourself with your opponent.

We will note that the non-digitised status of W40K is an element of its attraction to some players, thus the resistance to digital applications is not entirely associated with what is removed, but also a resistance to what is added. However, this participant’s resistance to a physical change to the dice rolling experience is indicative of a relationship that goes beyond any default resistance to computing technologies by players.

Discussion and Conclusion

In the literature review, we established that dice are frequently understood as mere computational tools and an ideal element of the game’s design which should be digitally augmented. We contextualized this within game studies recent critical turn against the dominance of the digital in research, suggesting that, like the “digital fallacy” (Stenros & Waern, 2011), there was a digital augmentation fallacy predominant in many investigations of the intersections between physical and digital play.

Based upon interviews of players of the non-digital tabletop strategic war game Warhammer 40,000, and observations of play in tournament and non-tournament sessions, we identified a number of ways in which the physicality of dice played an important role in the experience. The physicality of the loudness and chaoticness of rolling large numbers of dice simulates the chaos of war in a tangible way, an effect pronounced by the tangibility of the dice, the imagined representation of dice as being embodiments of fictional undertakings and the situational representation of dice as occurring next to these events. As a physical tool, they do this in a fashion difficult to emulate with a virtual application. Thus, similar to Bakker et. al. (2007) and Heijboer et. al.’s (2008) studies, the extent to which players are able to enhance their own experience by creating imaginative
emotional links with symbolic (rather than iconic) pieces should not be underestimated.

This article also contributes to our previous work (Carter et. al. 2012; Carter et. al. 2014; Harrop et. al. 2013) on the multitude of factors involved in the development of W40K army lists. The fashion in which many dice enhance, rather than diminish, the player experience provides players an additional resource for choosing what units to deploy in their army; those which receive as many dice as possible.

This perspective is distinct from approaches articulated elsewhere (e.g., Mandryk and Maranan 2002; Lundgren 2002; 2006; Peitz 2005), in which dice rolling is assumed to be a tedious process, eager for simplification and digitisation. Like Bergström et. al. (2010), we believe there are physical aspects of dice that are worthwhile and aught be retained when digitising. It is worth noting this is contradictory to the findings of de Boer & Lamers (2004) who implemented a digital dice version when testing an augmented version of Settlers of Catan. They found that suggesting this points towards the transparency of dice, but potentially also a minor role that the physicality of dice has on the Settlers of Catan experience. Consequently, we warn that the observations made within this article may not be generalisable to other non-digital games. This could both be because of the slightly more conceptual level of dice-events in Catan but also due to the small but consistent number of dice rolled each turn.

Our findings demonstrate that understanding the appeal of unaugmented non-digital games is an important step that game studies projects must take before being able to conservatively and rigorously explore the potential benefits of digitising board games. It is not the case that these results indicate that W40K should not be digitised, just that any digital augmentation should consider the broader impacts that dice have on the game play experience, and seek to retain them in some fashion. We would speculate that this could primitively be accomplished through recreated the sound of many (or few) dice rolling, or developing strategies to continue to enable
the shared experience of computation. More complex augmentation could even project events onto the tabletop to embody the representational effects of dice. However, even in these scenarios, the tangibility that dice brings to *W40K* would be removed, thus demonstrating how considerations about what non-digital games bring to the experience of play (beyond their facilitation of social interaction) should be considered in more depth. It may be the case that digitisation should be avoided all together. We do, however, acknowledge the possibility that due to the misconceptions outlined in this article, it is often easier to get funding for technology development work, which may have played a role in the dominance of augmentation studies.

We also believe that further research is warranted investigating the appeal of dice use in other non-digital games. In addition to the emergent practices that we have identified in this article, we also noted a broader range of rituals and superstitions that surround dice use in *W40K*, as well as precautions against cheating and the ownership of particular kinds of dice as way gamer identity was performed. As a central tool in non-digital game design, we argue that concerned study of these rituals and superstitions and the impact that they have on the experience of non-digital games may provide further insight into the role of dice and other tangible game tools have in the experience of physical games.

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de Boer, C., and M. Lamers. “Electronic Augmentation of Traditional


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ETC Press is a publishing imprint with a twist. We publish books, but we’re also interested in the participatory future of content creation across multiple media. We are an academic, open source, multimedia, publishing imprint affiliated with the Entertainment Technology Center (ETC) at Carnegie Mellon University (CMU) and in partnership with Lulu.com. ETC Press has an affiliation with the Institute for the Future of the Book and MediaCommons, sharing in the exploration of the evolution of discourse. ETC Press also has an agreement with the Association for Computing Machinery (ACM) to place ETC Press publications in the ACM Digital Library, and another with Feedbooks to place ETC Press texts in their e-reading platform. Also, ETC Press publications will be in Booktrope and in the ThoughtMesh.

ETC Press publications will focus on issues revolving around entertainment technologies as they are applied across a variety of fields. We are looking to develop a range of texts and media that are innovative and insightful. We are interested in creating projects with Sophie and with In Media Res, and we will accept submissions and publish work in a variety of media (textual, electronic, digital, etc.), and we work with The Game Crafter to produce tabletop games.

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Every text is available for free download, and we price our titles as inexpensively as possible, because we want people to have access to them. We’re most interested in the sharing and spreading of ideas.

This is definitely an experiment in the notion of publishing, and we invite people to participate. We are exploring what it means to “publish” across multiple media and multiple versions. We believe this is the future of publication, bridging virtual and physical media with fluid versions of publications as well as enabling the creative blurring of what constitutes reading and writing.
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