DIGAREC Keynote-Lectures 2009/10

Espen Aarseth, Lev Manovich, Frans Mäyrä, Katie Salen, and Mark J. P. Wolf

DIGAREC Series 06

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ed. by Stephan Günzel, Michael Liebe, and Dieter Mersch

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Introduction

Stephan Günzel, Michael Liebe, and Dieter Mersch

In the winter semester 2009/2010, the Digital Game Research Center of the University of Potsdam was able to hold the DIGAREC-Keynote Lectures for the first time. It followed a lecture series held in 2008/09, in which the members of the center introduced their research projects, spanning the fields of design, law, information science, psychology, and media studies. Together with the presentations of the 'scientific forum' at the German Game Days 2008 and 2009 in Berlin, the respective papers are published in the second Volume of the series.

Following up to this and with the support of the film-and mediafund of the Medienboard Berlin-Brandenburg as well as of the German association supporting computer game research, Gamology, DIGAREC was able to invite six keynote speakers to the University of Potsdam. The keynotes focused on the culture and nature of digital games and were held by Mark J. P. Wolf (Concordia University Wisconsin, USA), Espen Aarseth (IT-University Copenhagen, DK), Katie Salen (Parsons The New School for Design, New York, USA), Frans Mäyrä (University of Tampere, FIN), Keiichi Yano (iNiS, Tokyo, JP), and Lev Manovich (University of Southern California, San Diego, USA).

Espen Aarseth and Katie Salen were co-invited by the School of Design Thinking of the Hasso Plattner-Institute on December 3, 2009 and January 14, 2010, respectively, to speak at the campus Potsdam-Griebnitzsee. Keiichi Yano gave his presentation on "The Future of Music Games" on January 31 at the A MAZE.-Festival in Berlin. Lev Manovich's talk on April 22, 2010 opened the summer semester 2010 of the bachelor- and masters-programs in European Media Studies (EMW). It is a joint venture of the Department for Arts and Media at the University of Potsdam and the Department of Design of the University of Applied Sciences in Potsdam. Like Frans Mäyrä's talk on February 4, 2010, the presentation of Manovich was given in the Audimax-building of the University at the campus Neues Palais.

The opening keynote lecture by Mark J.P. Wolf on November 5, 2009 also opened the conference "Logic and Structure of the Computer Game", which took place at the House of Brandenburg-Prussian History in Potsdam over the following two days. The conference was supported by the German Research Foundation (DFG) and its results are published in Volume 4 of the DIGAREC Series. After Wolf's talk, a panel consisting of Barry Atkins from the School of Art, Media and Design at the University of Wales in Newport (GB), Gordon Calleja from the Computer Games Research at the IT-University of Copenhagen (DK), and Rune Klejver from the Department of Information Science and Media Studies at the University of Bergen (N) were invited to discuss trends in current game studies and to respond to the papers of the invited German scholars.

The papers of Mark Wolf and Espen Aarseth are original pieces published here for the first time. Katie Salen's paper is simultaneously published in the journal *Second Nature*. Frans Mäyrä's contribution is the reissue of a pivotal paper on immersion in games which he presented first together with Laura Ermi in 2005 at the DiGRA-conference in Vancouver. The reworked paper is preceded by a new introduction. Lev Manovich's article is available as a pre-print version. The presentation of Keiichi Yano does not exist in written form and thus is not included in this volume. Except for Keiichi Yano's presentation, all keynotes are also available as video on the website of the University of Potsdam. In three cases, these presentations vary from the printed version, which is indicated by the differing title of the talks of Espen Aarseth on "Locating the Game in Computer Games. From Game Structure to Game Semantics", of Frans Mäyrä on "The Dual Structure. Experiencing Digital Games in the Intersection of Gameplay and Media", and of Lev Manovich on "Visualization as a New Language of Cultural Theory".

Alternating with the keynote lectures, the regular lectures continued and papers of associated members of DIGAREC were presented. Participants were Jan Derer from the Media Design School Berlin on "Artificial Intelligence in Game Design", Stephan Humer from the Universtiy of Applied Studies Potsdam on "Digitality and Imagination", and Georg Spehr from the University of the Arts Berlin on "Game Sounds".

Mark Wolf, Espen Aarseth, Katie Salen, and Frans Mäyrä gave workshops for students of the MA program European Media Studies and invited guests at the University of Potsdam in addition to their lectures.

Mark Wolf's lecture on "Theorizing Navigable Space in Computer Games" was his first presentation in Europe. When Game Studies were established about ten years ago, they were very much occupied with the question whether digital games should be studied as a new form of texts or rather as a new form of games. In this discussion, a simple solution was overlooked. In other words, the debate between 'ludologists' and 'narratologists' would not have been necessary if the participants would have just read the works of Wolf carefully: During the heyday of the debate in 2001, he published a book entitled *The Medium of the Video Game.* Its editor and main author exactly pointed out what game scholars have to take into consideration: Computer Games are, in the first place, media in their own respect. This does not only mean that they need a computer to run – but what runs on the computer is something that has not existed as such before.

To consider the implications of the computer game as a medium became the frameset for his overwhelming work on digital games with numerous articles and books: In 2003, for example, Wolf edited a volume on *Virtual Morality* in which he anticipated a discussion which is now becoming prominent: the question of ethics in computer games. In the same year, he also published a compilation which is compulsive reading for game scholars until today: *The*

Video Game Theory Reader, the second volume of which has just been published in 2009 (In both cases the coeditor is Bernard Perron from the University of Montreal (CA), who in 2008 contributed to the first DIGAREC conference, the Philosophy of Computer Games Conference in Potsdam). Furthermore, in 2008, Wolf edited a comprehensive study on the history of computer games, entitled: *From Pong to PlayStation and Beyond*.

The main reason for inviting Mark Wolf to Potsdam, however, was that he works on two aspects that are essential for the understanding of digital games at DIGAREC: the *medium* and the *video*. When opening his book from 2001, a significant doubling can be noticed: The book does not only say "The Medium of the Video Game" on its cover, but there is also a chapter on the inside bearing the same title. By doubling the title, he pointed out that there is a difference between computer games as media and the computer game as a medium. While the media as artifacts are distributed on various platforms, like personal computers, consoles or even mobile phones, the medium is more than a technical device or a software package.

For this dimension, the expression 'mediality' is used at DIGAREC as opposed to medium. Others might address it as the 'aesthetics' of digital games or as their 'morphology' (as the very form of the medium). No matter which term will prevail, all these conceptual suggestions emphasize the fact that computer games bear certain elements they use to mediate whatever their content may be. And all these elements, forms, and appearances come together in the 'video' as *self-seeing*. It is not only that Wolf uses the word 'video' as an American scholar, where the term 'video game' is more common than 'computer game' or 'digital game'. What he mainly addresses becomes clear when one has a look into the other chapters of his book: Here one can find headings like "Time in the Video Game" or "Space in the Video Game". At this point, it is no longer features of the hardware or the software which are addressed, but possible experiences of mediation. Just as philosopher Immanuel Kant wrote in *The Critique of Pure Reason* that the condition of any experience is 'time' and 'space', Game Studies can learn from these findings that video games come into being as modalities of perception, predominantly the perception of an *interactive image*.

Coming from film studies, Mark Wolf took a concept that was originally developed by the francoamerican film-theorist Noël Burch and transferred it from movies to games. Doing so, Wolf tried to do justice to the very essence of computer games as modalities of perception and forms of mediation. The difference between the space *on* the screen and the space *off* the screen can be traced back a long way in the history of the picture itself, at least to the paradigm of the Renaissance, in which the picture plane according to the picture theory of Leon Battista Alberti is defined as an 'open window' to the world.

But other than Alberti, Wolf – with Burch – does not stress the aspect of pictorial illusion as much as the difference between what is presented by the picture and what is not. This is what is hidden by the frame and could or could not become an object for cognition. Wolf thus is able to rewrite the development of computer games in terms of a spatial or pictorial logic. In other words, the difference between *onscreen* and *offscreen* space is in itself a logical one: a logic of exclusion and inclusion, which also allows for hybrid configurations. Such a hybrid configuration may be an inclusion of the excluded as it is the case with onscreen representations of offscreen space in in-game mini-maps or in the cases of the so-called 'fog of war', in which certain areas of the playground are covered and cannot be seen and used by the player. However, the difference at stake can very well be witnessed in early games like PONG (Atari, 1972), where the aim of the game for each player is to keep the ball onscreen and to force the opponent to miss the ball and let it go off the screen.

Furthermore, in a recent article from 2009, entitled “Z-axis Development in Video Games”, Wolf reconstructs how pixel-graphic based games and vector-graphic based games need to not be seen under the misleading perspective of pictorial ‘realism’. Rather, it is suggested to regard them from the vantage point of the given limitations of a computer system and how the specific style of video games comes into being. Along the way, Wolf, for example, considers that the style of the first-person shooter with the characteristic limitation of sight and the bending of the pathway is not so much an attempt at resembling reality, but that it is the only mode in which 3D-presentations could have been implemented in the mid 1990s: As the graphics had to be rendered in real-time, designers had to keep the details low in order to limit sight and to bend the pathway.

Espen Aarseth is a researcher at the Center for Computer Games Research at the IT-University of Copenhagen. The center was established in 2003 and Aarseth was its director until 2008. The center was a major inspiration and model for DIGAREC in Potsdam. Before Aarseth went to Copenhagen, he was Professor at the Department for Humanistic Informatics at the University of Bergen since 1996. It dates back to these days, more specifically to 1997, that he published a book that without constraint can be called a *classical* text of game studies (it has even been translated into Spanish and Korean in the meantime). The book is entitled *Cybertext* and took up a discussion which until then had mainly been led in North America. It concerned the question of *interactive fiction* as a new genre of literature in the light of recent developments. In this case, this meant the emergence of hypertexts and a new ability to read and write.

Aarseth said that this new ability was an art, and described it as ‘ergodic literature’ – a term which became a standard not only for game studies – highlighting the fact that in this type of narrative, the work itself is produced along the way of its reception. However, it is remarkable that, even though he can be considered the founder of Game Studies (see the influential online-journal with the same name that was inaugurated in 2001), his approach was always much broader than the mere study of the computer game. In the case of his book on *cybertextuality*, for example, Aarseth looked at literature in general, and when he is analyzing games, he also always looks at them in the light of games in general. It is essential to his approach that he took the aspect of space to be a key to the understanding of computer games from the very beginning. This, by the way, positions him close to Mark Wolf on the landscape of game studies. In a short but influential text written in 1998, entitled “Allegories of Space” (first published in a German translation by Karin Wenz in the *Zeitschrift für Semiotik* in 2001), Espen Aarseth stated that the topic of every computer game is space, as it is a metaphorical transition and selection or an accentuation of an experienced space. Taking this position as a starting point in many conference contributions and essays, he then analyzed the very structure of games in respect to their spatial playability. He pointed out important categorical differences such as ‘omnipresence’ against ‘vagrancy’, and ‘metrical’ against ‘topological’ gaming, or ‘fictional’ aspects of game space in contrast to its ‘simulational’ parts. This provided game researchers with tools to better talk about games in their very essence. Aarseth laid the ground for a self-sufficient computer game research.

Many of his papers demonstrate that there is also a strong connection between ergodic literature and spatial analysis: In a paper on “Quest Theory” from 2004 (published the following year in the *Lecture Notes in Computer Science*), he demonstrates how computer games can be understood as a spatial practice consisting of quests of various forms. It becomes clear that narration understood as the possibility of choosing options in order to fulfill a certain task is no different to a game, which can be understood as a series of choices. In line with his previous publications, Aarseth, in his contribution to the volume at hand, gives “Remarks on Game Ontologies”, in which he lays out the basis for game analysis by qualifying the status of the 'real' in games and how the range of gaming cannot be simplified by a definition of what a game is. Rather, the very structures of games have to be described.

Katie Salen, who gave her first talk in Germany, is well-known for being an expert in (at least) three fields: She is a designer, a teacher, and a theorist. As a theorist, her name, together with Eric Zimmerman, is closely connected with *the* main topic of game studies: With the publication of the handbook of game design, *Rules of Play*, in October 2003, she and Eric Zimmerman explicitly outlined the concept of the 'Magic Circle' in order to describe what is specific about games, which is, in short, that they are separated from the 'real world'.

Even thought the term 'Magic Circle' itself can be found in classical game theory (namely in Johan Huizinga's *Homo Ludens* from 1938), it was not until the publication of the book *Rules of Play* that the term was valued as a key-concept for understanding games. Many discussions took off from here, asking whether it is justified to talk about computer games as such closed circles or not. (Researchers like Jesper Juul in his book *Half-Real*, for example defended the notion, others dismissed it as being appropriate for traditional games, but not for digital games.) Hardly acknowledged, however, is the fact that Salen and Zimmerman themselves already qualified the term as only being useful for describing games as rule systems, but not as events in the cultural context. In the latter, they are always part of the real world. *Rules of Play*, which is the standard handbook in the field of game research and design, was followed by the *Game Design Reader* in 2005, an anthology to *Rules of Play* containing essential texts on games in general and computer games in particular.

But Katie Salen is not only a theorist, she also is a game designer herself, as well as an animator for music videos and films, like Richard Linklater's famous movie *Waking Life* from 2001. As a game designer, she specializes in mobile games and online worlds. Since 2006, she is also the executive director and founder of the *Institute of Play* in New York, which aims at educating in 'gaming literacy'. An amazing enterprise began for this purpose: In October 2009, the public Gaming School in New York was opened, in which children learn by playing. The idea of gaming literacy not only implies the idea that playing is an ability equal to reading and thus has to be learned, but also that gaming can conversely be a method of learning in general.

The agenda of her school is to not only provide knowledge by presenting dates, facts, and content only, but to make pupils use it in practice: The curriculum makes children behave like scientists – taking science as a way of experimenting and playing. In the educational context of her work, another book of her has to be mentioned; in 2008, she edited *The Ecology of Games*, with contributions on the educational value of games, e.g. by Ian Bogost (who, along with Jesper Juul and Richard Bartle, gave a keynote presentation at the Philosophy of Computer Games conference in Potsdam). Katie Salen's keysnote lecture on "Pokéwalkers, Mafia Dons, and Football Fans" refers to recent developments in social networks and online gaming. She thereby focuses on the concept of meta-games: that which happens outside, between, and during gameplay, other than analyzing the game itself.

Frans Mäyrä from the University of Tampere in Finland is Professor of Hypermedia at the Department of Information Studies and Interactive Media since 2002 and the Head of the Department's Game Research Lab Group. Furthermore, he is the Founding President of the world organization of game studies: the Digital Games Research Association (DiGRA). He was its president from 2003 to 2006 and thus responsible for the first two conferences of the association, which set the tone for international game research until today: 2003 in Utrecht and 2005 in Vancouver.

Mäyrä studied Art History, Literature, Cultural Studies, English Philology, and Social Psychology. In 1999, he became Doctor of Philosophy at the University of Tampere, with a work on "Demonic Texts and Textual Demons". The thesis starts with the history of the *daimon* (the voice of the soul) and stretches out via Goethe's Faust and Nietzsche's *Birth of Tragedy* to Rushdie's *Satanic Verses*, while also providing insights into Gothic Fiction.

Taking these works, one could guess that this makes him a candidate for being called a 'narratologist' in game studies. However, as he demonstrates in his recent book from 2008, he is an expert in all branches of game studies as well as in the medial structure and cultural contexts of games.

Mäyrä's book *Introduction to Game Studies* from 2008 probably is the best introduction to the field available. It is both a working book for student classes as well as a resumée of the most prominent topics of current game studies. The book also holds a contribution of his dating back to the second DiGRA-conference at which he presented a paper together with Laura Ermi redefining the sometimes ambivalently used category of 'immersion'.

In this paper, Ermi and Mäyrä split immersion up into three different aspects: 1. sensory immersion, 2. challenge-based immersion, 3. imaginative immersion. They bring together the three leading paradigms of computer game studies; that is, the game as 'video' (in the sense of Wolf), the game as 'game' (in the sense of Aarseth) and the game as 'narration' or imagination. Mäyrä, just like Salen, studies the social aspects of play, and in the original talk in Potsdam about "Experiencing Digital Games in the Intersection of Gameplay and Media" he prefers using the challenges and benefits of interdisciplinary and multi-methodological studies for games cultures. In his new preface to "Analysing Immersion", Mäyrä gives a resume of the development of immersion-studies since the first publication of the DiGRA-paper.

Lev Manovich is professor at the Visual Arts Department at the University of California – San Diego and director of the Software Studies Initiative. When he published his book *The Language of New Media*, in 2001 he immediately was recognized as the Marshall McLuhan of the next century. In fact, by defining what is new about New Media, Lev Manovich overcame McLuhan's approach to define media as extensions of man and as technologies which determine their content by means of their material being. On the contrary, according to Manovich, one needs to understand the software (rather than the hardware) to understand new media. Just like he did already show in his Dissertation from 1993 on *The Engineering of Vision*, software can simulate any medial form that has existed before and was linked to certain hardware. Today, however, hardware itself has been overcome and preserved at the same time due to or within software. To speak with Hegel: hardware was abolished by it. This applies to photography as well as to cinema, which in the beginning were of particular interest to Manovich.

But in the course of the book from 2001, one medium came into consideration that was not abolished by software but came only into being through it: video games. The respective chapter on "Navigable Space" was presented at a conference in Karlsruhe on *Cinema in Transition* in 1999 and was first published in German in 2000. Again, it becomes obvious that at the beginning of Game Studies, whether coming from film like Wolf or from literature like Aarseth, 'space' was the key to understand that paradigmatic new medium. In his article, Manovich refers to two games that were published in the year of his Dissertation and are both milestones in the history of computer games: DOOM and MYST. Even though both do offer a perspectival, 'three-dimensional' view of space, they could not be more different: In DOOM, the rendering of space takes place in real-time, whereas the virtual space of MYST is a collection of pre-rendered images. While the first is an action-game in the literal sense, the latter stands in the tradition of a point-and-click adventures. Nevertheless, Manovich argues that MYST offers a way of free orientation (searching the whole surface of the screen), whereas in DOOM navigation is restricted to a certain path (canalized in the labyrinth). This difference is aesthetical and thus constitutes a difference in the perceivable form of the medium. To Manovich, this mediality of games, as it could be called today, is in both cases characterized by a specific characteristic of software. Manovich uses Erwin Panofsky's term, calling it a spatial 'aggregate'. This again links up to Wolf's contribution, in which video game spaces can not only be described due to the difference between on-screen space an off-screen space, but also due to the type of connection between spaces or spatial parts.

In his recent work, Manovich intensified his research on software and started to work with software itself in order to analyze the visual culture of the 21st century. His recent book *Software Takes Command* will be published in English in 2011 and is already available in an Italian translation, as well as online under a Creative Commons license. It is at the same time an introduction to the field of software studies in general. The article published in the DIGAREC Keynote Lectures volume discusses some case studies in relation to the question "What is Visualization?" The starting point as well as the central object of the text is the visualization of information and in which way the use of computer software changes it. Of special interest to Manovich is a form of direct visualization, while gathering the complete set of data in programs, so that the scale of depiction can be varied by the user.

Mark J. P. Wolf

Theorizing Navigable Space in Video Games

Space is understood best through movement, and complex spaces require not only movement but navigation. The theorization of navigable space requires a conceptual representation of space which is adaptable to the great malleability of video game spaces, a malleability which allows for designs which combine spaces with differing dimensionality and even involve non-Euclidean configurations with contingent connectivity. This essay attempts to describe the structural elements of video game space and to define them in such a way so as to make them applicable to all video game spaces, including potential ones still undiscovered, and to provide analytical tools for their comparison and examination. Along with the consideration of space, there will be a brief discussion of navigational logic, which arises from detectable regularities in a spatial structure that allow players to understand and form expectations regarding a game's spaces.

From simple single-screen games to elaborate adventure games requiring the exploration of convoluted networks of interconnections, space has always been an integral part of the video gaming experience; the graphical nature of video games seems to demand it. Decades of video game conventions and centuries of visual arts conventions help players to make sense of space, beginning with the division between a game's diegetic and nondiegetic spaces, and ultimately to understand the way spaces construct a game's world. Yet although the ability to read and comprehend graphical representations is always the starting point of understanding space, interaction within and with a space is the means by which space is best understood. Interactivity is made up of choices, and choices are made up

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of options; and as spatial design often is an indication of movement options, it is also typically the basis for the indication of interactive possibilities. For example, most of the player's choices in even a simple game like SPACE INVADERS (1978) involve four options: move left, move right, shoot, or do nothing; though the game features only one dimension of movement, three options are movement-related. Three-dimensional spaces suggest movement options along multiple axes, adding even more options to players' decision-making and dominating gameplay to an even greater extent.

Although players will mainly interact with tools, obstacles, and other characters within a game's spaces, navigation can be seen as interaction with space itself. Navigable space is space through which one must find one's way around, as opposed to a space in which one need not move, or a space in which one's movement is largely predetermined or so severely limited that one does not have the possibility of getting lost. Navigation is more than merely getting from one place to another; it is a cyclical process which involves exploration, the forming of a cognitive map of how spaces are connected, which in turn aids the decision-making processes employed by the player to move through those spaces for further exploration. Navigation, then, involves some degree of freedom of movement amidst connected spaces, the connections of which are explored and learned both by looking through and moving through them. After the first appearance of scrolling in Kee Games' SUPER BUG (1977) and the first screen-to-screen cutting in Atari's ADVENTURE (1979), many games would show only a tiny fraction of their space onscreen at any given time, making spatial navigation and the building of a cognitive map an important part of gameplay. Any discussion of navigable space, then, should consider how a game's spaces are shaped, connected, represented, and manipulated, and how all of these affect navigation and navigational logic. To do so, we will need a generalized way of

see video recording of this *DIGAREC Keynote-Lecture* on:
http://info.ub.uni-potsdam.de/multimedia/show_projekt.php?projekt_id=73#73
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describing video game space and its configurations which can be applied in all cases and can be used as a means of comparing spatial constructions across games. And to do that we must first look, for a moment, at space itself.

Representations of Space

The direct experience of physical space is understood though visual, sonic, haptic, and olfactic information which all aid in the mapping of space, but for most of us, visual information is the data most relied upon for the representation of space. For spaces represented in media forms, visual and sonic information are usually the only forms available for the representation of space. The human mind plays an active role as well; as Mark Wagner (2006:11) points out in his book on *The Geometries of Visual Space*, visual space is different than the physical space it seeks to represent and is often an affine transformation of it; he notes that "the geometry that best describes visual space changes as a function of experimental conditions, stimulus layout, observer attitude, and the passage of time". Wagner describes how visual space refers to physical space as we see it in lived experience; when we consider video game space, which is usually monocular, has reduced depth cues, and may not be fully three-dimensional in its construction, the potential variance from physical space is even greater.

A convenient way of categorizing spatial structures is dimensionality. As I have written elsewhere (Wolf 1997), many early games used planar, two-dimensional spaces, which can be described as being either a bounded single screen, a wraparound single screen, a space scrolling on one axis, a space scrolling on two axes, or a space divided into multiple screens depicting adjacent areas. In most of these games, two-dimensional space was used merely as a substitute for a three-dimensional space, such as those used for sports games or tank battles, rather than for an inherently two-dimensional scenario that required flatness. These games featured playing fields that were seen from above while the individual characters and objects on the fields were seen either in an overhead view or side view, giving the player a good sense of the spatial layout, and only those games which used off-screen space required navigation, and usually only a little of it at that.

Other games have a dimensionality that falls between two-dimensional spaces and ones that are computationally three-dimensional. These include games with independently-moving planes layered along the z-axis on which avatars may reside (as in SUPER MARIO BROS. (1985)), spaces with restricted z-axis movement (such as TEMPEST (1981), which only featured it in cut-scenes), spaces with oblique perspective that are largely only 2D-backdrops (such as ZAXXON (1982)), spaces that simulate 3D through the use of scaling sprites (such as POLE POSITION (1982)), and spaces with three-dimensional characters with limited movement and 2D-backdrops (such as TEKKEN (1994)). Such spaces, when they are large and complicated enough to require navigation, tend to still be only two-dimensional navigationally; player-character movement tends to be planar, even though there may be multiple planes of action, and the player's point-of-view tends to be more all-encompassing in games of such mixed dimensionality, as opposed to more immersive spaces that surround characters in three dimensions.

Three-dimensional spaces can also be non-navigable, like the live-action video sequences found in interactive movies, where the only navigation is narrative in nature. Even 3D-spaces involving true three-dimensional computation are often navigationally planar, though a first-person perspective makes navigation more challenging than an overhead view, and the malleability of video game spatial structures means that navigation has the potential to be far more difficult, and spaces far more confusing, than those of physical space.

Movement restrictions within spaces must also be considered, since avatars often cannot travel through all of a game's diegetic space. Games like PONG (1972), BREAKOUT (1976), SPACE

INVADERS, and almost all paddle-based games, allow movement only back and forth along a line, one-dimensionally, though the player can affect things elsewhere; thus the rest of the space, which the player can see into but not move into, is still important in gameplay. While spatial navigation relies heavily on visual information, boundaries and barriers can exist without visual counterparts, and can only be discovered through the active exploration of a space; before spaces can be navigated they must be identified as navigable. Accounts of spatial navigation, then, must take all of these things into account.

Navigable space, as opposed to space in which no navigation is needed, is a space in which way-finding is necessary, a space made of interconnected spatial cells through which the player's avatar moves, a network often organized like a maze. All of the space may be present onscreen at once, as in certain maze games, but typically much of the space resides off-screen, and the accessibility, and even the discovery of off-screen areas, relies on a player's navigational ability. Additionally, obstacles may occlude spaces and their interconnections, while opponents and enemies may complicate navigational tasks and limit the time available for them. But before we consider all of these things, we should first define what we mean by spatial cells, the units with which navigable space is composed. Such a description should attempt to be useful in a general sense, not only for all existing video games, but also universal enough to include potential future designs.

Defining Spatial Cells

A video game spatial cell can be defined as a continuous 2D- or 3D-space which allows non-contingent two-way movement between all possible positions within that space, all of which is contained within some kind of boundary, such as a barrier or entrance regulating movement into and out of the space like a wall or doorway; a line of demarcation, like the line between two countries on a map or between squares on a chessboard; or a technical limitation, like a screen edge or a cut to another screen. Generally speaking, movement within a cell, since it does not cross a boundary, does not require navigation because the cell's space is available all around the player's avatar; it is when boundaries are crossed, and movement occurs from one cell to another, that navigation comes into play. This does not necessarily mean that all the space of an individual cell need be visible to the player all at once; in three-dimensional spaces seen with a first-person perspective, the cell's space will usually surround the player's avatar, who must turn around in order for all the space of the cell to be seen; but turning around and looking does not require the crossing of boundaries or movement from one cell to another, and thus does not require navigation. Navigation requires *movement*, either of the avatar along with its implied point of view, or even, in some cases, of the player's point of view itself, as in the solving of complex mazes presented on screen or on paper which the solver sees all at once. In such a situation, the solver's gaze must follow individual pathways through the maze in order to solve it, requiring navigation. For the solving of complex mazes on paper, a pencil or other pointer is often used, which becomes almost like a surrogate or avatar traveling through the maze along with the solver's gaze, making the process very similar to the playing of a third-person perspective video game.

The defining of spatial cells naturally depends on their boundaries, which may exist diegetically as walls, doorways, thresholds, or changes of terrain, or extradiegetically, such as screen edges or level changes which move a player to another space. Boundaries also serve multiple purposes, such as separating player positions, hallways, rooms, or territories, narrative locations or events, or areas of different levels of difficulty, and help the player to conceptualize the game in pieces, rather than as a large unwieldy whole. Practical reasons may exist for boundaries, such as programming limitations like memory allotment, load times, screen resolution, and render time, and other game design and gameplay concerns which address separate sections individually. Finally, boundaries can aid player motivation by giving players a sense of progress and accomplishment as each space is conquered, completed, or added, and they may also give a player a chance to rest between levels, view a cut-scene, save a game, and so on. Boundaries can range from very obvious barriers to subtle lines of demarcation awaiting a player's decision between a choice of passageways, and they may or may not be foregrounded by the game's action.

The boundary enclosing a spatial cell can further be divided into sections, each of which is either impassable or, when crossed, leads to a different location. These crossings or connections between spatial cells include such things as openings, pathways, tunnels, doorways, windows, variations in horizontal levels like stairs or platforms, transporters that send avatars to other locations, or simply screen edges which demarcate on-screen and off-screen space. Whether connections to adjoining spatial cells are hidden or obvious depends on such things as game design, player experience, and generic conventions.

Because boundaries can be broken into multiple connections between spatial cells, spatial cells can even be connected to themselves, making their own space navigable insofar as the player must learn how the spatial connections operate between different sections of the cell's boundary. An example would be the wraparound single screen found in ASTEROIDS (1979), in which the screen edges are connected to the edges directly opposite from them. While the operation of a space linked to itself in this manner seems fairly intuitive, especially if one is accustomed to cinematic conventions regarding the conservation of screen direction, other possibilities exist involving rotations and reflections; for example, a space which is linked to itself through a ninety-degree rotation, so that avatars leaving off the right side of the screen reappear moving up from the bottom of the screen, and so forth. Individual screen edges could be further subdivided into multiple boundary sections, and even neighboring sections on the same side of the screen could become connected.

The locating and using of the connections between spatial cells is a foundational part of navigation, and a cell's boundary can contain connections to many cells; so it is to these connections, and their variations, to which we must next turn.

Connections between Spatial Cells

Connections between spatial cells can be defined by their passability and visibility, and each of these traits can be further described regarding their reversibility and contingency, and whether they are open or closed. Each of these traits affects the player's ability to learn a game's spatial layout and navigate it successfully.

Passability refers to whether or not a connection between adjoining spatial cells is one that allows the player's avatar to move from one cell to the other. Such spaces need not be connected in the typical physical sense; for example, you could have pictures on the wall of a room which a player can click on and enter. The linking books in the MYST series operate in this way. Spaces could also be connected through the use of wormholes or transporters or other devices which allow transit between nonadjacent spaces. Connections which are initially closed but can later become opened or unlocked would still be considered passable. A connection is considered impassable only when no direct transit between connected cells is ever allowed. Passability is also in reference to the player's avatar in particular, since the player is the one doing the navigating; a connection that other characters are passing through but which never allows passage for the player's avatar would be considered impassable.

Visibility refers to whether a connection renders the space of an adjoining cell either visible, even partially, or completely obscured. In most cases, you can see into adjoining spaces before entering them.

It is also possible for a connection to be impassable yet visible: for example, one can see adjoining spaces through windows, locked doors, or from high vantage points, even though in such cases the player cannot directly enter the spaces viewed from where they are. Impassible connections which still provide visibility aid in navigation since they give players information about how spaces are arranged, yet at the same time they can be frustrating since they do not allow movement into those spaces. Many games will often hint at spaces and spatial layouts in this way, giving players the navigational sub-goals of finding their way into the spaces seen. Numerous examples of this can be found in RIVEN (1997), where the grates of locked doors and high vistas tantalize players with glimpses of unexplored spaces. Spaces which are visible but cannot be traveled into are also usually used as vistas lining the borders of the game's diegetic world, to suggest a larger world beyond the spaces in which the game takes place, even though they are typically no more than simply 2-D backdrops draped around the game world's perimeter. Maps of spaces function in a similar manner, revealing spaces without showing them directly or allowing direct passage into them.

Connections that are passable, visible, or both can further be defined by their reversibility. *Reversibility* refers to whether a connection is two-way or one-way in nature. Whether players can cross over to another cell but still be able to return to the one from which they just came will determine the way they are able to explore a space, and sometimes the reversibility of a connection remains unknown until a player tries to pass through it both ways. An irreversible connection can also appear to be impassable, if one is on the receiving end of a one-way connection. A one-way connection can also result in the player's avatar being transported to another location, with nothing at that location to indicate that a one-way connection ends there. Therefore, a spatial cell may have one-way connections that end in the cell, yet do not pass through any specific boundary sec-tion; and there may be no prior indication that a cell is the endpoint of a one-way connection. For example, in MYST (1993), the linking books of different ages return the player to the library on Myst Island, but there is nothing in the library to indicate that the ages link to it. Unless such connections follow some kind of rules, they can complicate a game's navigational logic. Likewise, while visibility is normally two-way between adjoining cells, connections similar to a one-way mirror are possible, wherein visibility is only available on one side of the connection. Views from surveillance cameras, for example, like those found in RIVEN, would be one example of one-way visibility.

Connections that are passable, visible, or both can also be defined by their contingency. *Contingency* refers to whether or not a connection always connects to the same place every time the avatar crosses it or looks through it. Most connections will always connect to the same spaces no matter what happens, while others, like certain doorways encountered by characters in the *Matrix* movies, change the destination cells of connections based on the state of different variables in the game. Those variables can include the state of the connection itself and how many times it has been used; for example, each use may take the avatar to a different place or narrative result. A contingent connection could also depend on the state of the player's avatar; for example, whether or not avatars have had a certain experience, or ability, or an object in their inventory. Contingencies can also be determined by the state of other parts of the game, like switches and levers, object positions, narrative branches, or other conditions. Some connections can randomly send the player to other spaces in the game (like the wormholes in EVE ONLINE (2003) or the 'Mass Relays' in MASS EFFECT (2007)), or even to other positions within the same spatial cell (like the hyperspace jump in ASTEROIDS). In the games NARBACULAR DROP (2005) and PORTAL (2007), players can use a special gun to create portals that connect to different areas and use them to move from one place to another.

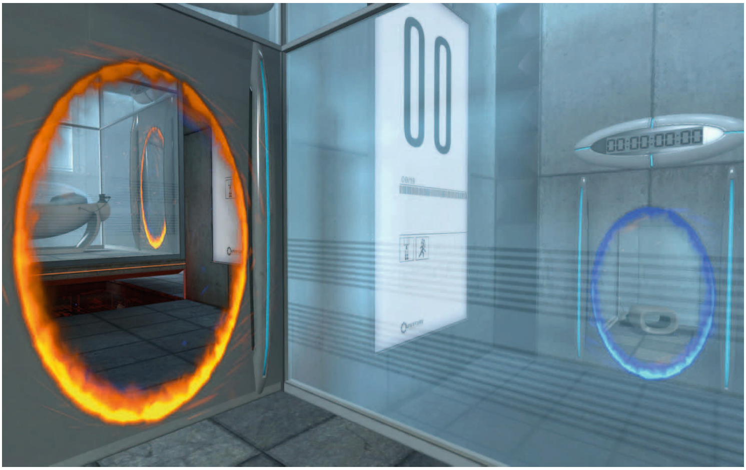

Fig. 1: In Portal (2007), Players Shoot Holes that Open into Portals that Connect Disjoint Spaces Together (the Three Portals Seen Here are Actually the Same Portal Seen from Different Angles)

In the game PORTAL, the conservation of momentum that occurs when a player uses a portal is even used to solve certain puzzles and difficulties posed by the game's geography. Because of their dynamic nature, contingent connections can greatly complicate navigation, and can act as nexuses where spatial, temporal, and narrative structures intersect and determine each other.

Finally, the passability and visibility of a connection may each be either *open* or *closed*. Changing a connection from one to the other may be as simple as opening a door, or it may require a key or passcode to unlock and open it, or other actions or conditions. A connection that is closed and not easily opened may provide players with additional sub-goals that need to be pursued before navigation can continue, like the finding of a key. The fact that a connection can be open or closed should not be confused with the contingency of a connection; such connections are contingent only if they do not always connect to the same spaces and their connectivity changes. The issue of whether a connection is open or closed can be used to hide the impassable nature of a connection; for example, a player may encounter a locked door, and expect that it can be opened once the key is found. If it turns out that the game does not contain a key to open the door, then the connection is really an impassable one, if it can even be said to connect to anything at all; such a door could be no more than a detail in an uninteractive backdrop. Examples of locked doors that are never used and do not connect to anything appear in RETURN TO CASTLE WOLFENSTEIN (2001), as Espen Aarseth (2006) has pointed out.

Whether a connection is open or closed at any given time is often dependent on the player's actions, and as such it is really descriptive of the *state* of a connection, rather than its nature, which is described by such traits as passability, visibility, reversibility, and contingency. These four traits describe properties of connections; they may be initially misconstrued. A connection thought to be impassable may in fact turn out to only be closed once the means of opening the connection is found. Likewise, the visibility of a connection may be obscured or merely closed and able to be opened. Therefore, certain attributions are more difficult to confirm than others. Just as existence is more easily proven than nonexistence, connections can be proven to be passable, visible, reversible, and contingent, but they cannot be conclusively proven to be impassible, obscured, irreversible, or non-contingent without reference to the computer code that controls the game. Critical analysis, then, must be careful when describing connections in negative terms, since it is usually difficult to exhaustively experience all possible game states and conditions and be certain that one has discovered all the game's Easter eggs, although a game's structural logic may help to confirm or reject an analyst's assumptions regarding a game's overall spatial structure.

When passability, visibility, reversibility, and contingency are all taken into account, we find that there are 25 different types of connections possible between spatial cells, not including open and closed states which do not change the essential nature of the connection. The 25 types of connections are as follows:

1. impassable, obscured
2. impassable, visible (irreversible, contingent)
3. impassable, visible (irreversible, non-contingent)
4. impassable, visible (reversible, contingent)
5. impassable, visible (reversible, non-contingent)
6. passable (irreversible, contingent), obscured
7. passable (irreversible, contingent),
   visible (irreversible, contingent)
8. passable (irreversible, contingent),
   visible (irreversible, non-contingent)
9. passable (irreversible, contingent),
   visible (reversible, contingent)
10. passable (irreversible, contingent),
    visible (reversible, non-contingent)
11. passable (irreversible, non-contingent), obscured
12. passable (irreversible, non-contingent),
    visible (irreversible, contingent)
13. passable (irreversible, non-contingent),
    visible (irreversible, non-contingent)
14. passable (irreversible, non-contingent),
    visible (reversible, contingent)
15. passable (irreversible, non-contingent),
    visible (reversible, non-contingent)
16. passable (reversible, contingent), obscured
17. passable (reversible, contingent),
    visible (irreversible, contingent)
18. passable (reversible, contingent),
    visible (irreversible, non-contingent)

19. passable (reversible, contingent),
    visible (reversible, contingent)
20. passable (reversible, contingent),
    visible (reversible, non-contingent)
21. passable (reversible, non-contingent), obscured
22. passable (reversible, non-contingent),
    visible (irreversible, contingent)
23. passable (reversible, non-contingent),
    visible (irreversible, non-contingent)
24. passable (reversible, non-contingent),
    visible (reversible, contingent)
25. passable (reversible, non-contingent),
    visible (reversible, non-contingent)

While most of these connections are either passable or visible and can therefore provide the player with information useful to spatial navigation and the learning of the layout of a game's world, the first type of connection, which is both impassible and obscured, would seem to be a situation indistinguishable from the existence of no connection at all. Yet it is possible for connections that allow no movement or visibility between spaces to still provide navigational information and indicate an implied space. This can be as simple as the appearance of a locked door which implies an unseen adjoining space. Spaces can also be implied through the careful mapping of a game's space. For example, consider a three-by-three grid of adjoining screens that cut one to the next as the player moves through them.

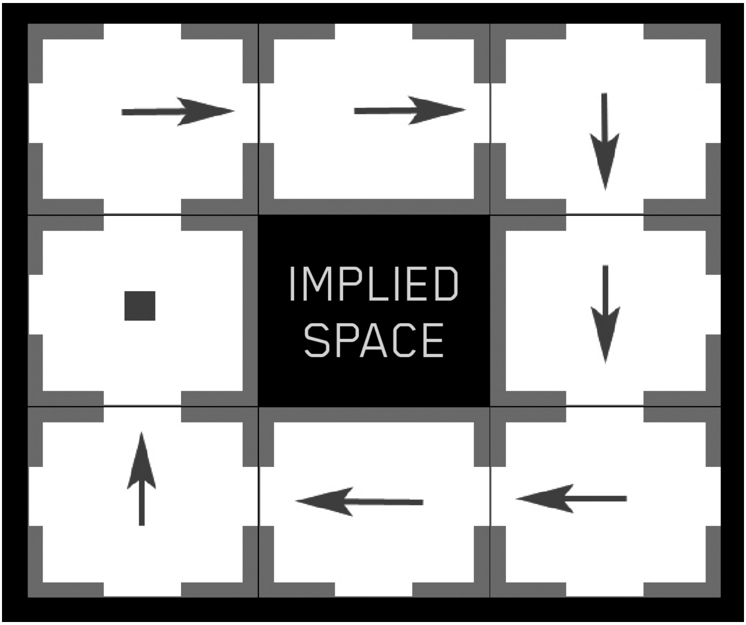

Fig. 2: Spaces Can be Linked Together in Such a Way as to Imply other Spaces in between Them

As the player moves through the eight edge screens surrounding the middle screen, the mapping of the adjoining spaces reveals an implied space in between them in the center, which must exist, provided the overall space of the game's world is consistent, non-contingent, and Euclidean in nature. Another way to imply spaces is with a map showing spaces and their connections, without actually showing the spaces themselves or allowing access to them. Maps can even be used to imply space just by having blank spaces between other labeled spaces, showing that an area exists somewhere. Maps can provide a wealth of information about how spaces are connected, without allowing access to those spaces, or even allowing the player to look into them, since the map is only a representation of the space and not an image produced by a point of view looking into the space.

While they can be one of the greatest aids to navigation, maps can be designed to provide as little information as possible about the actual spaces themselves, and even limit what can be implied regarding the status of their connections.

Of course, without a map, implied spaces can only be implied when the spatial structure in question is designed consistently around some kind of background logic upon which a player can rely. In the navigation of physical space, people rely on assumptions based on a Euclidean space in which Cartesian coordinates can be used, as is evident on most maps. Only for great distances do spherical distortions come into consideration. Just as 3D video games often rely on cinematic conventions to convey meaning, many also rely on assumptions about the Euclidean nature of space to aid players' navigation. But this not always need be the case, as the malleability of space in video games can easily allow for non-Euclidean configurations.

Non-Euclidean Spatial Structures

Although their use is relatively infrequent, non-Euclidean spaces appeared early in video game history and have continued to appear periodically since then, though their potential usage is still far from being realized. The Euclidean nature of video game space is due not only to its patterning after physical space to make it more comprehensible to players, but also because of the mathematical nature of the programming underlying the computational creation of space, which used to rely heavily on Euclidean Cartesian coordinate systems. Binary space partitioning 3D-engines, developed during the 1980s and early 1990s, would take a game-world space and recursively subdivide it into convex subsets, a hierarchical process resulting in a space-partitioning tree. Since binary space partitioning uses planes to divide spaces into subsets, there is an underlying assumption that the space is Euclidean. More recently developed portal-based systems, however, join spaces according to their connections, rather than where they are located in a larger grid of space, making non-Euclidean configurations easier to create (Laurila 2000). Like binary space partitioning systems, portal-based systems begin by drawing the sector the player is in, and then the other sectors visible from the player's sector, only they do not depend on an overall coordinate system, making non-Euclidean arrangements possible. Non-Euclidean geometry is even possible with a grid-based system, if a contingency system is used. For example, Ken Silverman's Build Engine for 3D Realms allows two rooms to occupy the same space on the grid, and decides which one will be rendered at any given time. Thus changes in the way spaces and their connections are conceptualized, and the programming methods that incarnate them in games, have opened up new spatial possibilities that have yet to be fully explored.

The space within individual spatial cells, then, is almost always Euclidean space when the cells are taken separately, and non-Euclidean spaces only arise through the way cells are connected to each other or to themselves. Thus the space within individual spatial cells is usually understood intuitively by players, even when the overall space of a game is designed counter to intuitive assumptions. So on the local level of the cell, space is almost always Euclidean, while on the global level it need not be at all.

There are several ways in which Euclidean cells can be connected so as to produce non-Euclidean structures. The first is to connect a single cell to itself in ways that violate Euclidean space. Single-screen games with wraparound space like ASTEROIDS are the most common example. The right and left sides of the screen are joined, as are the top and bottom, so that avatars leaving one side of the screen reappear on the opposite side. Mathematically, such a space is known as a 2-torus space, which is non-Euclidean because every line tracing the circumference of the torus is the same length, whether it lies on the inner or outer part of the ring. As mentioned earlier, another possible configuration for a single-screen space with four sides is one in which players leaving one side of the screen reenter through an adjacent side, rotated by ninety degrees.

Connections can also join together nested spaces of different sizes. For example in VENTURE (1981), some screens are enlarged areas of other screens, and cut to them when entered. And in ADVENTURE for the Atari 2600, castles are depicted onscreen with gates that are in the middle of the screen, yet the interiors of the black and white castles are each larger than a single screen. COSMIC OSMO (1989) subverts the assumption that a player's avatar remains a consistent size, and allows tiny spaces and openings to be entered, as the implied size of the avatar changes from one image of the game space to the next, even though the images are depicting different views of the same space.

Due to the way games depict three-dimensional spaces with two-dimensional images, the two can become interchangeable and open up possibilities for connections. An image might be used as a painting or photograph hanging on a wall, suggesting it is two-dimensional, but when a player clicks on it or moves into it, it can suddenly become three-dimensional. This effect can be used to create nested diegesis, for example, mini video games that can be played within the diegesis of other video games, like the 'Ship Chip Lander'-game found in COSMIC OSMO. The nesting of diegeses also has the potential to introduce interesting recursive loops into video games; COSMIC OSMO'S own title screen is seen on a Macintosh computer that appears within its own diegesis. Unfortunately, when the player clicks on the screen, the game does not become playable; though it could have easily been made to return the player to the title screen and begin the game again.

One-way spatial connections often violate Euclidean space. To cite an early example, SUPERMAN (1979) for the Atari 2600 had a subway depicted by a series of screens which had one-way connections by which the player exited into different parts of Metropolis. When the player makes the transition, the screen changes behind the avatar, leaving it in the same position, and there is no indication of the connection the avatar has just traversed. The linking books found in the ages of MYST return the player to the library on Myst Island in a similar fashion. More commonly, the moving up from one level of a game to a higher one is another instance of one-way movement, since the player usually cannot return to a lower level.

Another way to form a non-Euclidean structure is to join multiple cells together in ways that violate Euclidean space. For example, in the 'Lunatic Fringe'-level of DUKE NUKEM 3D (1996), there is a 720° circular hallway that the player must go around twice to return to the same position. Changing a few connections in a Euclidean arrangement of cells is usually enough to break the consistency and render the space non-Euclidean. It should be noted that connections in and of themselves are neither Euclidean nor non-Euclidean; it is the way they connect cells together that produces one kind of space or the other. It is only through movement and navigation, then, that the Euclidean or non-Euclidean nature of a space becomes apparent; most likely, a player will assume a Euclidean configuration until a structure's connectivity proves otherwise.

As mentioned earlier, in games like NARBACULAR DROP and PORTAL, players can create their own contingent non-Euclidean spatial connections. In ECHOCHROME (2008), players can even design their own non-Euclidean levels. Inspired by the work of M. C. Escher, ECHOCHROME features black-and-white line drawings of rotatable 3D structures, which obey different laws of perspective when rotated. The trailer (www.gametrailers.com/game/echochrome/5156) for the game describes and demonstrates the 5 perspective laws that the player must master:

– Perspective traveling: when two separate pathways appear to be touching, they are.
– Perspective landing: if one pathway appears to be above another, it is.
– Perspective existence: when the gap between two pathways is blocked from view and the pathways appear to be connected, they are.
– Perspective absence: when a hole is blocked from view, it does not exist.
– Perspective jump: when the mannequin jumps, it will land on whatever appears beneath it.

ECHOCHROME uses Jun Fujiki's Object Locative Environment Coordinate System, which translates the global three-dimensional space into a two-dimensional coordinate system locally around the avatar, and determines movement constraints based on the two-dimensional interpretation. Thus the game tests the player's ability to quickly shift back and forth between interpreting the game image as a two-dimensional space and as a three-dimensional space, since the manipulation of the space occurs in three dimensions, while the avatar's behavior requires a two-dimensional interpretation.

Finally, contingent connections can violate Euclidean space, unless there is some explanation for the way connections between spaces change; for example, an elevator that connects to different floors depending on the position to which it is moved. If the contingency of a connection renders a space non-Euclidean by changing a connection's destination cell, it may be the case that each of the resulting spatial structures is Euclidean and the only violation is a dynamic one, in which the space does not remain consistent over time; for example, if a particular room is replaced by another of the same size. Thus, spatial structures can become non-Euclidean in a spatial sense, through an unchanging network of connections that break Euclidean consistency, or become non-Euclidean in a temporal sense, through contingent connections that differ over time and break consistency in a dynamic way (in ECHOCHROME, for example, such contingent connections are based on the player's point of view).

Non-Euclidean spaces can be navigated once their constituent pieces and the connections between them are understood. But there are other difficulties that exist at a more local level. Some spaces can be more difficult to reconcile with the model of interconnected spatial cells I have been describing, and it is to these kinds of spaces that we must next turn.

Track-like Spaces and Other Structures

Many games do not allow the kind of free exploration that necessitates the learning of the layout of a spatial structure, and an avatar's movements may be so restricted that navigational skills are not needed to play the game. For example, PONG, TEMPEST, and TETRIS (1985) all involve no navigation. But many racing games, driving games, and rail-based shooting games each have a space that is a gradually-revealed continuous strip of track-like space that the avatar or player's point-of-view moves along. Movement along such a track is typically one-way, and the speed of the movement may or may not be controlled by the player. Such games may require the player to steer around obstacles, shoot targets, or both, and often at a quick pace. Space in these games is experienced in largely a linear fashion, with little or no navigation occurring, because *steering* (which involves avoiding obstacles or staying within the bounds of a pathway) is different than *navigating* (which involves making choices and finding one's way around in a mazelike spatial structure). To consider these large, track-like spaces as single cells or even series of cells can be problematic, because free movement within them is usually not available, and because the player is unable to make choices that result in a change of destination. Both of these things are required for navigation, which requires not only a certain *type* of decision-making (which involves choosing which path to take out of several possibilities, based on the player's knowledge of the game's spatial structure), but a minimum *number* of such decisions as well, since the process of navigation is a cyclical one, involving exploration, the gathering of knowledge gained through exploration and the integration of new knowledge into existing knowledge, and finally the application of the integrated knowledge to further exploration.

Yet track-like spaces can be combined into navigable environments of spatial cells, and act like a cell within them. An example would be a vehicle that the player rides to a new location where exploration and navigation can resume. The same can be said for the mixing of two-dimensional, two-and-a-half dimensional, and three-dimensional spatial structures; they can be combined together in a game, like SUPER PAPER MARIO (2007), though most games typically limit their diegesis to a single type of dimensionality. If enough track-like spaces are joined together, with forking paths and decision points along the way, then navigation can gradually come into play again, as the network of track-like spaces becomes a maze.

Another kind of space is a large 3D space with obstacles or characters that obstruct the player's point of view, creating hidden spaces which are revealed and obscured as the obstructions move around. One such game space is organized around the surface of a sphere or other three-dimensional form, half of which faces the player and is visible and half of which faces away from the player and is hidden from view. For example, SUPER STARDUST HD (2007) and SUPER MARIO GALAXY (2007) feature small planets that the player's avatar traverses while avoiding enemies. Each of these spaces could be conceived as a single spatial cell, only half of which is seen at any given time, or as two cells whose boundaries change according to the player's movement; the visible area and the occluded area. In a similar fashion, the edges of the screen on scrolling landscapes change according to the avatar's positioning; such boundaries are conditional, as opposed to unchanging boundaries such as walls, mountains, or other fixed lines of demarcation.

The movement of the playing field relative to the avatar's position need not be the only exception. One could conceive of a video game in which the space of the game's world is dynamic. Instead of having fixed boundaries, spatial cells could have boundaries that are continually changing, expanding and shrinking, to the point where new spatial cells are coming into existence while others are going out of existence as they shrink down to nothing. SUPER MARIO GALAXY has a level in which spaces shrink and vanish after the player's avatar has passed over them, although even more complex expansion and contraction patterns could be designed. In such games, players would have to constantly keep on the move, to avoid getting caught in a cell that is disappearing, and they would also keep relearning the spaces and how they connect in order to navigate them. When the world and the player's mental map of it constantly changes, players can succeed only when they have a sense of the game's navigational logic.

Navigational Logic

Navigational logic can be seen as being made up of four distinct kinds of things players must learn:

1. what spaces exist in the game's world (which includes those that can be accessed, those that are only seen but are inaccessible, and those that are neither accessible nor visible, but are only implied);
2. how those spaces are interconnected (which involves the learning of boundaries, obstacles, and geographical layout);
3. how interconnections between spaces work (in terms of their passability, visibility, reversibility, contingency, and how they are opened and closed); and
4. how spaces and their configurations change over time, if they do.

Of course, the learning process is simultaneous and cyclical, as each of these four things relies on the learning of the other three, and because spaces and their boundaries mutually define each other.

To investigate these questions we would next have to ask, how is each of these incorporated into gameplay? Are they foregrounded or backgrounded within the game's main objective, or are one or more of them involved in the game's main objective? What conventions are relied upon, and what kind of knowledge or experience is the player assumed to have? Different genres use them to differing degrees, with maze games, adventure games, and first-person shooting games the most likely to require more complex navigation. How much replaying of a game is necessary to learn its navigational logic, due to irreversible crossings or nonrepeatable events? The navigation of space may also involve the navigation of branching narrative possibilities, though at the same time these may also provide a player with clues to the navigation of space.

Spatial navigation can be made difficult either passively or actively. Elements that work passively against a player's ability to navigate include a game's design and the layout of its spaces: complex configurations can tax the player's memory, patience, and endurance. Nonintuitive designs, especially non-Euclidean ones and ones involving contingency or irreversibility, can work against players usual assumptions and disorient them, requiring more exploration and trial-and-error in gameplay. Euclidean configurations tend to be the default in game design, especially for games in which navigation is not foregrounded or intended to be a challenge. If non-intuitive spatial structures are used, learning them will most likely be an important part of the game, if not its main objective. Finally, navigation can be passively thwarted by the lack of a consistent logic in the way game spaces and their connections operate. This differs from complex designs, since complex designs can be still be consistent and logical in the way they work, and it is usually more a result of poor design than deliberate design. Lack of a navigational logic is more likely to be seen as frustrating than as a challenge to be enjoyed.

Other things can actively work against the player's ability to navigate. Enemies who block connections, chase after players, and attack them, forcing them to respond, certainly make navigation more difficult. Even inanimate obstacles can block connections, making them impassable and obscuring visibility. Both enemies and obstacles demonstrate how other tasks can interfere or compete with navigational tasks, forcing players to prioritize and multitask, sometimes at the same time. Time constraints can act in a similar way, limiting the amount of time for exploration as well as for decisions regarding exploration. Narrative sequences can interrupt exploration, and possibly change a game's state in ways that affect navigation. Finally, if a game's spatial cells, the connections between them, and their contingencies continuously change during gameplay, navigation may become confoundingly complicated.

Spaces are created not only by software, but by hardware as well. To date, most games have been designed for a single, flat, rectangular screen. A few exceptions, like the Nintendo Virtual Boy and the Nintendo DS, have used multiple screens, although the Virtual Boy's screens were used together to produce a single stereo image. But new flat screen technologies, and developing technologies like flexible screens and electronic paper, will be able to help designers explore new screen configurations. Imagine playing even a simple game like PONG on a cylindrical screen which the player cannot see all at one time, and which must be physically turned as the game is played. Or PAC-MAN (1980) played on multiple screens on the sides of a cube, or even on a spherical screen in which Pac Man stays at the top of the sphere, which must be rotated to move him through the maze. Screens that the player cannot see in their entirety at any given time open up new design possibilities. Instead of having only on-screen and off-screen space, on-screen space would be further divided into on-screen space that the player can see and on-screen space the player can't see. Game events occurring simultaneously on multiple screens would act similar to games in which multiple actions are occurring on split screens, only they may be more difficult to monitor; six events occurring at once on the sides of a cube would not only place interesting demands on the mental aspects of gameplay, but on the physical ones as well, requiring dexterity and speed.

Likewise, interface devices (such as a joystick, controller, mouse, or keyboard) are usually used for moving a player's avatar through a two-dimensional plane of movement, which in turn determines what spaces are displayed. Some games turn these ideas around, so that the controllers manipulate the game's space directly, and this movement determines the avatar's movement, which is not directly under the player's control but instead is automated and responsive to changes in the spatial orientation of the surrounding environment, making spatial manipulation a prerequisite for spatial navigation. In some of these games, space is manipulated through the movement of the screen itself; position-sensing mercury switches have begun to make more of these games possible commercially, for example, on the iPhone. In other games, the screen itself stays stationary, while spaces are manipulated by conventional control devices. A brief analysis of one game in each category will help to examine the potential of spatial manipulation.

In ECHOCHROME, players manipulate space so as to change their viewpoint, which in turn changes the way the spatial structure behaves, opening and closing connections for the automated avatar. The main navigational challenge is the moving of the space combined with the constant perceptual shifting between the three-dimensional and two-dimensional interpretations of the game imagery, the first of which is needed for the manipulation of space while the second is needed to connect one space to another for the avatar's passage. Because the five rules of perspective are made explicit, players can adopt them more quickly, allowing them to concentrate on the puzzle aspects of the game. The automatic movement of the avatar can add a further time pressure, for example when it is heading for a hole or a gap that the player must hide by readjusting the perspective. The game could have been further complicated by the presence of monsters whose movements obey the same principles as the avatar, and who could be trapped and released in other areas of the structure as the perspective opens and closes connections. This would have required the player to focus on multiple areas of the game space simultaneously, and could create puzzles requiring the containment of monsters on geographically-isolated beams before certain moves could be safely completed. Perhaps we will see additional challenges like these in future iterations of the game.

A good example of the physical manipulation of space through analogous movements of the hardware on which the game space appears is Julian Oliver's game LEVELHEAD (2007), which uses a form of augmented reality. The player manipulates small cubes atop a

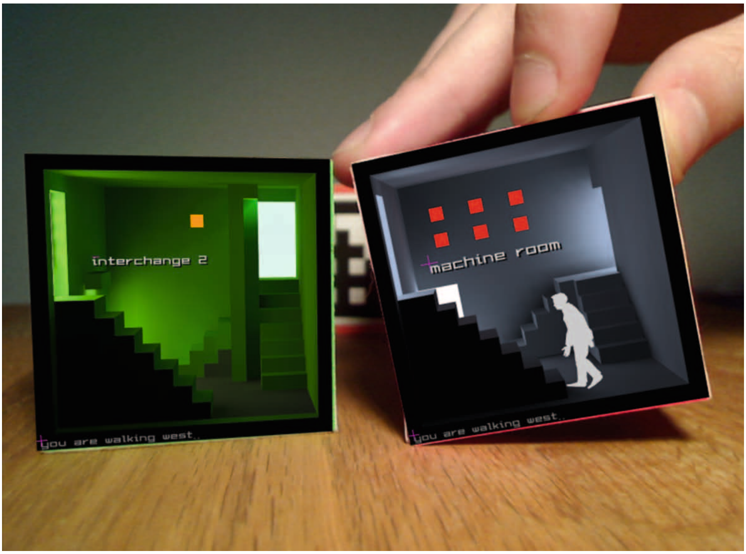

Fig. 3: Julian Oliver's levelHead (2007) – a Game with an Augmented Reality Interface

pedestal, the movements of which are recorded by a small camera on the pedestal. The image from the camera appears on a large screen in front of the player, but this image has been processed by a computer so that the images of spaces within the cubes appear on the surfaces of the cubes facing the camera. When the player moves the cubes, the spaces shift perspective, and the avatar, a white silhouette of a walking man, moves as the cubes are tipped, passing from one space to another, and even from one cube to another.

The cubes in LEVELHEAD each contain six different rooms, one on each face of the cube, and each room appears to occupy the entire interior of the cube. Through subtle clues like the position of the doorways and the color of the light spilling in through them, players must figure out how these rooms are connected, and also how the rooms in one cube are connected to rooms in the other cubes. The cube must be oriented properly so that the floor side of a room is on the bottom, something that can differ from one room to another. The game integrates game space and physical space in an interesting way, since players must watch their own hands interacting with the cubes on the big screen, in order to see the cube interiors composited into the image. The space in the large screen is that of the physical world of the player, being re-represented, and within it, the game's diegetic space is seen to reside, as though it were connected to the physical space of the player. Thus game space, physical space, and the interface itself are all combined in a unique way that makes the navigation of space, through spatial manipulation, the central challenge of the game.

As is the case with ECHOCHROME, the difficulty of LEVELHEAD could be increased with the addition of subgoals and enemies that chase the avatar through the space of the game. While the use of space in games like ECHOCHROME and LEVELHEAD is new, spatial navigation remains the games' central challenge. As more conventions regarding the use of non-Euclidean space and games with spatial manipulation become more common, spatial navigation may become only one of multiple tasks demanding a player's attention. As game screens, controllers, and other hardware devices evolve, and new software appears to integrate them into gameplay, new potential for spatial relationships will emerge, which in turn will affect the player's relationship to the game space and its navigational logic. Whatever the future of video games may hold in store, it is certain that questions regarding the design of video game spaces, how those spaces are connected, and how they are experienced, will remain essential to video game studies and the study of the human experience of spatial representations in general.

References

Aarseth, Espen (2007): "Doors and Perception. Fiction vs. Simulation in Games", in: *Intermédialités* 9, 35–44.

Laurila, Pietari (2000): "Geometry Culling in 3D Engines", posted October 9, 2000, on GameDev.net, http://www.gamedev.net/reference/articles/article1212.asp.

Wagner, Mark (2006): *The Geometries of Visual Space*, Mahwah, New Jersey and London, England: Lawrence Erlbaum Associates.

Wolf, Mark J. P. (1997): "Inventing Space. Towards a Taxonomy of On- and Off-Screen Space in Video Games", in: *Film Quarterly* 51, 11–23.

Wolf, Mark J. P. (2001): "Space in the Video Game", in: *The Medium of the Video Game*, ed. by M. J. P. Wolf, Austin: University of Texas Press, 52–75 [1997].

Wolf, Mark J. P. (2008): "Z-axis Development in the Video Game" in *The Video Game Theory Reader 2*, ed. by Bernard Perron and Mark J. P. Wolf, New York: Routledge, 151–168.

ADVENTURE (1979), Atari, Atari VCS 2600.

ASTEROIDS (1979), Atari, arcade (also ported to other systems).

BREAKOUT (1976), Atari, arcade (also ported to other systems).

COSMIC OSMO (1989), Cyan, Macintosh.

DUKE NUKEM 3D (1996), 3D Realms, Microsoft Windows (also ported to other systems).

ECHOCHROME (2008), PlayStation 3 (also ported to other systems).

EVE ONLINE (2003), online game.

LEVELHEAD (2007), downloadable game.

MASS EFFECT (2007), Bioware, Xbox 360, Microsoft Windows.

MYST (1993), Cyan, Macintosh (also ported to other systems).

NARBACULAR DROP (2005), downloadable game.

PAC-MAN (1980), Namco, arcade (also ported to other systems).

POLE POSITION (1982), Atari, arcade (also ported to other systems).

PONG (1972), Atari, arcade (also ported to other systems).

PORTAL (2007), Valve Corporation, downloadable (ported to various systems).

RETURN TO CASTLE WOLFENSTEIN (2001), Activision, Microsoft Windows (also ported to other systems).

RIVEN (1997), Cyan, Macistosh (also ported to other systems).

SPACE INVADERS (1978), Taito, arcade (also ported to other systems).

SUPER BUG (1977), Kee Games, arcade.

SUPER MARIO BROS. (1985), Nintendo, NES.

SUPER MARIO GALAXY (2007), Nintendo, Wii.

SUPER PAPER MARIO (2007), Nintendo, Wii.

SUPER STARDUST HD (2007), Housemarque, PlayStation 3.

SUPERMAN (1979), Atari, Atari 2600.

TEKKEN (1994), Namco, arcade.

TEMPEST (1981), Atari, arcade.

TETRIS (1984), Alexey Pajitnov, (ported to various systems).

VENTURE (1981), Exidy, arcade (also ported to other systems).

ZAXXON (1982), Atari, arcade (also ported to other systems).

The Matrix (1999), Andy Wachowski and Larry Wachowski, Australia/USA.
The Matrix Reloaded (2003), Andy Wachowski and Larry Wachowski, Australia/USA.
The Matrix Revolutions (2003), Andy Wachowski and Larry Wachowski, Australia/USA.

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– *The Video Game Explosion. A History from PONG to PlayStation and Beyond*, Westport 2007.
– *The Medium of the Video Game,* Austin 2001.

Espen Aarseth

"Define Real, Moron!"

Some Remarks on Game Ontologies

Academic language should not be a ghetto dialect at odds with ordinary language, but rather an extension that is compatible with lay-language. To define 'game' with the unrealistic ambition of satisfying both lay-people and experts should not be a major concern for a game ontology, since the field it addresses is subject to cultural evolution and diachronic change. Instead of the impossible mission of turning the common word into an analytic concept, a useful task for an ontology of games is to model game differences, to show how the things we call games can be different from each other in a number of different ways.

> Define real moron. I think you're confusing the terms 'real' and 'physical'. You're assuming the medium used justifies whether or not people should be respectful. (Discussion on *YouTube*)

Introduction: The Need for Game Ontologies

As games demand more and more attention in both public and academic discourse, the need to understand *what games are* becomes increasingly acute. Are games works of art? Are they rule-based systems? Are they player-driven processes? Are they media? Are games just for fun, or can they be as serious as life itself? Games are many different things to different people and their societies and practices, and, therefore, to different academic disciplines and practices. When two or more game researchers are using the word "game", they may or may not be speaking about the same thing.

'Game' is primarily an everyday term constructed in layman's language, and to reconstruct it as a precisely defined analytical term is

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http://pub.ub.uni-potsdam.de/volltexte/2011/4981/ [urn:nbn:de:kobv:517-opus-49810]

to ask for a lot of trouble. Two simple anecdotes may serve to illustrate this problem: When random people were asked on the phone by Danish telemarketers what games they played, they would typically answer with the name of a lottery service. For them, 'game' (Danish *spil*) did not refer to computer games at all, but to national gambling. A former student of mine, Malene Erkmann, did a survey of primary school children and their playing habits. She observed that they would use the phrase "playing computer" ("spille computer") about the activity of using an online chat-room. For them, a computer game was not needed to play on the computer.

When we as game researchers try to construct formal definitions for commonplace, historical terms like *game* and *play*, we are in danger of reducing them to theoretical constructs that have no direct relationship with real-world phenomena. The range of phenomena recognized as games in everyday language is simply too broad for easy theoretical demarcation. Thus, an ontology of games cannot productively start with a crisp, formal definition of what a game is, but must accept that it means different things to different people, and that this is as it should be. Even the sharpest and best of the many attempts to define what a game is, such as Jesper Juul's "classic game model" (2005:44), falls short of including all forms of games that are clearly recognized as games in their cultural contexts and by their players, such as live action role-playing games, or informal children's games. Juul wisely acknowledges the limits of his definitional model, but does not come up with a broader alternative.

It also seems implausible that the concept of games in an earlier ('classic') era was unequivocally identified with Juul's "classic" model. Games have always been a vague cultural category, and at no point in history has a concise and exclusive notion of Juulian 'gameness' (e.g. negotiable consequences, fixed rules) established itself. For example, the *Ludi Romani* entertainment spectacles in ancient Rome consisted of parades, dramatic performances, extremely dan-

see video recording of this *DIGAREC Keynote-Lecture* on:
http://info.ub.uni-potsdam.de/multimedia/show_projekt.php?projekt_id=78#78
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gerous chariot races, as well as the famously deadly gladiator games. *Ludus*, it seems, simply meant performative entertainment.

One merely has to consider that *ludus* is the Latin root of the English word "ludicrous" to realize that 'game' and its many cognates in other languages denote not only the formal, rule-based contest of serious contenders but also the irreverent, informal revels of people having fun. If we declare that only the former is hereafter called "game", and the latter something else, e.g. "play", we are going against common language use. The reason for this miscomprehension in contemporary Game Studies seems to be inspired by Roger Caillois, who used 'ludus' as a term for his dichotomy between skill based, rule-bound gaming and free improvisation, which he labeled with the Greek term for play: *paidia*.

Academic language should not be a ghetto dialect at odds with ordinary language, but rather an extension that is compatible with lay-language. To define 'game' with the unrealistic ambition of satisfying both lay-people and experts should not be a major concern for a game ontology, since the field it addresses is subject to cultural evolution and diachronic change. Even if game researchers could manage to agree upon a definition, which is not likely to happen, the common meaning would remain to challenge our wisdom.

The Word Game

When a new academic field is constructed, some of the work to be done will inevitably be to create and find consensus for sound definitions of key terms. However, while there are a number of game definitions put forward, so far no consensus has been reached. Hovering over this process is the ghost of Ludwig Wittgenstein, who used "game" ("Spiel") as a main example in his *Philosophical Investigations* and concluded that a word like game has no essential definition, but is rather a term for a "family" of similar phenomena that share some features, but there is not one set of features that all share. The game of defining games – “das Sprachspiel mit dem Worte ‘Spiel’” (Wittgenstein 2001:38) – that is played in Game Studies today was thus dismissed by Wittgenstein more than fifty years ago.

Not because Wittgenstein claimed it was impossible to define games, but because any definition would have to reduce the demarcation to something less than games in general, and because defining games is not really necessary; we know what a game is even if we can’t express it clearly, just as we, in Wittgenstein’s poetic example, know how a clarinet sounds, even if we are not able to say it. Wittgenstein was using the concept of games for a purpose not at all invested in game research, but his point is still valid in Game Studies. If we as game scholars want to define games in a particular way, we reduce the concept to a narrower area than that which is indicated by popular language use. Should game scholars be allowed to do this? What purpose is being served hereby? There is of course a significant difference between defining the general notion of games too narrowly, and defining a narrower subset of games more precisely.

‘Games’ is a historical, socially constructed term, and not a theoretical one, at least not to begin with. The attempt to define or redefine a historical term theoretically is to instill something imprecise with faux-precise meaning, and these acts are wagers in a game of power, an attempt to change language and to steer meaning in a particular direction. The main danger in doing so is that some phenomena that used to be called games now no longer have a name for what they are, as demarcations and definitions exclude and marginalize that which they do not put in focus. This is fine if no previous usage existed, but in the case of games, a number of phenomena will be excluded by any specific definition, as Wittgenstein predicted.

Instead of the impossible mission of turning the common word ‘game’ into an analytic concept, a useful task for an ontology of games is to model game differences, to show how the things we call games can be different from each other in a number of different ways.

For the purpose of this article, I will pragmatically and very broadly define games as *facilitators that structure player behavior, and whose main purpose is enjoyment* (Aarseth 2007).

Game ontological research is one of a number of possible approaches to games. It is a descriptive rather than a normative approach, but a successful game ontology should be able to support normative approaches such as game criticism or game design theory by providing a precise language and models with which to analyze and map the landscape of possible games and their key formal differences. While game criticism may be concerned with qualitative aspects of games, and game ontology with formal aspects, the critical analysis of games will benefit from a formal, model-based understanding of the object in question. In return, the game ontologist can benefit from the experience gained by the game critic's application of the ontological model. The same should be the case for other descriptive approaches, such as the psychological study of game effects or sociological studies of how games are used by actual players. When, for instance, 'media effects'-researchers lack a clear understanding of the formal qualities of the games they base their clinical observations on, misinterpretation and invalid results typically follow.

One example is from the literature on the effects of violent games, where Anderson and Dill (2000) compared two games, MYST (1993) and WOLFENSTEIN 3D (1992), without taking into account that a lot of factors besides violence differed between the two games, such as gameworld structure, navigation mode and temporal intensity. With so many factors unaccounted for, the findings of their research were worthless. Simply put, Anderson and Dill ignored the functional, mechanical dimension of video games and based their selection only on the semiotic dimension. To avoid such a fundamental blunder, a game ontology might have been used to select two games that are functionally identical except for the violence (say, a fast-paced sports game and a shooter game), thus, it would have been possible to isolate the one factor to be studied.

Similarly, game sociologists studying player freedom and influence over the game world in Massively Multiplayer Online-games (MMOs) may benefit from a formal model describing exactly how one game allows more intervention, social communication and personal configuration than another, thus avoiding potentially overbroad conclusions that would apply to some but not all MMOs. Also, a game designer may benefit from a model that lets them see and construct previously unused combinations of common game features, such as the combination of practices found in adventure games and team-based strategy games, but never before seen in the same game.

The empirical scope of this essay is entertainment games in virtual environments; that is, games that feature tactical positions in a virtual landscape as a gameplay component, and typically do not have any other purpose than entertainment. I find terms such as 'video games', 'computer games' and 'digital games' arbitrarily limiting and henceforth will not use them, since the games that are relevant to my argument could be without a visual (while still having a spatial) interface, such as sound-based 3D-games for the blind, or non-graphical (text only) games like COLOSSAL CAVE ADVENTURE (1976) and ZORK I: THE GREAT UNDERGROUND ADVENTURE (1980). Likewise, there are many mechanical games that also use digital technology for some part of their operation, e.g. later generations of pinball machines. Games that have ulterior purposes (such as for example learning) or games that have a physical rather than a virtual playing ground or interface – such as soccer or GUITAR HERO (2005) – or no significant playing ground at all but tokens only (such as e.g. blackjack or poker) may or may not be framed by this discussion. I do not make any such claims regarding their relevance.

The word 'ontology' can have several meanings. It can refer to the most general branch of metaphysics, concerned with the study of being and existence. More specifically, it can refer to a particular theory of being. In the field of computer science, it refers to a formal description of a domain, including definitions of objects and relationships.

Typically, game ontologies are ontologies in the 3rd, computer-science sense: They describe what games are (and what they are made of): the fundamental building blocks and their relations. However, as we shall see, a game ontology can also address the philosophical questions of being and existence, such as the relationship between, real, virtual and fictional phenomena in games.

A Brief Overview of Formal Computer Game Ontologies

An early attempt to map the possibility space of so-called “interactive fiction” (another name for text-only adventure games) was made by Richard Ziegfeld (1989): He listed a number of technical and interface elements (“simulation”, “interaction” etc.) and suggested how they could be combined. While his terms were typically too imprecisely defined and too overlapping to form a truly useful ontology, he deserves recognition as probably the first computer game ontologist, inspiring later work such as Aarseth (1995). The latter is an attempt to build a comprehensive, generative model that can describe games’ formal features along a number of dimensions, such as perspective (vagrant, omnipresent), teleology (finite, infinite), goals (absolute, relative) and so on.

Like Ziegfeld’s model, it produces a multidimensional space where all games and possible games can be described, but more care is taken to make the dimensions independent and orthogonal. The model can be used for both game design, by identifying new combinations of structures that can result in new games, and game genre analysis, by classifying a number of existing games according to the model, and then analyze the data set with an explorative method such as correspondence analysis.

Inspired by Christopher Alexander’s concept of Design Patterns, Björk and Holopainen (2005) have approached the question of mapping game structures onto a large number of game design patterns, design elements that can be found in a number of games. One example is the pattern 'Paper–Scissors–Rock', which can be found in games where the player must choose a weapon or tactic that has strengths and weaknesses relative to the other players' choice. Their method is highly specific and yields a large number of patterns, which may be beneficial for game designers looking for inspiration, but can be challenging to apply in an analysis of a specific game. Jan Klabbers (2003) proposes a top-down ontology where a game consists of three main elements 'Actors', 'Rules' and 'Resources'. The *Game Ontology Project* by Michael Mateas et al. (gameontology.org) is an ongoing project to map structural game elements hierarchically. It has four top-level categories, 'Interface', 'Rules', 'Entity Manipulation' and 'Goals', and a large number of sub-entries. This ontology is mainly a selection of examples, and the hierarchy is at times less than intuitive (e.g. why is 'Entity Manipulation' a top-level entry, and not placed under Rules?).

The main problem facing game ontologists is that of choosing the level of description for their game models. Games can differ by minute details, and most differences would be too particular to generalize into a model. Similarly, the list approach taken by the game design patterns project invites an endless list of patterns; there is no natural stopping point in the model. Another problem is that ontologies that are useful for one purpose may be much less so for another. A general-purpose ontology may therefore end up being much less useful than one that has been constructed with a special purpose in mind.

What's in a Game: A Simple Model of Game Components

Even within the narrower domain of games in virtual environments there are tens, maybe hundreds of thousands of games that are somehow formally different from each other. A game like TETRIS (1985) has almost nothing in common with WORLD OF WARCRAFT (2004), or with SUPER MARIO SUNSHINE (2002). Where media formats such as print or film have certain well-defined material characteristics that have remained virtually unchanged since they emerged, the rapid evolution in games and game technology makes our assumptions about their media formats a highly unreliable factor to base a theory on. We simply cannot assume that the parameters of interface, medium structure and use will provide a materially stable base for our observations the way the codex paperback has remained the material frame for students of literature for more than five hundred years. In ten years' time, the most popular games, played by tens if not hundreds of millions of people, may have interfaces that could be completely different from the MMOs of today.

The lack of a stable material frame of reference is not necessarily a problem, however, since it actually allows us to see beyond the material conditions and formulate a descriptive theory with much larger empirical scope, both synchronically and diachronically. Indeed, a trans-material ontology of games may also be used to frame phenomena we normally don't think of as games, for example art installations and other forms of software. In my theory of cybertext (Aarseth 1997), I presented a general model of what I called 'ergodic' communication, which included all works or systems that require active input or a generative real-time process in order to produce a semiotic sequence. I used games as a main example of these 'cybernetic texts'.

As I pointed out, it is fundamental for these systems that they consist of two independent levels, the internal code and the semiotic, external expression (ibid:40). This distinction was inspired by Stuart Moulthrop's (1991) observation that hypertexts contain a 'hypotext', the hidden, mechanical system of connections driving the choices presented to the hypertext reader. This duality is the most fundamental key to the understanding of how games work, how they signify, and how they are different from other signifying systems such as literary fiction and film:

> what goes on at the external level can be fully understood only in light of the internal. [...] To complicate matters, two different code objects might produce virtually the same expression object, and two different expression objects might result from the same code object under virtually identical circumstances. The possibilities for unique or unintentional sign behavior are endless (Aarseth 1997:40).

This structural relationship should *not* be confused with the notions of form and content, e.g. syntax and semantics, or signifier and signified. Both the internal code and the external skin exist concretely and in parallel, independently and not as aspects of each other. To conflate surface/machine with signifier/signified is a common misunderstanding made by semioticians and other aesthetic theorists who are only used to study the single material layer of literature and film. Together with gameplay, we propose that semiotics and mechanics are the key elements of which any virtual environment game consists.

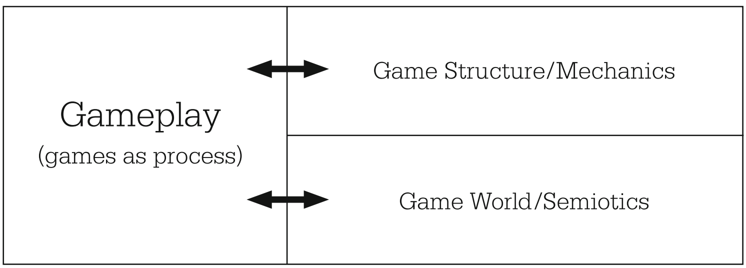

Fig. 1: A simple division of the empirical object into three main components

Mechanics and semiotics together make up the Game Object, which is a type of information object, and when a player engages this object the third component, gameplay, is realized. The Game Object should not be confused with the material object we buy in a game store.

This is a software package that may contain many kinds of information objects besides one or several games. For instance, when using MAX PAYNE (2001), we are exposed to animated movie sequences and comic book sequences in addition to the gameplay.

To use a cliché, game software often contains "more than just a game". – The Game Object is the part of the software that allows us to play. The semiotic layer of the Game Object is the part of the game that informs the player about the game world and the game state through visual, auditory, textual and sometimes haptic feedback. The mechanical layer of the game object (its *game mechanics*) is the engine that drives the game action, allows the players to make their moves, and changes the game state. The tokens or objects that the player is allowed to operate on can also be called game objects (plural); these are all discrete elements that can enter into various permanent or temporary relations and configurations determined by the game mechanics.

Game objects are dual constructs of both semiotics and mechanics. Some games may have a player manifested in the game as a game object, typically called an avatar. Other games may simply allow the player to manipulate the game objects directly through user input. A typical example of the latter is TETRIS, where the game objects are blocks of six different shapes, and which the player manipulates, one by one, with the simple movement mechanics of move left or right, or turn left or right. – To illustrate the duality of semiotics and mechanics, consider the two simple internet games THE HOWARD DEAN FOR IOWA GAME (2004) and KABOOM! – THE SUICIDE BOMBER GAME (2002).

Fig. 2: THE HOWARD DEAN FOR IOWA GAME (Screenshot)

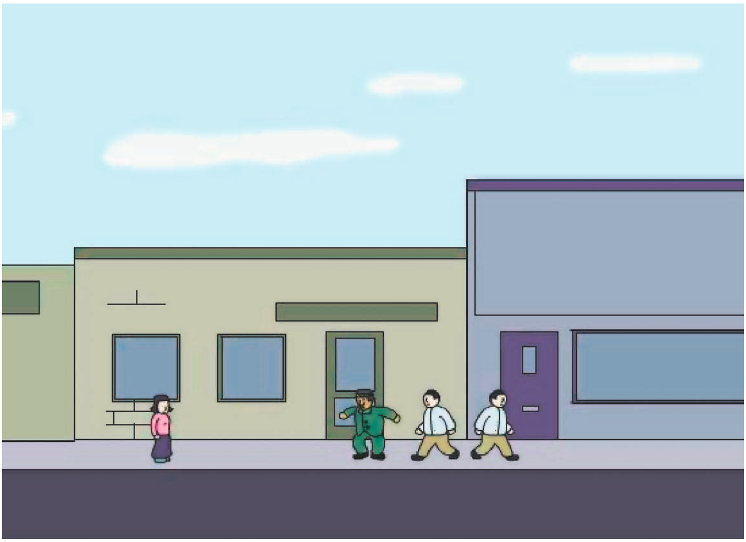

Fig. 3: KABOOM! – THE SUICIDE BOMBER GAME (Screenshot)

In DEAN FOR IOWA, the player must flash an election campaign sign at the right moment to attract the maximum number of people's attention. In KABOOM! the player must detonate the bomb at the right moment to kill and injure the maximum number of people. In both games, the player's character can run bi-directionally on a busy street where people walk back and forth at different speeds, and the points are scored in the same way, by pressing a button at the optimal time. Mechanically, these two games are identical. In terms of semiotics and meaning, they could hardly be more dissimilar. Even so, are they the same game, despite the very different references to the world outside?

As we move from observing the games as played by others and become players ourselves, the different visuals fade into the background and the engagement with the game becomes an obsession with the game goals and mechanics, a narrowly targeted exercise where the number of points scored becomes the dominant value, not the sight of convinced voters or dead, mangled bodies. While suicide bombing might be too disagreeable for many players, scoring points by symbolically killing virtual enemies is typically not.

So the reason why we as players are able to enjoy symbolic killing is that the internal value system of scoring points takes precedence over the violent symbolism of the external reference. When I started playing the online team part of RETURN TO CASTLE WOLFENSTEIN (2001), where players choose between German and US avatars, because of my family history from wartime Norway, where both my grandfathers were affected by the Nazi occupation, I was very hesitant to play as a German WWII soldier. However, as the game became familiar, I came to enjoy the defensive role afforded by the German position of my favorite map, and my initial reluctance vanished. A total decoupling between external and internal value systems had taken place.

The mechanical layer of a game is of course not completely devoid of any ideological meaning, but it will, through players playing, create its own ideological discourse, through a reinterpretation of the game's semiotics, which de-emphasizes the ideological meanings and interpretations that non-players will produce upon seeing the game semiotics for the first time.

Neither would it be correct to suggest that the production of game meaning is a deterministic process uni-directionally produced by the game system. Players typically fight and disagree over games, and this conflict discourse is an integral part of what a game is. Gameplay is inherently ambiguous (Sutton-Smith 1997), and playing a game is a constant renegotiation of what playing means and how important it is.

Games are real to the players playing, but in different ways, and the ambiguous reality of games allows different interpretations. "It is just a game" is the eternal protest heard when player A feels that player B takes the game too seriously. But player A would not have felt the need to remind player B of this seemingly trivial fact, if it had been trivially true at all times. A game is never 'just a game', it is always also a ground or occasion to discover, contest and negotiate what the game really is, what the game means.

Confusing the Real with the Physical

On March 4th 2006, a group of people is meeting for a memorial service for a recently deceased friend at her favorite fishing spot, a lake in a remote place called 'Winterspring'. As the group forms a long line down towards the water, Mozart's *Requiem* is playing. Not far away, another group is running through a tunnel, then out into the open valley, to the tune of horror punk band *The Misfits'* "Where Eagles Dare" from 1979. When the running group reaches the procession, they start slaughtering the mourners, who are dressed in black, and, not carrying weapons, not in a state to fight back. Soon, all the mourners are dead, their bodies strewn across the landscape.

This event took place in the MMO WORLD OF WARCRAFT, after one of the players had died of a stroke a few days earlier. The two groups were opposing "guilds", player organizations that would fight each other as part of the normal gameplay. The event was announced on the web forum of the game, and the attacking guild, called "Serenity Now," made an in-game footage film about the attack and posted it on *YouTube*, with parts of text from the forum reactions to the event.

Perhaps more interesting than both the event itself and the video production was the ensuing debate, typically between players who were either amused or abhorred by the incident:

> – I know a real girl died but it wasn't a real funeral, I bet most people didn't even knew her in real life
>
> – Define real moron. I think you're confusing the terms 'real' and 'physical'. You're assuming the medium used justifies whether or not people should be respectful.
>
> – I'm not being insensetive [sic] or disrespectful at all. I just find it stupid how people are getting pissed at people playing a game that revolves around fighting other players, the way it's meant to be played… Which is what happened.
>
> – Even know [sic] it was mean it was really god damn funny.

This example may serve as a perfect illustration of how the same in-game event can be interpreted both as a serious act of commemoration interrupted by harassment, and as playing a game "the way it's meant to be played". Situations like these are typical for any kind of game where it is possible for players to interpret events in more than one way. The players' subsequent discussion in the YouTube comments field shows how the ambiguity of games and gaming situations can produce profound ontological and ethical reflections:

Why must “real” always mean ‘physical’? Is it not a real commemoration when it takes place in a virtual game world? Should players feel justified in disrupting events like these, just because the game rules do not stop them? The profoundly bipolar and irreconciliatory disagreement between the players who found the incident perfectly acceptable and even funny, and those who found it utterly distasteful suggests that sentiments and attitudes towards events in virtual environments are far from universal or developed into a common ideology, if it ever will be.

Online games are among the first intellectual tools for exploring what it means to communicate ‘in cyberspace’, and is therefore often used as a metaphor for the online social experience. In Vernor Vinge’s classic novella *True Names* from 1981, for example, a group of hackers conspire against an oppressive government via a fantasy-based online virtual world. Vinge captures very accurately the experience of future multiplayer games such as EVERQUEST (1999) as he explores the social dynamics of online game culture.

The Implied Game: The Phenomenology of the Game Object

The game object, as mentioned above, is not a material entity, but a phenomenological one. Players cannot comprehend the game object directly, and so must project or construct an ideal game object in its stead. There are several reasons for this: A game session is the result of combinatorially determined choices both on the part of the player and the game; the player cannot access a *general* play session (unlike watching a movie or reading a novel) but only *particular* ones; actions taken preclude other potential actions, etc. Still, the player is aware of playing the same game object, but never exhaustively, and thus, they cannot claim complete knowledge about an ideal game object, only that such knowledge may in principle exist. This object we may then call the ‘implied game object’.

In very simple games, such as TETRIS, the difference between the implied game object and the actual game object (the object the player actually encounters) is not great. TETRIS is an extremely simple game (like all puzzle games with very simple geometry) in the sense that it is perfectly solvable given enough time (which is what the player, increasingly, is denied). In other words, in the case of TETRIS there is almost no complexity, which means that the essence of TETRIS is revealed in virtually any particular game session. TETRIS' implied game object, then, is very close, but not identical to, the actual game object encountered by most players.

An implied game object does not exist, but is imagined by the player as what the game *is*, or ought to be. A game riddled with software bugs, for example, is perceived as merely the flawed, actual version of an uncompleted, implied game. We conceptualize the *real* game as being without the annoying bugs, and the present version as a premature, unwanted stand-in version for the real (implied) thing.

In games with a higher level of complexity, the difference between actual game object and implied game object increases. Players are aware of the partial nature of their experience, the numerous strategies and paths not taken, and the fact that the game may contain mysteries they will never encounter, solutions outside their reach, tactics beyond their skill level. The implied game contains all these secret moments that the actual game may never reveal. Even for deterministic games with simple rules, such as John Conway's Game of Life, or Chess, the complexity of massively parallel actions or mutually exclusive moves makes the gameplay practically indeterminate.

Game ontology is a necessary first step in the slow process of making sense of games and gaming. It is not possible to say anything about games without a game ontology as basis, but this simply means that unspoken, poorly conceived notions about what games are will always be an alternative to the more sophisticated ontologies of games. As this article no doubt shows, we are still scratching the surface of ludic understanding, and it does not take much imagination to predict that better ontologies will succeed the current ones.

References

Aarseth, Espen (1995): "Text, Hypertext or Cybertext? A Typology of Textual Modes Using Correspondence Analysis", Presentation at *ALLC/ACH 1995*, UC Santa Barbara, July 15.

— (1997): *Cybertext. Perspectives on Ergodic Literature*, Baltimore/London: Johns Hopkins UP.

— (2007): "Doors and Perception. Fiction vs. Simulation in Games", in: *Intermédialités* 9, 35–44.

Anderson, Craig A./Dill, Karen E. (2000): "Video Games and Aggressive Thoughts, Feelings, and Behavior in the Laboratory and in Life", in: *Journal of Personality and Social Psychology* 78/ 4, 772–790.

Björk, Staffan/ Holopainen, Jussi (2005): *Patterns in Game Design*, Hingham: Charles River.

Elverdam, Christian/Aarseth, Espen (2007). "Game Classification and Game Design. Construction Through Critical Analysis", in: *Games and Culture* 2/1, 3–22.

Juul, Jesper (2005): *Half-Real. Video Games between Real Rules and Fictional Worlds*, Cambridge/London: MIT.

Klabbers, Jan H. J. (2003): "The Gaming Landscape. A Taxonomy for Classifying Games and Simulations", in: *Level Up. Digital Game Research Conference*, ed. by Marinka Copier and Joost Raessens, Utrecht: University of Utrecht, 54–68.

Moulthrop, Stuart (1991): "You Say You Want a Revolution? Hypertext and the Laws of Media", in: *Postmodern Culture* 1/3, http://pmc.iath.virginia.edu/text-only/issue.591/moulthro.591.

Sutton-Smith, Brian (1997): *The Ambiguity of Play*, London/Cambridge: Harvard UP.

Wittgenstein, Ludwig (2001): *Philosophical Investigations*, trans. by G. E. M. Anscombe, Malden/Oxford/Carlton: Blackwell [1953].

Ziegfeld, Richard (1989): “Interactive Fiction. A New Literary Genre?”, in: *New Literary History* 20/2, 341–372.

COLOSSAL CAVE ADVENTURE (1976), Will Crowther and Don Woods, PDP-10.
THE HOWARD DEAN FOR IOWA GAME (2004), Persuasive Games, Browser.
EVERQUEST (1999), Sony Online Entertainment, PC Online.
GUITAR HERO (2005), RedOctane, Playstation 2.
KABOOM! – THE SUICIDE BOMBER GAME (2002), anonymous, Browser.
MAX PAYNE (2001), Rockstar Games, PC.
MYST (1993), Cyan Worlds, PC.
RETURN TO CASTLE WOLFENSTEIN (2001), Grey Matter, Activision, PC.
SUPER MARIO SUNSHINE (2002), Nintendo, Gamecube.
TETRIS (1985), Alexey Pajitnov (Computer-Center Moscow), Elektronika-60.
WOLFENSTEIN 3D (1992), id Software, PC.
WORLD OF WARCRAFT (2004), Blizzard Entertainment, PC Online.
ZORK I: THE GREAT UNDERGROUND EMPIRE (1980), Personal Software, Amiga.

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– "Narrative Literature in the Turing Universe", in: *The Novel,* ed. by F. Moretti, Vol. 2: Forms and Themes, Princeton 2007, 839–870 [2002].
– *Cybertext. Perspectives on Ergodic Literature,* Baltimore/London 1997.

Katie Salen

Pokéwalkers, Mafia Dons, and Football Fans

Play Mobile with Me

This paper addresses a theoretical reconfiguration of experience, a repositioning of the techno-social within the domains of mobility, games, and play, and embodiment. The ideas aim to counter the notion that our experience with videogames (and digital media more generally), is largely "virtual" and disembodied – or at most exclusively audiovisual. Notions of the virtual and disembodied support an often-tacit belief that technologically mediated experiences count for nothing if not perceived and valued as human. It is here where play in particular can be put to work, be made to highlight and clarify, for it is in play that we find this value of humanity most wholly embodied. Further, it is in considering the design of the metagame that questions regarding the play experience can be most powerfully engaged. While most of any given game's metagame emerges from play communities and their larger social worlds (putting it out of reach of game design proper), mobile platforms have the potential to enable a stitching together of these experiences: experiences held across time, space, communities, and bodies. This coming together thus represents a convergence not only of media, participants, contexts, and technologies, but of human experience itself. This coming together is hardly neat, nor fully realized. It is, if nothing else, multifaceted and worthy of further study. It is a convergence in which the dynamics of screen play are reengaged.

> Play is a structuring activity, the activity out of which understanding comes. Play is at one and the same time the location where we question our structures of understanding and the location where we develop them. (James J. Hans)

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http://pub.ub.uni-potsdam.de/volltexte/2011/4982/ [urn:nbn:de:kobv:517-opus-49824]

Three Vignettes for the Future

Tyler Luera knows a little something about the networked life of a teenager. On any given day he is a writer, designer, media producer, consumer, critic, friend – Gamer. His networks are simultaneously global and local, spanning SMS, YouTube, Twitter, Xbox Live, Yahoo email, Civilization player forums, his school's lacrosse team and the local YMCA, where he works after school. He has long known that the networks he inhabits define his access to people, resources, and ideas. He also knows that his mobile phone is the key to participation – teen salvation in a screen-sized box.

Rai and her friends Joe and Celia text each other the minute they wake, making plans to meet up to work on breaking the mathematical code they discovered yesterday hidden in the source code of a Wikipedia page of an obscure Russian poet. Each had gone home the previous evening and messaged the code across their various social networks, in the hopes that someone, somewhere, might recognize its pattern. Hundreds of their peers tweeted in response. It was now up to them to make sense of the data they'd received. Is school supposed to look like this?

Globally distributed, inter-generational teams of amateurs and experts collaborate by the thousands, the hundreds of thousands, and even the millions, to make political decisions, to solve mysteries, to create art, and to predict and forestall health pandemics, terrorist attacks, and economic crises. Participants do not simply gather, master and deploy pre-existing information and concepts. Instead, they work with the collected facts and viewpoints to actively author, discover and invent new, game-fueled ways of thinking, strategizing, and coordinating. No one knows everything, says one player. But it is almost certain that everyone knows something.

see video recording of this *DIGAREC Keynote-Lecture* on:

http://info.ub.uni-potsdam.de/multimedia/show_projekt.php?projekt_id=71#71
[urn:nbn:de:kobv:517-mms-71-205-7]

Today

Of all the transformational catalysts brought about by the rise of digital connectivity, perhaps one of the most fundamental is the ability to form groups quickly and easily. "New technology has enabled new kinds of group-forming," says Shirky, and boy does he have it right. From sites like Google Image Labeler and Meetup.com to ARGs like PERPLEX CITY (2005) and the massively-multiplayer problem-solving game FOLDIT (2008), the free and ready participation of a large, distributed group with a variety of skills has enabled a new way of thinking about what we, as humans, can do together.

Yet where the web and its widgets have ruled the enabling of groups in recent years, mobile devices in their various forms (cell phones, PDAs, mobile game platforms like the PSP and DSi, etc.) are poised to lay ubiquitous claim to the group-forming domain. Consider a few statistics: mobile technologies around the world total 4 billion subscribers, or 60% of the world's population (TomiAhonen Consulting 2009). Europe has passed 100% per capita penetration and leading countries like Hong Kong, Taiwan, Israel and Italy are past the 140% subscription rate per capita. One in four Africans has a mobile phone subscription, a statistic made possible by the sharing of one phone handset in a village among several users. Sharing anchors the creation of new groups (Shirky again).

Within social networking sites like MySpace and Facebook the total value of *mobile* social networking is twice as large as the total of internet-based online social networking. This includes networks like Flirtomatic, Itsmy, Twitter and Qik, as well as truly innovative social-mobile platforms like Japan's Mobage Town and South Korea's Cyworld Mobile (TomiAhonen Consulting 2009). Design for mobility is increasingly the design of *community*. Thus, when people go mobile, they rarely do it in order to be alone.

The design of community is the territory of game design today, and as a result requires game designers to address a theoretical reconfiguration of experience, a repositioning of the techno-social within the domains of mobility, place, play, and embodiment. Doing so may seem to run counter to the notion that our experience with videogames (and digital media more generally) is largely ‘virtual’ and disembodied – or at most exclusively audiovisual. Notions of the virtual and disembodied support an often-tacit belief that technologically mediated experiences count for nothing if not perceived and valued as *human.* It is here where play in particular can be put to work, be made to highlight and clarify, for it is in play that we find this value of humanity most wholly embodied. As Brian Sutton-Smith (2008:124) has written,

> Play is neurologically a reactive itch of the amygdala, one that responds to archetypal shock, anger, fear, disgust, and sadness. But play also includes a frontal-lobe encounter, reaching for triumphant control and happiness and pride. Play begins as a major feature of mammalian evolution and remains as a major method of becoming reconciled with our being within our present universe. In this respect, play resembles both sex and religion, two other forms – however temporary or durable – of human salvation in our earthly box.

We don’t often consider the reconciliatory function of games and play, their ability to bring together the real and imaginary, their role in our coming to be. Instead, games, like mobile media, are most often accused of placing players in a state of disembodied separation – virtually engaged rather than *real*-ly engaged. But we may have had it wrong all along. The recent blossoming of mobile technology from a down and dirty solution for workplace connectivity to an enabler of community formation and participation has the potential to reconfigure our thinking about the integrative and human nature of play and mobility.

Playful Futures

Genevieve Bell from Intel and Paul Dourish from University of California, Irvine (2008), social scientists with a particular interest in ubiquitous and mobile computing and the practices surrounding new media, began work on a paper that explored science fiction as a cultural backdrop shaping technological design. Through a comparative reading of sci-fi shows like *Dr. Who, Star Trek,* and *Planet of the Apes* and design research texts, they argued that design researchers by and large have tended to see problems of cultural context as issues to be taken up once technological infrastructure rolls out in the world. In the case of mobile gaming, for example, questions centered on secure data exchange, cross-platform compatibility, user interface design, location sensing, etc., have tended to take center stage. Questions of space, place and corporeality, embodiment and presence, on the other hand, have tended *not* to be the kinds of issues raised when mobile, as a technological infrastructure, was first dreamt up.

In imagining a technologically inscribed future it is easy to treat cultural questions as a consequence of design practice – remote questions to be later encountered – rather than questions that are *prior* to the practice itself. By way of example, Bell and Dourish ask readers to consider the provision of location-based services on handheld and portable devices, noting researchers' emphasis on the privacy implications of location monitoring. Must a device's location be reported to a central infrastructure or to other users in order to achieve localization? Through what strategies might users take control of this information and its reporting? While Bell and Dourish agree that such questions are important, they point out that the questions already prespecify certain relations, namely decision-making occurring in the context of commercial exchange with a service provider. As they note, questions

> of individuality and the nature of one's relationships to others, to commercial entities, and to states, and questions of responsibility for ensuring the accuracy, provenance, and protection of data, and questions of the rights to particular forms of spatial representation are *already figured* by a technological solution. (Bell/Dourish 2008:12)

Thus, it is critical to recognize that any description of a technology is already social and cultural (Ito et al. 2006). The questions that have grown up around screen media, games, and mobile technology broadly are ones that arise not in the deployment of technologies but in the imagining of them – an imagining that arises *before* design. According to Bell and Dourish (2008:12)

> Social and cultural forces do not merely come into play after a technology has been deployed, shaping its diffusion and appropriation; rather, social and cultural are already thoroughly implicated in how a technology is imagined and designed.

Thinking about mobile gaming in an age of web 2.0, then, requires a deep understanding of the kinds of social and cultural futures caught up in mobile technology's original imagining. It requires that explicit attention be paid not only to the ways in which mobile play comes to be embedded in society, but also to play as a force shaping the very imagining of a mobile society itself.

Play

It is worth spending a few moments on the topic of play, as it is the engine that drives the design of games and increasingly, the design of groups and therefore of communities. Play arises from the design of rules, which organize player action. Think of a child walking down the sidewalk, zigzagging along, stopping and hopping as she encounters a sidewalk crack. Play arises as the child follows a rule that demands she not step on a crack (for fear of breaking her mother's back!). When rules are combined in specific ways, they create forms of activity for players called play. Play is therefore an emergent property of rules: rules combine to create behaviors that are more complex than their individual parts (Salen/Zimmerman 2003).

During play, action is both stylized and limited in ways that encourage a pushing against the rules. As philosopher James S. Hans (1981:5) notes: "The role of play is not to work comfortably within its own structures but rather constantly to develop its structures through play." – Play requires rules but constantly seeks its own release. Players explore the limits of the system not only in order to perform within it, but also in an attempt to transform it.

The transformative nature of play must therefore be part of any imagining about the current and future state of mobile gaming. This imagining, popular within mobile game development communities, includes an envisioning of a technological apparatus linked to the production of media objects and experiences. In a recent presentation on the future of mobile games, for example, Nokia executive VP Tero Ojanpera estimated that there are more than one billion people worldwide who will first access the Web through a mobile phone (Leigh 2009). As a result of this speculation, games that integrate their play with web-based features like location information and media libraries (image, music, video) on the phone have become a core focus for Nokia. An mobile game called DANCE FABULOUS (2009) combines music, dance and game elements by allowing users to play along to their music library. Another game turns user-generated photos of streets into racecourses for a driving game where players can race against each other. In both of these examples, the design of mobile games arises out of a technological imagining valuing the shared storage of media on a single mobile device. Transformative play is linked to the language of code, operating as a baseline strategy for remixing media assets in ways that aspire to give them new meaning.

Handheld gaming king Nintendo, on the other hand, roots its transformative mobile imaginings in the physical world. A new peripheral device for the DS and DSi called the 'Pokéwalker' – soon to be seen being clutched in the small sweaty hands of POKÉMON HEARTGOLD- and SOULSILVER (2010)-players – links physical movement to digital game play. As players take to the sidewalks they can "train" one of their digital Pokémon, earning experience points for each step taken. The device, which resembles a Pokéball, interfaces wirelessly with Nintendo DS infrared and converts footsteps into "watts," which can be used to catch wild Pokémon and find items as part of the play. The Pokéball locates the transformative nature of play in the bodies of participants, linking an expenditure of energies across physical and virtual space.

Both the Pokéwalker, which fits into an emerging genre of games called exergames, and media mix games like *Dance Fabulous* rely on social and cultural practices implicated in mobile technology's early design. The imagining of lightweight, feature-laden mobile phones that could be accessed anytime anyplace, for example, was also an imagining of communication across far-flung, multiple, and partial communities with physical and digital dimensions (Ito et al. 2006). "It is time to consider a new era," wrote Howard Rheingold (2002), "how the peripatetic mobile users of the Internet communicate with the members of their social networks and communities". Then, as now, communication was seen as a central feature of how social life in a mobile world would be supported (Taylor 2006).

This vision continues to play out in the kinds of mobile games and mobile social applications being produced today. Puma's *Together Everywhere*-campaign, which ran during the Euro 2008 Championship, brought together supporters of the 16 national teams in real time. Fans could sign up for a service that would immediately place them in a mobile teleconference with ten of their friends each time their favorite team scored. Perhaps to extend the odds that the conversations moved beyond screams of "Goooooooooooooal!," and "F***ing amazing, man," the service also allowed fans to connect with ten anonymous supporters of their national team chosen at random.

To what extent fans were able to game the system by using the calls to save minutes they would have otherwise spent on non-football related conversation might never be known (Two fans I spoke with were non-committal on the subject.) But the mobile campaign is a good example of the growing importance of linking design with the social life of a game. Game studies researchers Nick Yee (2008) and T.L. Taylor (2006) have both pointed out that players within connected, multiplayer game spaces are social laborers and act as central productive agents in game culture. Mobile-enabled participatory experiences like Together Everywhere thus highlight a shift in thinking about where the site of mobile game design resides. Is it on the device? In the data tracked and stored? In the community that rises up around the game? In the players? The answer is all of these, and more.

The Social Life of Games

Designers of fantasy role-playing games like *Dungeons & Dragons* and *Magic: The Gathering* first modeled an approach to game design that took into account a game's relationship to outside elements – player attitudes, play styles, social reputations, social contexts, and so forth. Kids pouring over *Pokémon*-strategy guides or discussing the configuration of their decks are taking part in activities considered part of the 'metagame', a term that refers to the way a game engages with elements outside its formal space of play. DROP 7 (2008)-iPhone players who play *Sudoku* on the subway home as a way to hone their in-game skills are engaged in DROP 7's metagame, as are the four DS-equipped ten year-olds who trash-talk each other during a networked round of MARIO KART (2005).

Understanding how to design for the metagame is a key consideration for game designers generally, but is of special significance for those designing mobile games today. The connected, collaborative, physically-enabled, context-sensitive, and above all social nature of mobile plus web makes this platform combo especially suitable for metagame-rich experiences. It is difficult, in fact, to imagine a platform *more* suited to the design of game experiences that span physical and virtual space, leverage the social labor of players in ways that reinforce and extend the game experience, allow players to easily form distributed groups for synchronous and asynchronous participation, and generate, store, track, and visualize data in ways that improve player performance within the game. It sounds almost too good to be true, which is part of the rub. Mobile games with meaningful metagames are difficult to design – to date there are only a handful of examples to look to (e.g. BOTFIGHTERS (2001), MAFIA WARS (2009), LINE RIDER IRIDE (2008), or the numerous TEXAS HOLD'EM variants) and even fewer that have enjoyed a strong commercial release. Design for the metagame requires that one understand that the play of the game occurs within an ecology of experiences, only a subset of which can be anticipated in advance.

In an essay titled "Metagames," written for *Horsemen of the Apocalypse. Essays on Roleplaying*, game designer Richard Garfield presents a useful model for thinking about metagames. In it, he defines metagame as the way in which "a game interfaces outside of itself." Within this definition, Garfield (2000) argues that the following four categories make up a metagame framework:

1. What a player brings *to* a game
2. What a player takes away *from* a game
3. What happens *between* games
4. What happens *during* a game other than the game itself

To: What a Player Brings to a Game

Players always bring something to a game, sometimes in tangible form and sometimes not. For example, players of many location-based games bring with them phones with specific capabilities: camera, Internet connectivity, Bluetooth, video, email, messaging, and so forth. The phones often contain software that functions like a piece of equipment in the game, as when a player brings a ball and bat to a pick-up game of baseball. This software might be a Nokia product like *Friendview* or *Upcode*, an iPhone app like *QR Code Reader*, or a custom piece of software like *7Scenes*, a GPS platform for mobile games developed by the Waag.

Today's mobile-savvy players bring social media tools with them as well – Twitter, Facebook, Google Talk – which they can use in any number of ways before, during, or after a game to exchange information, socialize, document, or even cheat. These same players also bring membership in various online and offline communities, reputations, status and a variety of other social attributes that can influence their interactions with others during the play of the game.

A player usually has some level of choice in what to bring to a game, though some resources are mandatory: no GPS-enabled device, no geocaching. The selection of resources for a game is a process that players often enjoy. Consider the number of hours iPhone aficionados spend curating their collecting of apps.

While this category of "To" might seem very broad, Garfield organizes what players bring to a game into the following way:

1. *Game Resources* refers to necessary game components, such as a certain model of Smartphone, a data plan, QR codes, or even physical reflexes.
2. *Strategic Preparation or Training* includes studying an opponent's playing style or memorizing levels.

3. *Peripheral Game Resources* refers to optional elements like game guides, cheats, and knowledge of play patterns. These resources are often created and shared among a game community, either through 'official' channels or unofficial ones, such as fan sites.
4. *Player Reputation* is the final category of what players bring to a game, and is often not voluntary. Are you known to bluff, collaborate well, or take advantage of weaker players?

From: What a Player Takes Away from a Game

Players always take something away from a game. It is not uncommon, for example, to play a game for some kind of *stakes.* Winning a stakes game might mean taking away something quantitative, like prize money or standings in a formal competition, or the stakes might be something less tangible, like gloating rights or social status among a group of players. Sometimes, a player takes something away after just a single game. Other times, victory might emerge from a series of games: *best two out of three.* Large-scale tournaments can span weeks, and many mobile games that have an ARG component, for example, can span months. The seriousness with which players take a game is affected by how much the current game affects another game, particularly within a ladder structure or other organized contest. This aspect of the metagame can have a strong positive or negative influence on player attitude and performance (Salen/Zimmerman 2003).

Players also take things away from a game unrelated to the stakes, such as the *experience* of the game itself. A player's experience might serve to validate or contradict their beliefs about an opponent or about the game as a whole, thereby influencing future games. Crafting play experience into a narrative, a player can also take away the story of the game: the way victory was seized from the jaws of defeat (or vice versa), spectacularly good or bad moves, the bizarre occurrences that happened during the course of play. *I can't believe how long it took to capture that darn semacode!* Certain mobile games, like those developed by Blast Theory, often make a retelling of a game experience an explicit part of the game. Of course, players can also take away *resources* for future games, whether it is the knowledge about how the game works, an Inbox full of SMS messages that can be studied like a strategy guide, membership in a team, or an archive of images that can be reused in a future round of play.

Between: What Happens Between Games

The space between games is filled with many overlapping metagame activities that can add value to the core play experience. For many players, the activities that take place between games can be as important as what happens during a game. Players commonly reflect on strategy, training, or planning for the next game. *I've got to build a better team next time.* Planning what to bring to the next game, whether that involves studying a game map, upgrading a data plan, or planning a new play strategy, are all-important between-game activities. But not everything that happens between games is a solitary pursuit. Because of the networked status of most players today, metagaming will likely include players pouring over status updates on Facebook, Tweeting, and texting each other about what happened last game, spreading stories, and building reputations.

During: What Happens During a Game Other than the Game Itself

This category of the metagame is quite diverse, and refers to the influence of real life on a game in play. There are many factors external to a game, which enter into the experience of play, factors that are always present and often quite powerful. Among the ways that the metagame occurs during play are social factors such as competition and camaraderie, or the physical environment of play such as bad cell phone reception, temperamental software, or a Bluetooth cluttered Starbucks. Trash talking, playing "head games," and exploiting player reputations all affect the metagame as well. Because so much of mobile play lends itself to documentation within social media tools, player reputations can rise and fall in real time, in often very public ways. A player of MAFIA WARS that tries to distract an opponent via a Twitter stream of vociferous insults is playing the metagame, although perhaps not in the most sportsmanlike of ways. Players within the community may choose to speak out against this type of play. When they do, they too are participating in an aspect of the metagame.

Conclusion

> Play consisted of ideas, not just of actions; it became something inside my head, something subjective, something that forever afterward affected my existence in peculiar but positive ways (Sutton-Smith 2008:84).

It is in considering the design of the metagame in the age of mobility that the question of the reconciliatory function of games and play is perhaps most powerfully engaged. While most of any given game's metagame emerges from play communities and their larger social worlds (putting it out of reach of game design proper), mobile platforms have the potential to enable a stitching together of these experiences: experiences held across time, space, communities, and bodies. This coming together thus represents a convergence not just only of media, participants, contexts, and technologies, but of human experience itself. This coming together is hardly neat, nor fully realized. It is, if nothing else, multifaceted and worthy of further study. It is a convergence in which the dynamics of digital play are reengaged.

References

Ahonen, Tomi T./Moore, Alan (2009): *Communities Dominate Brands. Business and Marketing Challenge for the 21st Century*, http://communities-dominate.blogs.com/brands/2009/02/bigger-than-tv-bigger-than-the-internet-understand-mobile-of-4-billion-users.html.

Alexander, Leigh (2009): "GDC. Nokia's Ojanpera Talks Mobile Gaming's Future", http://www.gamasutra.com/php-bin/news_index.php?story=22886.

Bell, Genevieve/Dourish, Paul (2008), "'Resistance is Futile'. Reading Science Fiction alongside Ubiquitous Computing", http://www.dourish.com/publications/2009/scifi-puc-draft.pdf.

Garfield, Richard (2000): "Metagames", in: *Horsemen of the Apocalypse. Essays on Roleplaying*, ed. by J. Dietz, Sigel: Jolly Roger Games, 16–22.

Hans, James S. (1981): *Play of the World*, Boston: Massachusetts UP.

Ito, Mizuko/Okabe, Daisuke/Matsuda, Misa (Ed.) (2005): *Personal, Portable, Pedestrian. Mobile Phones in Japanese Life*, Cambridge/London: MIT.

Rheingold, Howard (2002): *Smart Mobs. The Next Social Revolution*, Cambridge: Basic Books.

Salen, Katie/Zimmerman, Eric (2003): *Rules of Play.* Cambridge/London: MIT.

Shirky, Clay (2008): *Here Comes Everybody. The Power of Organizing without Organizations*, London/New York et al.: Penguin.

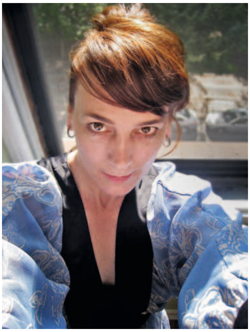
Sutton-Smith, Brian (2008): "Play Theory: A Personal Journey and New Thoughts", in: *American Journal of Play* 1/1, 82–125.

Taylor, T. L. (2006): *Play between Worlds. Exploring Online Game Culture.* Cambridge/London: MIT.

Yee, Nick (2008). “Maps of Digital Desires. Exploring the Topography of Gender and Play in Online Games”, in: *Beyond Barbie and Mortal Kombat. New Perspectives on Gender and Gaming*, ed. by Y. Kafai, C. Heeter, J. Denner and J. Sun, Cambridge/London: MIT, 83–96.

BOTFIGHTERS (2001), Digiment Games,
Mobile Phones (Wireless Java).
DANCE FABULOUS (2009), Nokia, N-Gage.
DROP 7 (2008), Area/Code Entertainment, iPhone.
FOLDIT (2008), University of Washington, Transmedia.
LINE RIDER IRIDE (2008), Jonathan Bettis, iPhone.
MAFIA WARS (2009), Zynga, Facebook.
MARIO KART DS (2005), Nintendo, Nintendo DS.
PERPLEX CITY (2005), Mind Candy, Transmedia.
POKÉMON HEARTGOLD AND SOULSILVER (2010),
Nintendo, Nintendo DS.

Biography



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– *The Game Design Reader. A Rules of Play Anthology*, ed. by K. S. and Eric Zimmerman, Cambridge/London 2005.
– *Rules of Play. Game Design Fundamentals* (with Eric Zimmerman), Cambridge/London 2003.

Laura Ermi, and Frans Mäyrä

Fundamental Components of the Gameplay Experience

Analysing Immersion

Introductory Note

This co-authored paper is based on research that originated in 2003 when our team started a series of extensive field studies into the character of gameplay experiences. Originally within the *Children as the Actors of Game Cultures* research project, our aim was to better understand why particularly young people enjoy playing games, while also asking their parents how they perceive gaming as playing partners or as close observers. Gradually our in-depth interviews started to reveal a complex picture of more general relevance, where personal experiences, social contexts and cultural practices all came together to frame gameplay within something we called game cultures. Culture was the keyword, since we were not interested in studying games and play experiences in isolation, but rather as part of the rich meaning-making practices of lived reality.

In retrospect, our analysis of immersion has maintained much of its significance, and I must again thank my co-author Laura Ermi, who as a trained psychologist also was the main author during the construction of research instruments and in the analysis of our findings. I personally profited not only by learning immensely from Laura, but also from the interdisciplinary team work that later led us to study casual games and gamers, as well as social games played on Facebook and elsewhere. This was also a direction that best reveals the inevitable limitations of the present paper.

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http://pub.ub.uni-potsdam.de/volltexte/2011/4983/ [urn:nbn:de:kobv:517-opus-49831]

Not all players and game experiences are as powerfully oriented towards immersion as the others; this is something that we already hint at the end of the paper as we discuss THE SIMS 2 as proving to be a less immersive game than some others. Yet, apparently this game was much preferred and enjoyed by some players, probably in part because of its playful and casual, toy-like characteristics. Therefore, strong immersion cannot be directly equated with a 'good game experience', even while it might mean a 'powerful game experience'. As the game takes complete hold of a player's faculties – of their mind and hands as well as imaginations – it inevitably also blocks off certain other directions. Particularly in social situations a less immersive game might be preferred, so that it is possible to divide attention to social interactions with other people, in addition to the stimulus provided by the game. The model presented in this paper can nevertheless be used to understand and evaluate how the different elements in more casual games also involve a degree of (casual) gameplay challenge, an incentive for imagination and some sensory attractions.

After this work was first published in 2005, I have developed a more comprehensive view into how games can be approached within a wider setting of cultural, societal and intellectual contexts in my book *An Introduction to Game Studies. Games in Culture* from 2008. A key distinction in that book relies on the dual structure model: the 'surface' of digital games as digital audiovisual media is equally as important for understanding games and gameplay experiences, as the 'core gameplay' which is at the heart of playful interaction. This is effectively a continuation of the SCI-model presented in this paper, as it builds upon the ontological differences between challenge, which is at the core of playful action, and visual, auditive and fictional elements that relate to everything else that frames these challenges into certain kinds of experiences. Game experiences differ on the basis of

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http://info.ub.uni-potsdam.de/multimedia/show_projekt.php?projekt_id=72#72
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these relationships: sometimes the gameplay becomes the focus of our attention, sometimes it is the fictional universe in which the game is situated, sometimes it is the graphic splendour that emerges as the real reason why we play a particular game. None of them is worse than another. Games are what we make out of them – what we do with them, what we think about them, speak about them, and even the ways in which we approach them in scholarly practice have an effect of how the meaning and experience of games becomes constructed.

Wishing you all productive gaming

Frans Mäyrä – Tampere, May 31, 2010

Introduction: Players, Experiences and Fun

There has been a relative boom of games research that has focused on the definition and ontology of games, but its complementary part, that of research into the gameplay experience, has not been adopted by academics in a similar manner. This is partly due to the disciplinary tilt among the current generation of ludologists: a background in either art, literary or media studies, or in the applied field of game design, naturally leads to research in which the game, rather than the player, is the focus of attention. Yet, the essence of a game is rooted in its interactive nature, and there is no game without a player. The act of playing a game is where the rules embedded into the game's structure start operating, and its program code starts having an effect on cultural and social as well as artistic and commercial realities. If we want to understand what a game is, we need to understand what happens in the act of playing, and we need to understand the player and the experience of gameplay. In this chapter, we discuss the ways in which the gameplay experience can be conceptualized, provide a model that organizes some of its fundamental components, and conclude with an assessment of the model with some directions for further research.

Human experience in virtual environments and games is made of the same elements as all other experiences, and the gameplay experience can be defined as an ensemble made up of the player's sensations, thoughts, feelings, actions, and meaning-making in a gameplay setting. Thus it is not a property or a direct cause of certain elements of a game but something that emerges in a unique interaction process between the game and the player. It has also been suggested that games are actually more like artifacts than media (Hunicke et al. 2004). Players do not just engage in ready-made gameplay, but also actively take part in the construction of these experiences: they bring their desires, anticipations and previous experiences with them, and interpret and reflect the experience in that light. For example, a certain gameplay session might be interpreted as fun, challenging, and victorious until one hears that a friend of the player reached a better score effortlessly, after which it might be reinterpreted as closer to a waste of time. Experiences are also largely context dependent: the same activity can be interpreted as highly pleasant in some contexts but possibly unattractive in other kinds of settings (Blythe/Hassenzahl 2003). The social context is central to gameplay experiences, which was also illustrated by the example above.

Looking at the discourses of current digital game cultures, 'gameplay' is used to describe the essential but elusive quality defining the character of a game as a game, the quality of its 'gameness.' In their book on game design, Rollings and Adams (2003:199) decline to define the concept because, according to them, gameplay is "the result of a large number of contributing elements". Yet, anyone who plays games long enough will form their own conception of bad or good gameplay on the basis of their experience. This experience is informed by multiple significant game elements, which can be very different in games from different genres, as well as by the abilities and preferences of the players. This starting point can further be illustrated by a quote from Chris Crawford (1982:15):

> I suggest that this elusive trait [game play] is derived from the combination of pace and cognitive effort required by the game. Games like TEMPEST have a demonic pace while games like BATTLEZONE have far more deliberate pace. Despite this difference, both games have good game play, for the pace is appropriate to the cognitive demands of the game.

This definition actually translates gameplay into a particular balanced relation between the level of challenge and the abilities of the player. Challenge consists of two main dimensions, the challenge of speed or 'pace' and 'cognitive challenges.' The quality of gameplay is good when these challenges are in balance with each other, and what the appropriate balance is obviously depends on the abilities of the player. On the other hand, one of the most influential theories of fun and creative action, the flow theory by Mihaly Csikszentmihalyi (1991), identifies the 'flow state' as a particularly successful balance of the perceived level of challenge and the skills of the person. In this highly intensive state, one is fully absorbed within the activity, and one often loses one's sense of time and gains powerful gratification. Digital games are generally excellent in providing opportunities for flow-like experiences since the challenges they present are often gradually becoming more demanding, and thus players end up acting at the limits of their skills. In addition, the feedback given to the player is immediate. The activity of playing a game is a goal in itself.

People play games for the experience that can only be achieved by engaging in the gameplay. In other words, a game's value proposition lies in how it might make its players think and feel (Lazzaro 2004), and 'fun' is the ultimate emotional state that they expect to experience as a consequence of playing (Bartle 2004). Expectations and enjoyment are shaped by the schemas that players have. A player can, for example, recognize the genre of a game by observing various genre-typical details and then use her schema of that genre to interpret those details (Douglas/Hargadon 2000). Brown and Cairns (2004) have noted that players choose games they play according to their mood, and it is to be expected that people especially seek games that elicit optimal emotional responses or response patterns (Ravaja et al. 2004). Thus, when choosing to play a certain game, one might anticipate it to create certain types of experiences.

However, fun and pleasure are complex concepts. Playing games does not always feel fun: on the contrary, it quite often appears to be stressful and frustrating. Experiences that are usually classed as unpleasant can be experienced as pleasurable in certain contexts (DeJean 2002). So, what makes, for example, failing fun? Klimmt (2003) has applied Zillmann's excitation transfer theory and proposed that the suspense, anxiety and physical arousal elicited by playing are interpreted as positive feelings because players anticipate a resolution and a closure such as winning the game or completing the task. When players manage to cope with a given situation successfully, the arousal is turned into euphoria, and the players experience this kind of cycle of suspense and relief as pleasurable. Klimmt has constructed a three-level model of the enjoyment of playing digital games, the first level of which consists of the interactive input-output loops, the second of cyclic feelings of suspense and relief, and the third is related to the fascination of a temporary escape into another world.

Grodal (2003) regards digital games as a distinctive medium because they allow what he calls "the full experiential flow" by linking perceptions, cognitions, and emotions with first-person actions. The player must have and develop certain skills, both motor and cognitive, in order to engage in gameplay. It is widely acknowledged that digital gameplay experiences are based on learning and rehearsing (Gee 2003, Koster 2005), and according to Grodal (2003) it is the aesthetic of repetition that characterizes the pleasures of gameplaying. In the first encounter with a new game, the player experiences unfamiliarity and challenge and starts to explore the game. After enough effort and repetitions, the player can get to a point where they master the game, and game playing eventually reaches the point of automation and does not feel as fun any longer. Thus, games can be considered as puzzles that the players try to solve by investigating the game world (Newman 2004).

When playing games, it is not enough to just sit and watch and possibly activate some cognitive schemas. Instead, the player must become an active participant. When successful, this type of participation leads to strong gameplay experiences that can have a particularly powerful hold on the player's actions and attention. This basic character of gameplay becomes even clearer when we study the way immersion is created in playing a game.

Immersion as a Component of the Gameplay Experience

Pine and Gillmore (1999) have categorized different types of experiences according to two dimensions: participation and connection. The dimension of participation varies from active to passive participation and the dimension of connection varies from absorption to immersion. Absorption means directing attention to an experience that is brought to mind, whereas immersion means becoming physically or virtually a part of the experience itself. Four realms of experience can be defined with these dimensions: entertainment (absorption and passive participation), educational (absorption and active participation), aesthetic (immersion and passive participation) and escapist (immersion and active participation). In terms of this categorization, gameplay experiences can be classified as escapist experiences, where in addition to active participation, immersion also plays a central role.

Furthermore, the concept of immersion is widely used in discussing digital games and gameplay experiences. Players, designers, and researchers use it as well, but often in an unspecified and vague way without clearly stating to what kind of experiences or phenomena it actually refers. In media studies, the concept of "presence" has been used with an aim to assess the so-called immersivity of the system. There are different ways to define the sense of presence, but on the whole, the concept refers to a psychological experience of non-mediation, i.e. the sense of being in a world generated by the computer instead of just using a computer (Lombard/Ditton 1997). As immersion can be defined as "the sensation of being surrounded by a completely other reality […] that takes over all of our attention, our whole perceptual apparatus" (Murray 1997:98) immersion and presence do not actually fall very far from each other, and are in fact often used as synonyms. However, since the term 'presence' was originally developed in the context of teleoperations it also relies heavily on the metaphor of transportation. In the context of digital games, we prefer using the term "immersion," because it more clearly connotes the mental processes involved in gameplay.

It is often taken for granted that a bigger screen and better audio quality equal greater immersion (Newman 2004). It is of course likely that the audiovisual implementation of the game has something to do with immersive experiences, but it is by no means the only or even the most significant factor. McMahan (2003:69) has listed three conditions to be met in order to create a sense of immersion in digital games: the conventions of the game matching the user expectations, meaningful things to do for the player, and a consistent game world. Genre fiction encourages players to form hypotheses and expectations and, according to Douglas and Hargadon (2000), pleasures of immersion derive from the absorption within a familiar schema. On the other hand, meaningful play as defined by Salen and Zimmerman (2004) occurs when the relationships between actions and outcomes are both discernable and integrated. Discernability indicates letting the player know what happens when they take action, and integration means tying those actions and outcomes into the larger context of the game. And just like any manipulation, acting in the game world requires relevant functionality and ways to access this functionality (i.e., usability) (Hassenzahl 2003). Thus, the audiovisual, functional, and structural playability as defined by Järvinen, Heliö and Mäyrä (2002) can be seen as prerequisites for gameplay immersion and rewarding gameplay experiences. On a very basic level, it can be argued that it is the basic visual-motor links that enable experiences of immersion even in games in which the graphics are not very impressive (Klimmt 2003, Grodal 2003). The increasing demand on working memory also seems to increase immersion (Gee 2003). For example, an increase in the difficulty level may cause an increase in the feeling of presence (Douglas/Hargadon 2002).

Brown and Cairns (2004) have presented a classification that categorizes immersion into gameplay in three levels of involvement. Ranging from "engagement" via "engrossment" to "total immersion," their model is useful in pointing out how the amount of involvement may fluctuate. However, this approach nevertheless fails to adequately respond to the qualitative differences between different modes of involvement, which is also apparent in the clear individual preferences different players have in different game types or genres. Brown and Cairns see total immersion as a synonym for presence. They agree that immersion seems to have many common features with flow experiences. However, in the context of digital games flow-like phenomena seem only to be fleeting experiences, which in turn suggests that they are something different from flow as traditionally conceived. Thus, the flow-like experiences related to gameplay could be called "micro-flow" (Blythe/Hassenzahl 2003) or "gameflow" (Järvinen et al. 2002), for example.

Funk, Pasold and Baumgardner (2003) have created a gameplay experience questionnaire in order to investigate the effects of exposure to fantasy violence. They developed a measure that concentrates on what they call "psychological absorption", but does not differentiate between different kinds of gameplay experiences even though the theoretical model presented suggests that there are at least two kinds of experiences: absorption and flow. We argue that in order to understand what games and playing fundamentally are, we need to be able to make qualitative distinctions between the key components of the gameplay experience, and also relate them to various characteristics of games and players. In this chapter, we approach immersion as one of the key components of the gameplay experience and analyze its different aspects.

The Attractions of Digital Games

The starting point of our research was the twofold perspective we gained in 2003 while interviewing Finnish children who actively played digital games alongside with their parents, who mostly did not play such games themselves (Ermi et al. 2004). The parents expressed concern because they thought that their children became too intensely emotionally immersed, or too involved with the game fiction, while playing. They agreed with the common conception that it was particularly the realistic and high-quality graphics and audio of contemporary games that explained their immersive powers. In contrast, the children thought that the emotional immersion and involvement in fiction was typically stronger for them while reading a good book or while watching a movie. They emphasized the role of the characters and storylines in this kind of experience, while they also acknowledged often becoming immersed in games, but in different ways than in literature or cinema, in which emotional identification or engrossment was more common for them than in games.

> Well, you immerse yourself more into a book, I think. I don't know many reasons for that, but at least I lose myself more into books than in games. In games I usually only just play, or then I sort of follow the plot, but in books it is kind of more exciting, because

> the plot is the main part, and in games the main part is moving things yourself and such, in games the plot is just secondary. (Boy, 12 years)
>
> When discussing games, children stated that the main difference between games and novels or movies was the games' interactivity: the opportunity to make decisions, take actions, and have an effect on the gameplay. Some of them also considered this to be the most immersive aspect of games. In movies I do not identify with the main character at all. I just watch what he does. But in a book, if I read about the actions of some main character, then I identify with him as I would be the character myself. Or at least I immerse myself more into it. But in a game you immerse yourself most of all, because you actually do things with that guy, with that character, most of all. (Boy, 11 years)

Another thing that clearly separated children's experiences with games from their experiences with books and movies was the social quality of gameplay. Children often played together with their friends and siblings, and games were notable discussion topics on schoolyards etc.

> When in it [a book] you can go and figure with your own brain like, ok, now it [the character] is doing this and that. [...] Yes it [a game] is a bit different, as you can say to your friend that hey, look this is doing this and that, but in books you cannot really, because you are not reading with your friend. (Girl, 10 years)

As we were curious about these different ways of perceiving game "immersion," we studied the responses further and analyzed the children's accounts of playing games and the different holding powers they had recognized in games in order to shed some light on the structure of the experience.

In the light of the interviews, the pleasures of gameplay derive from several different sources (Ermi/Mäyrä 2003); see Figure 1. According to the children, the *audiovisual quality and style* was one of the central aspects of good digital games. For example, good-looking graphics could make the game more appealing, and well-functioning camera angles were associated with good playability. However, children perceived game aesthetics in different ways. Some of them especially liked cartoon style graphics, whereas others felt they were too childish and preferred as realistic looking graphical style as possible.

Children also analyzed the various ways in which the *level of challenge* was balanced in games quite carefully.

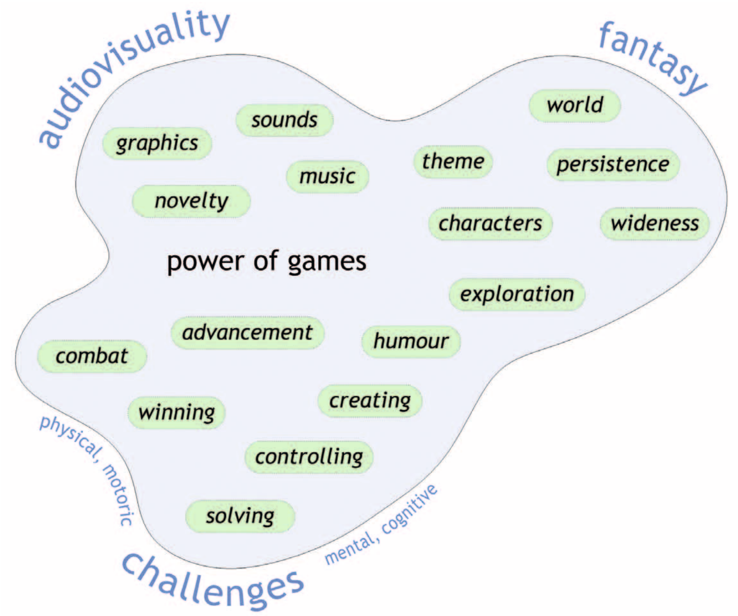

Fig. 1: Elements Related to Pleasurable Gameplay Experiences that Emerged in the Interviews with the Children (Ermi/Mäyrä 2003)

The pleasure derived from playing was strongly related to experiences of succeeding and advancing, and uncertainty of the final outcome was an important factor in the overall suspense of playing. The challenges of gameplay seemed to be related to two different domains: to sensomotor abilities such as using the controls and reacting fast, and, secondly to the cognitive challenges. Even though pure puzzle games were not very popular, children liked games in which problem solving was an integral part of the storyline or adventure of the game.

Thirdly, children considered *imaginary world and fantasy* to be central in many games. For them, the game characters, worlds and storylines were central elements of the games they liked to play. One important aspect of the imaginary worlds was that children could do things in them that were not possible or even acceptable in their everyday lives, for example beating up a policeman or having two children living in a big house without any adults. After analyzing these observations, we followed the principles of grounded theory approach to create a theory that accounted for the findings.

A Gameplay Experience Model

Our research suggests that the gameplay experience and immersion into a game are multidimensional phenomena. The issue here is not that parents would have drawn the wrong conclusions while observing their child's playing, or that the children themselves would not be able to understand their own immersion experiences. Rather, the answer is that immersion is a many-faceted phenomenon with different aspects that can appear and be emphasized differently in the individual cases of different games and players.

In the gameplay experience model presented here (abbreviated as SCI-model, on the basis of its key components; see Fig. 2), gameplay is represented as interaction between a particular kind of a game and a particular kind of a game player. Our model is a heuristic representation of key elements that structure the gameplay experience.

It is not intended to constitute a comprehensive analysis, but rather designed to guide attention to the complex dynamics that are involved in the interaction between a player and a game. The complex internal organization of a "game" and a "player" in particular are left schematic here, as the focus is on the consciousness structured by the interplay, rather than on an analysis of games or players in themselves. The gameplay experience can be perceived as a temporal experience, in which finally the interpretation made by the player also takes into account other information such as peer influence, game reviews, and other frames of sociocultural reference.

The first dimension of a gameplay experience that we distinguish is the *sensory immersion* related to the audiovisual execution of games. This is something that even those with less experience with games – like the parents of the children that were interviewed – can recognize: digital games have evolved into audiovisually impressive, three-dimensional and stereophonic worlds that surround their players in a very comprehensive manner. Large screens close to player's face and powerful sounds easily overpower the sensory information coming from the real world, and the player becomes entirely focused on the game world and its stimuli.

Another form of immersion that is particularly central for games, as they are fundamentally based on interaction, is *challenge-based immersion*. This is the feeling of immersion that is at its most powerful when one is able to achieve a satisfying balance of challenges and abilities. Challenges can be related to motor skills or mental skills such as strategic thinking or logical problem solving, but they usually involve both to some degree.

In several contemporary games the worlds, characters and story elements have also become very central, even if the game would not be classifiable as an actual role-playing game. We call this dimension of game experience, in which one becomes absorbed with the stories and the world, or begins to feel for or identify with a game character, *imaginative immersion*. This is the area in which the game offers the player a chance to use their imagination, empathize with the characters, or just enjoy the fantasy of the game.

For example, multi-sensory virtual reality environments such as CAVE (Cruz-Neira et al. 1992), or just a simple screensaver, could provide the purest form of sensory immersion, while the experience of imaginative immersion would be most prominent when one becomes absorbed in a good novel. Movies would combine both of these. But challenge-based immersion has an essential role in digital games since the gameplay requires active participation: players are constantly faced with both mental and physical challenges that keep them playing. Since many contemporary digital games have richer audiovisual and narrative content than, for example, classic *Tetris*, these three dimensions of immersion usually mix and overlap in many ways. In other words, the factors that potentially contribute to imaginative immersion (e.g., characters, world, and storyline) are also apparent in the interaction design (e.g., goal structures) and the audiovisual design (how goals, characters and, the world are represented and perceived) of well-integrated game designs.

The overall significance of a game for a player can be greater than the sum of its parts. In our model, 'meaning' is the part through which a player makes sense of their play experience and constructs their interpretation of the game against the backdrop of the various personal and social contexts of their life. Thus it relates to the traditions of pragmatics, phenomenology, and cultural studies as much as to that of semiotics or psychology in a conceptual sense. The contexts of a gameplay experience also include factors such as who the player is (in terms of the rich complexities of personal histories), what kind of previous experience they have with this game or game genre, and how cultural and social factors affect the role games have in their life in more general terms. In addition, situational contexts can have a decisive role in structuring the experience: Who is the game played with? Is there a specific reason to play this game right at that moment? Is the player playing to vent frustrations, for example, or is the significance of this gameplay in the shared moments with friends? All these various contextual factors have their distinctive roles in the interpretation of an experience and are therefore included in the model.

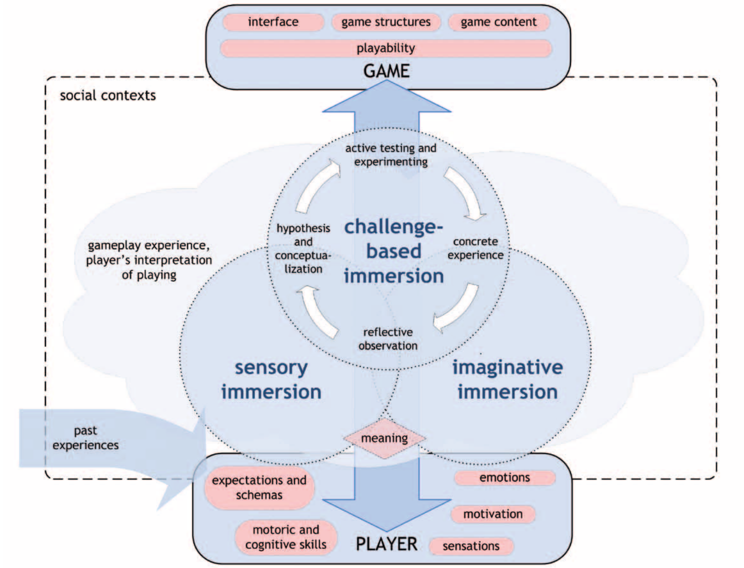

Fig. 2: SCI-Model Identifies the Three Key Dimensions of Immersion that are Related to Several Other Fundamental Components, which Have a Role in the Formation of the Gameplay Experience

The Gameplay Experience Model in Practice

After creating the model, we were interested to find out how the different aspects of immersion actually appear in contemporary digital games. We constructed a questionnaire that initially consisted of thirty statements addressing the three aspects of gameplay immersion and responses given on a 5-point Likert scale. In March 2005, we invited players of certain popular games to evaluate their experiences of these games. The respondents were recruited from among thousand Finnish participants that had filled in another game-related online questionnaire. The games were chosen on a twofold basis: on one hand, we had to pick games that were played among the informants and on the other hand, we tried to cover as wide a range of different kinds of game genres as possible. The games and the amount of the completed gameplay experience self-evaluation questionnaires are shown in Fig. 3.

WORLD OF WARCRAFT (2004)	35
HALF-LIFE 2 (2004)	34
GRAND THEFT AUTO: SAN ANDREAS (2004)	25
HALO 2 (2004)	21
CIVILIZATION III (2001)	20
THE SIMS 2 (2004)	20
FLATOUT (2004)	17
STAR WARS: KNIGHTS OF THE OLD REPUBLIC II: SITH LORDS (2005)	16
ROME: TOTAL WAR (2004)	16
NETHACK (1987)	14
PRO EVOLUTION SOCCER 4 (2004)	13
NEVERWINTER NIGHTS (2002)	9
NHL 2005 (2004)	7
TOTAL	*247*

Fig. 3: The Distribution of the Completed Gameplay Experience Self-Evaluation Questionnaires into Different Digital Games

There were 203 respondents altogether, but since some of them evaluated two different games, the total amount of completed gameplay experience self-evaluation questionnaires was 247. Almost all of the respondents were male (91%), THE SIMS 2 being the only exception with 55% of the responses given by females. The age of the respondents varied between 12 and 40 years (mean 21.4 years). The platform used for playing was a PC computer in 73% of the cases, but HALO 2 was played only on Xbox and GRAND THEFT AUTO: SAN ANDREAS only on PlayStation 2. In the majority of the cases, the game was played as a single-player game (75%), but WORLD OF WARCRAFT was played as a multiplayer game on the Internet. In a few cases (4%) the game was played as a multiplayer game in which the players also shared physical location.

After examining the correlations between the thirty questionnaire items with explorative factor analysis, some of the statements were eliminated so that the number of items was reduced to eighteen. The scale of sensory immersion consisted of four statements related to the capturing of senses done by the game (e.g., “The sounds of game overshadowed the other sounds of the environment”), the scale of challenge-based immersion of seven statements addressing the orientation to goals and flow-like experiences (e.g., “The game challenged me to try to reach the limits of my abilities”), and the scale of imaginative immersion included seven statements that measured how involved the player and their imagination were with the game (e.g., “I identified with how the game characters felt in different situations”). Cronbach’s alphas for this sample were 0.69, 0.73, and 0.82 respectively.

It is not possible to go through the results in great detail here, and again we emphasize that the main goal was to develop and validate our model. In that respect, the first obvious finding when looking at the data is that the immersion levels in the examined games were quite high overall, so that no game with almost non-existent immersion experience was found. This is an understandable consequence of the fact that our informants were analyzing gameplay experiences from games that were their personal favorites. It would no doubt be possible to also obtain results from the different end of the spectrum if random or less-favored games and not as enthusiastic players would be examined. Nevertheless, the results appear to support the SCI-model and the questionnaire derived from it.

Comparing games that fall on the opposite ends of the scales is illuminating. The sensory immersion is experienced as particularly strong in HALF-LIFE 2 and lowest in NETHACK, as we expected. The role of audiovisual technology is clear: the sensory experience provided by an old game from an ASCII graphics era appears distinctly different from that provided by the latest three-dimensional game engines.

The situation is different as we turn to the results from the analysis of challenge-based immersion. Here NETHACK is the game that acquired the top score, followed by CIVILIZATION III, ROME: TOTAL WAR and PRO EVOLUTION SOCCER 4. These games are interesting also in the sense that they probably provide players with distinctly different kinds of challenges: NETHACK with those of a seemingly simple dungeon game that actually provides players with an endless supply of complex puzzles linked to randomly generated items and interactions, CIVILIZATION III and ROME: TOTAL WAR with the predominantly strategic challenges in warfare and empire-building scenarios, and PRO EVOLUTION SOCCER 4 testing players' reactions and coordination skills at a faster speed. The lowest challenge-based immersion rating of the examined games was that of THE SIMS 2, which can be related to its non-competitive and toy-like basic character.

Imaginative immersion, the third component of the model, is at its strongest in role-playing games and plot-driven adventure games, again confirming expectations how the scale should operate. STAR WARS: KNIGHTS OF THE OLD REPUBLIC 2, HALF-LIFE 2, and NEVERWINTER NIGHTS lead the statistics, with PRO EVOLUTION SOCCER 4, the rally game FLATOUT and strategy games CIVILIZATION III and ROME: TOTAL WAR inhabiting the other end of the scale. The result is logical since games with characters and storylines provide players with more possibilities to identify with something in the game and use their imagination.

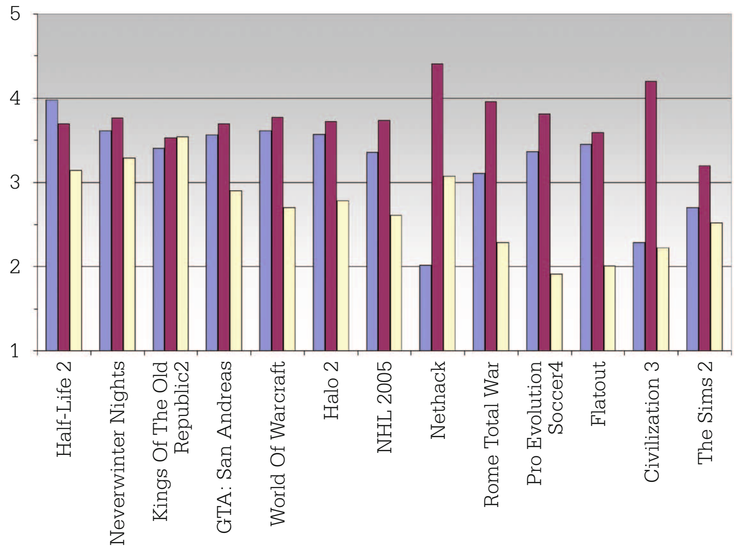

Fig. 4: The Average Amount of Each Immersion Type Reported by the Players in Different Digital Games (the Total Amount of Immersion Reported is Highest on the Left-Hand Side)

There are several interesting aspects of the results that invite further research. Summing up mean values of all the three components of gameplay immersion, HALF-LIFE 2 appears to be the overall strongest game in immersing its players. On the other end, the experience of playing THE SIMS 2 is apparently not felt as immersive. However, it would be a mistake to claim that HALF-LIFE 2 was a better game than THE SIMS 2 on this basis. It may well be that the more 'casual' character of THE SIMS 2 gameplay is one of the reasons behind its appeal for these particular players. THE SIMS 2 was also the only one of the examined games with a notable amount of female respondents, but the relatively low evaluation of immersion is not related to the gender of the informants, since females gave overall higher evaluations to the immersion in that game than men.

Conclusions and Future Work

> To each and every one of the above 'explanations' it might well be objected: 'So far so good, but what actually is the fun of playing? Why does the baby crow with pleasure? Why does the gambler lose himself in his passion? Why is a huge crowd roused to frenzy by a football match?' This intensity of, and absorption in, play finds no explanation in biological analysis. Yet in this intensity, this absorption, this power of maddening, lies the very essence, the primordial quality of play. (Johan Huizinga, *Homo Ludens)*

This research has been driven by a desire to better understand the nature of gameplay experience. In the existing research which we synthesized in the beginning of this chapter, there proved to be several useful observations and conceptualizations that address or can be applied into the study of gameplay. Nevertheless, there is a need for a game-specific model that would take the diversity of contemporary digital games into account, and that would address its full complexity. We have presented one version of such a model in this chapter, while also acknowledging the need for further research.

In the future, we will test and fine-tune the questionnaire further, and also look into the applicability of the model for evaluation of gameplay characteristics both within a controlled environment and as a part of pervasive gameplay experience evaluation. The games examined here represent only a fraction of the variety of games. For such purposes, new applications of the model will be needed, as well as further extensions of the evaluation criteria to include dimensions of experience relevant to game types that are not played with a personal computer or game console and television screen. It is also necessary to broaden the conception and evaluation of gameplay experiences to include all the other components presented in the model besides immersion. For example, what is the role of emotions, social contexts and players' expectations and interpretations, and how do the different aspects of gameplay immersion link to the characteristics of the player and features of the game?

In a sense, this research has at this point opened more questions than it is able to answer. For example, it would be highly relevant and important to further examine the role of social and cultural contexts for the gameplay experience. Do the pre-existing expectations and experiences with related games determine the gameplay experience with a new one, and to what degree? And finally, what are the exact interrelationships and relative weights of the components included in our model? It might also be possible that game players are able to switch from one attitude or repertoire of game playing into another one, and the gameplay experience will vary on the basis of such "eyeglasses" or filters. How much does the situational context really affect the way games are experienced? As usual in research, when new knowledge is created, new horizons into the unknown and unexplored are also opened up.

Acknowledgments

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References

Bartle, Richard A. (2004): *Designing Virtual Worlds*, Indianapolis: New Riders.

Blythe, Mark/Hassenzahl, Marc (2003): "The Semantics of Fun. Differentiating Enjoyable Experiences", in: *Funology. From Usability to Enjoyment*, ed. by M. Blythe, K. Overbeeke, A. F. Monk and P. C. Wright, Dordrecht: Kluwer, 91–100.

Brown, Emily/Cairns, Paul (2004): "A Grounded Investigation of Game Immersion", in: *CHI'04 Extended Abstracts on Human Factors and Computing Systems*, New York: ACM, 1297–1300.

Crawford, Chris (1982): *The Art of Computer Game Design*, Berkeley: Osborne/McGraw-Hill.

Cruz-Neira, Carolina/Sandin, Daniel J./DeFanti, Thomas A./Kenyon, Robert V./Hart, John C.: "The CAVE. Audio Visual Experience Automatic Virtual Environment", in: *Communications of the ACM* 35/6 (1992), 64–72.

Csikszentmihalyi, Mihaly (1991): *Flow. The Psychology of Optimal Experience*, New York: Harper & Row.

DeJean, Pierre-Henri (2002): "Difficulties and Pleasure?", in: *Pleasure with Products. Beyond Usability*, ed. by W. S. Green and P. W. Jordan, London: Taylor & Francis, 147–150.

Douglas, Yellowlees/Hargadon, Andrew (2000): "The Pleasure Principle. Immersion, Engagement, Flow", in: *Proceedings of the Eleventh ACM Conference on Hypertext and Hypermedia*, New York: ACM, 153–160.

Ermi, Laura/Heliö, Satu/Mäyrä, Frans (2004): *Pelien voima ja pelaamisen hallinta. Lapset ja nuoret pelikulttuurien toimijoina [Power and Control of Games. Children as the Actors of Game Cultures]*, http://tampub.uta.fi/tup/951-44-5939-3.pdf.

—/Mäyrä, Frans (2003): “Power and Control of Games. Children as the Actors of Game Cultures”, in: *Level Up. Digital Game Research Conference*, ed. by M. Copier and J. Raessens, Utrecht: University of Utrecht, 234–244.

Funk, Jeanne B./Pasold, Tracie/Baumgardner, Jennifer (2003): “How Children Experience Playing Video Games”, in: *Proceedings of the Second International Conference on Entertainment Computing*, Pittsburgh: Carnegie Mellon University, 1–14.

Gee, James Paul (2003): *What Video Games Have to Teach Us about Learning and Literacy*, New York: Palgrave Macmillan.

Grodal, Torben (2003): “Stories for Eye, Ear, and Muscles. Video Games, Media, and Embodied Experiences”, in: *The Video Game Theory Reader*, ed. by M. J. P. Wolf and B. Perron, New York/London: Routledge, 129–155.

Hassenzahl, Marc (2003): “The Thing and I. Understanding the Relationship between User and Product”, in: *Funology. From Usability to Enjoyment*, ed. by M. Blythe, K. Overbeeke, A. F. Monk and P. C. Wright, Dordrecht: Kluwer, 31–42.

Hunicke, Robin/LeBlanc, Marc/Zubek, Robert (2004) “MDA: A Formal Approach to Game Design and Game Research”, http://www.cs.northwestern.edu/~hunicke/pubs/MDA.pdf.

Järvinen, Aki/Heliö, Satu/Mäyrä, Frans (2002): *Communication and Community in Digital Entertainment Services. Prestudy Research Report*, http://tampub.uta.fi/tup/951-44-5432-4.pdf.

Koster, Raph (2005): *A Theory of Fun for Game Design*, Scottsdale: Paraglyph.

Klimmt, Christoph (2003): “Dimensions and Determinants of the Enjoyment of Playing Digital Games. A Three-Level Model”, in: *Level Up. Digital Game Research Conference*, ed. by M. Copier and J. Raessens, Utrecht: University of Utrecht, 246–257.

Lazzaro, Nicole (2004): "Why We Play Games. Four Keys to More Emotion in Player Experiences", http://www.xeodesign.com/whyweplaygames/xeodesign_whyweplaygames.pdf.

Lombard, Matthew/Ditton, Theresa (1997): "At the Heart of It All: The Concept of Presence", in: *Journal of Computer Mediated Communication* 3/2, http://jcmc.indiana.edu/vol3/issue2/lombard.html.

McMahan, Alison (2003): "Immersion, Engagement, and Presence. A Method for Analyzing 3-D Video Games", in: *The Video Game Theory Reader*, ed. by M. J. P. Wolf and B. Perron, New York/London: Routledge, 67–86.

Murray, Janet (1997): *Hamlet on the Holodeck. The Future of Narrative in Cyberspace*, Cambridge/London: MIT.

Newman, James (2004): *Videogames*, New York/London: Routledge.

Pine, B. Jospeh/Gilmore, James H. (1999): *The Experience Economy. Work is Theatre and Every Business a Stage*, Boston: Harvard Business School.

Ravaja, Niklas/Salminen, Mikko/Holopainen, Jussi/Saari, Timo/Laarni, Jari/Järvinen, Aki (2004): "Emotional Response Patterns and Sense of Presence during Video Games. Potential Criterion Variables for Game Design", in: *Proceedings of the Third Nordic Conference on Human-Computer Interaction*, New York: ACM, 339–347.

Rollings, Andrew/Adams, Ernest (2003): *On Game Design*, Indianapolis: New Riders.

Salen, Katie/Zimmerman, Eric (2004): *Rules of Play. Game Design Fundamentals.* Cambridge/London: MIT.

BATTLEZONE (1980), Atari, Arcade.
CIVILIZATION III (2001), Infogrames, PC.
FLATOUT (2004), Empire Interactive, PC.

GRAND THEFT AUTO: SAN ANDREAS (2004), Rockstar Games, Playstation 2.

HALF-LIFE 2 (2004), Sierra Entertainment, PC.

HALO 2 (2004), Microsoft Game Studios, Xbox.

NETHACK (1987), NetHack DevTeam/Open Source, PC.

NEVERWINTER NIGHTS (2002), Atari, PC.

NHL 2005 (2004), EA Sports, Playstation 2.

PRO EVOLUTION SOCCER 4 (2004), Konami, Playstation 2.

ROME: TOTAL WAR (2004), Activision, PC.

STAR WARS: KNIGHTS OF THE OLD REPUBLIC 2 (2005), LucasArts, PC.

TEMPEST (1980), Atari, Arcade.

THE SIMS 2 (2004), Electronic Arts, PC.

WORLD OF WARCRAFT (2004), Vivendi, PC Online.

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- L. E. & F. M.: "Player-Centred Game Design. Experiences in Using Scenario Study to Inform Mobile Game Design", in: *Game Studies 5/1* (2005), http://www.gamestudies.org/0501/ermi_mayra/.

Lev Manovich

What is Visualization?

Over the last 20 years, information visualization became a common tool in science and also a growing presence in the arts and culture at large. However, the use of visualization in cultural research is still in its infancy. Based on the work in the analysis of video games, cinema, TV, animation, Manga and other media carried out in Software Studies Initiative at University of California, San Diego over last two years, a number of visualization techniques and methods particularly useful for cultural and media research are presented.

I first drew the Chart in order to clear up my own ideas on the subject, finding it very troublesome to retain a distinct notion of the changes that had taken place. I found it answer the purpose beyond my expectation, by bringing into one view the result of details that are dispersed over a very wide and intricate field of universal history; facts sometimes connected with each other, sometimes not, and always requiring reflection each time they were referred to. (William Playfair, *An Inquiry into the Permanent Causes of the Decline and Fall of Powerful and Wealthy Nations* (1805) *[in reference to "The Chart, No. 1, representing the rise and fall of all nations or countries, that have been particularly distinguished for wealth or power, is the first of the sort that ever was engraved, and has, therefore, not yet met with public approbation."]*)

The pretty photographs we and other tourists made in Las Vegas are not enough. How do you distort these to draw a meaning for a designer? How do you differentiate on a plan between form that is to be specifically built as shown and that which is, within

in: *DIGAREC Keynote-Lectures 2009/10*, ed. by Stephan Günzel, Michael Liebe, and Dieter Mersch, Potsdam: University Press 2011, 116-156.
http://pub.ub.uni-potsdam.de/volltexte/2011/49849/ [urn:nbn:de:kobv:517-opus-49849]

> constraints, allowed to happen? How do you represent the Strip as perceived by Mr. A. rather than as a piece of geometry? How do you show quality of light – or qualities of form – in a plan at 1 inch to 100 feet? How do you show fluxes and flows, or seasonal variation, or change with time? (Robert Venturi, Stefan Izenour, and Denise Scott Brown, *Learning from Las Vegas* (1972))

> 'Whole' is now nothing more than a provisional visualization which can be modified and reversed at will, by moving back to the individual components, and then looking for yet other tools to regroup the same elements into alternative assemblages. (Bruno Latour, *Tarde's Idea of Quantification* (2010))

What is information visualization? Despite the growing popularity of infovis (a common abbreviation for "information visualization"), it is not so easy to come up with a definition which would work for all kinds of infovis projects being created today, and at the same would clearly separate it from other related fields such as scientific visualization and information design. So let us start with a provisional definition that we can modify later. Let's define infovis as a mapping of data to a visual representation. Of course, we can also use different concepts besides 'representation,' each bringing additional meaning. For example, if we believe that the brain uses a number of distinct representational and cognitive modalities, we can define infovis as a mapping from other cognitive modalities (such as mathematical and propositional) to an image modality.

My definition does not cover all aspects of information visualization – such as the distinctions between static, dynamic (i.e. animated) and interactive visualization – the latter, of course, being most important today. In fact, most definitions of infovis by computer science researchers equate it with the use of interactive computer-

see video recording of this *DIGAREC Keynote-Lecture* on:
http://info.ub.uni-potsdam.de/multimedia/show_projekt.php?projekt_id=79#79
[urn:nbn:de:kobv:517-mms-79-231-0]

driven visual representations and interfaces. Here are the examples of such definitions: "Information visualization (InfoVis) is the communication of abstract data through the use of interactive visual interfaces." (Keim et al. 2006) – "Information visualization utilizes computer graphics and interaction to assist humans in solving problems." (Purchase et al. 2008) If we accept this, our own definition also needs to include software tools that allow users to interact with and modify visual representations.

Interactive graphic interfaces in general, and interactive visualization in particular, bring all kinds of new techniques for manipulating data elements – from the ability to change how files are shown on the desktop in modern OS to multiple coordinated views available in some visualization-software such as Mondrian (www.theusrus.de/Mondrian/). However, regardless of whether you are looking at a visualization printed on paper or a dynamic arrangement of graphic elements on your computer screen which you generated using interactive software and which you can change at any moment, in both case the image you are working with is a result of mapping. So what is special about images such mapping produces? This is the focus of my article.

For some researchers, information visualization is distinct from scientific visualization in that the latter works with numerical data while the former focuses on non-numeric data such as text and networks of relations: "In contrast to scientific visualization, information visualization typically deals with nonnumeric, nonspatial, and high-dimensional data" (Chen 2005). Personally, I am not sure that this distinction reflects the actual practice – certainly, plenty of infovis projects use numbers as their primary data, but even when they focus on other data types they still rely on numbers to create visualizations. For instance, typical network visualization may use both the data about the structure of the network (which nodes are connected to each other) and the quantitative data about the strength of these connections (for example, how many messages are exchanged between members of a social network). As a concrete example, consider the well-known project *History Flow* (www.research.ibm.com/visual/projects/history_flow/), which shows how a given Wikipedia page grows over time as different authors contribute to it.

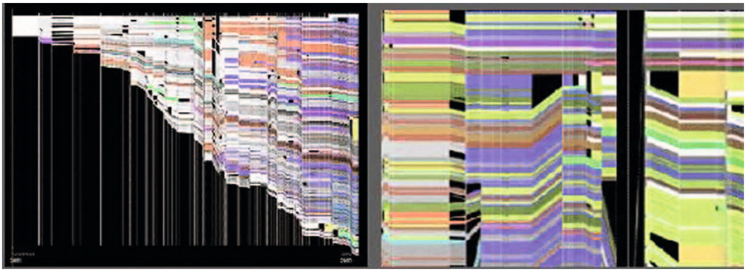

Fig. 1: History Flow by Fernanda B. Viégas and Martin Wattenberg, 2003 (Screenshot)

The contribution of each author is represented via a line. The width of the line changes over time reflecting the amount of text contributed by an author to the Wikipedia page. To take another infovis classic, *Flight Patterns* (www.aaronkoblin.com/work/flightpatterns/) uses the numerical data about the flight schedules and trajectories of all planes that fly over US to create an animated map which displays the pattern formed by their movement over a 24-hour period.

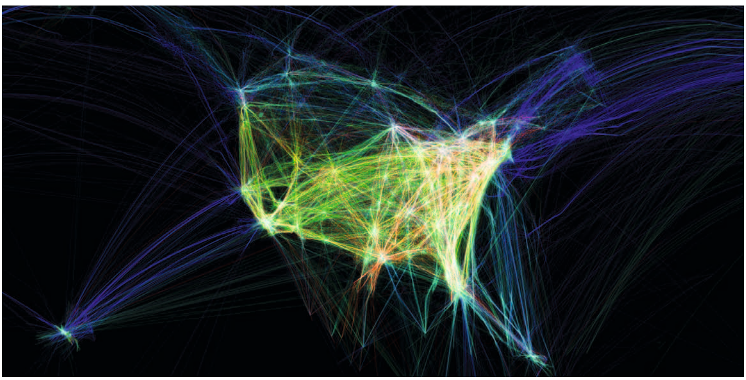

Fig. 2: Flight Patterns by Aaron Koblin, 2005 (www.aaronkoblin.com)

Rather than trying to separate information visualization and scientific visualization using some a priori idea, lets instead enter each phrase into Google image search and compare the results. The majority of images returned by searching for 'information visualization' is two dimensional and use vector graphics, i.e., points, lines, curves, and other simple geometric shapes. The majority of images returned by searching for 'scientific visualization' are three-dimensional; they use solid 3D-shapes or volumes made from 3D-points (called 'voxels'). The two fields therefore are indeed distinct on the level of visual techniques and technologies used. They also come from different cultures (science and design) and correspond to different areas of computer graphics technology. Scientific visualization developed in the 1980s along with the field of 3D-computer graphics, which at that time required specialized graphics workstations. Information visualization developed in the 1990s along with the rise of desktop 2D-graphics software and its adoption by designers; its popularity accelerated in the 2000s – the two major factors being the easy availability of big data sets via APIs provided by major social network services since 2005 and new high level programming languages specifically designed for graphics – *Processing* (processing.org) – and graphics software libraries – *Prefuse* (prefuse.org).

Can we differentiate information visualization from information design? This is trickier, but here is my way of doing it. Information design starts with the data that already has a clear structure, and its goal is to express this structure visually. For example, the famous London tube map designed in 1933 by Harry Beck starts with already organized data: tube lines, tube stations, and their locations over London geography.

Fig. 3: London Tube Map by Harry Beck (www.tfl.gov.uk/)

In contrast, the goal of information visualization is to discover the structure of a data set. This structure is not known a priori; visualization is successful if it reveals this structure. As is always the case with the actual cultural practice, it is easy to find examples that do not fit such a distinction – but a majority does. Therefore I believe that this distinction can be useful in allowing us to understand the practices of information visualization and information design as partially overlapping but ultimately different in terms of their functions.

Finally, what about the earlier practices of visual display of quantitative information in the 19th and 20th century that are known to many via the examples collected in the books by Edward Tufte (1983, 1990, 1997, 2006)? Do they constitute infovis as we understand it today? As I already noted, most definitions provided by the researchers working within Computer Science equate information visualization with the use of interactive computer graphics. (A number of definitions of information visualization from the recent literature is available at www.infovis-wiki.net/index.php?title=Information_Visualization.)

Using software, we can visualize much larger data sets than it was possible previously; create animated visualization; show how processes unfold in time; and, most importantly, manipulate visualizations interactively. These differences are very important – but for the purposes of this article, which is concerned with the visual language of infovis, they do not matter. When we switched from pencils to computers, this did not affect the core concept of visualization – mapping some properties of quantified data into visual dimensions. Similarly, while use of software led to the development of new visualization techniques, the basic visual language of infovis remains the same as it was in the 19th century – simple graphic primitives. Given this continuity, I will use the term "infovis" to refer to both earlier visual representations of data created manually and contemporary software-driven visualization.

Reduction and Spatiality

In my view, the practice of information visualization from its beginnings in the second part of the 18th century until today relied on two key principles. The first principle is reduction. Infovis uses graphical primitives such as points, strait lines, curves, and simple geometric shapes to stand in for objects and relations between them – regardless of whether these are people, their social relations, stock prices, income of nations, songs, or anything else. By using graphical primitives (or, to use the language of contemporary digital media, vector graphics), infovis aims to reveal patterns and structures in the sets of objects that these primitives represent. However, the price being paid for this power is extreme schematization. We throw away %99 of what is specific about each object to represent %1 – in the hope of revealing patterns shared by this %1 of objects' characteristics.

Information visualization is not unique in relying on such an extreme reduction of the world in order to gain new power over what is extracted from it. It came into its own in the first part of the 19th

century, when in the course of just a few decades almost all contemporary graph types commonly found today in statistical and charting programs were invented. This development of the new techniques for visual reduction parallels the reductionist trajectory of modern science in the 19th century. Physics, chemistry, biology, linguistics, psychology and sociology proposed that both the natural and the social world should be understood in terms of simple elements (molecules, atoms, phonemes, just noticeable elements) and the rules of their interaction. This reductionism became the default "meta-paradigm" of modern science, and it continues to rule scientific research today. For instance, think of the popular paradigms of complexity and artificial life that focus our attention on how complex structures emerge out of interaction of simple elements.

Even more direct is the link between 19th century infovis and the rise of social statistics. Philip Ball (2004:64–65) summarizes the beginnings of statistics in this way:

> In 1749 the German scholar Gottfried Achenwall suggested that since this 'science' [the study of society by counting] dealt with the natural 'states' of society, it should be called Statistik. John Sinclair, a Scottish Presbutrian minister, liked the term well enough to introduce it into the English language in his epic Statistical Account of Scotland, the first of the 21 volumes of which appeared in 1791. The purveyors of this discipline were not mathematicians, however, nor barely 'scientists' either; they were tabulators of numbers, and they called themselves 'statists'.

In the first part of the 19th century, many scholars – Adolphe Quetelet, Florence Nightingale, Thomas Buckle, Francis Galton, and others – used statistics to look for 'laws of society.' This inevitably involved summarization and reduction – calculating the totals and averages of the collected numbers about the citizens' demographic characteristics, comparing the averages for different geographical regions, asking if they followed bell-shaped normal distribution, etc. It is therefore not surprising that many – if not most – graphical methods that are standard today were invented during this time for the purposes of representations of such summarized data. According to Michael Friendly and Daniel J. Denis (2009, Sec. 5), between 1800 and 1850:

> In statistical graphics, all of the modern forms of data display were invented: bar and pie charts, histograms, line graphs and time-series plots, contour plots, and so forth. In thematic cartography, mapping progressed from single maps to comprehensive atlases, depicting data on a wide variety of topics (economic, social, moral, medical, physical, etc.), and introduced a wide range of novel forms of symbolism.

Do all these different visualization techniques have something in common besides reduction? They all use spatial variables (position, size, shape, and more recently movement) to represent key differences in the data and reveal the most important patterns and relations. This is the second core principle of modern infovis practice at work for 300 years – from the very first line graphs (1711), bar charts (1786) and pie charts (1801) to their ubiquity today in all graphing software such as Excel, Numbers, Google Docs, OpenOffice, etc.

This principle means that spatial dimensions are privileged over other visual dimensions. That is, we map the dimension of our data set that we are most interested in onto the topology and geometry of the visualization elements. Other, less important properties of the objects are represented through different visual dimensions – tones, shading patterns, colors, or transparency of the graphical elements.

As the examples, consider two common graph types: a bar chart and a line graph. Both first appeared in William Playfair's Commercial and Political Atlas published in 1786 and became commonplace in the early 19th century. A bar chart represents the differences between data objects via rectangles that have the same width but different heights. A line graph represents changes in the data values over time via changing height of the line. In both cases, spatial relations are reserved for the key dimension of data we want to understand.

Now imagine making a scatter plot in order to understand relations in a large data set. If some objects cluster together, this implies that they have something in common; if you observe two distinct clusters, this implies that the objects fall into two different classes; and so on. Here as well, we use spatial variables (positions and distances between points) to make sense of the data.

Let us take another example – network visualizations which function today as distinct symbols of 'network society'. (See Manuel Lima's authoritative gallery visualcomplexity.com, which currently houses over 700 network visualization projects). Like a bar chart and a line graph, network visualizations also privilege spatial dimensions: position, size, and shape. Their main addition is the use of straight lines or curves to show connections between objects. For example, in Ben Fry's *distellamap* (benfry.com/distellamap), the lines connect pieces of code and data to show the dynamics of the software execution in Atari 2600 games.

Fig. 4: distellamap of ADVENTURE by Ben Fry, 2005 (benfry.com)

In Marcos Weskamp's *Flickr Graph* (marumushi.com/projects/flickr-graph) the lines visualize the social relationships between users of *flickr.com*.

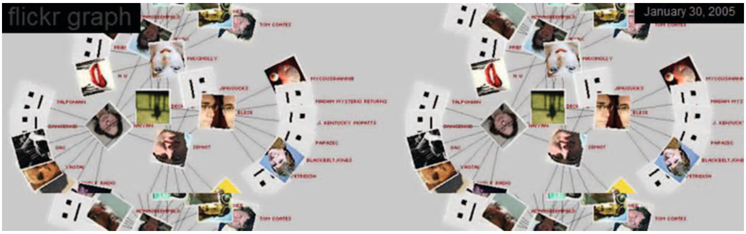

Fig. 5: Flickr Graph by Marcos Weskamp, 2005 (marumushi.com)

I believe that the majority of information visualization practices from the second part of the 18th century until today follow the same principle – reserving spatial arrangement (we can call it "layout") for the dimensions of the data that are most important for the authors of visualizations. This principle can be found in works ranging from famous dense graphic showing Napoleon's March on Moscow by Charles Joseph Minard to a recent The Evolution of 'The Origin of Species' by Stefanie Posavec and Greg McInerny.
(www.visualcomplexity.com/vc/project.cfm?id=696)

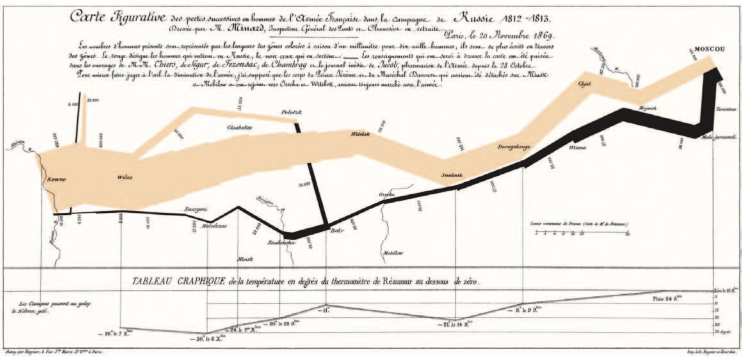

Fig. 6: Napoleon's March to Moscow 1812/13 by Charles J. Minard, 1869 (www.edwardtufte.com)

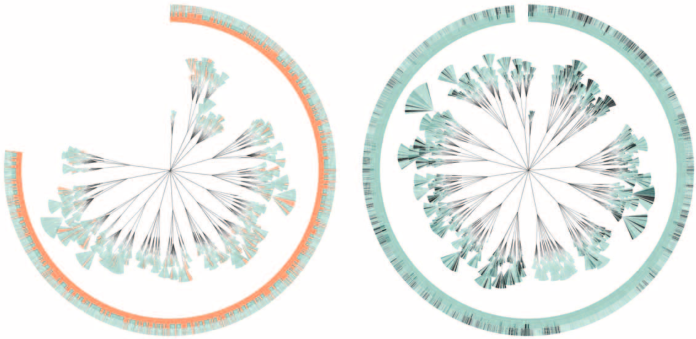

Fig. 7: The Evolution of 'The Origin of Species' by Stefanie Posavec and Greg McInerny, 2009 (www.visualcomplexity.com)

Spatial variables represent the most important dimension(s) of the data. Color is typically employed to identify graphical objects that belong to a particular group. In other words, it functions as a label. For example, Google Trends (www.google.com/trends) uses line graphs to compare the search volume of a few words or phrases.

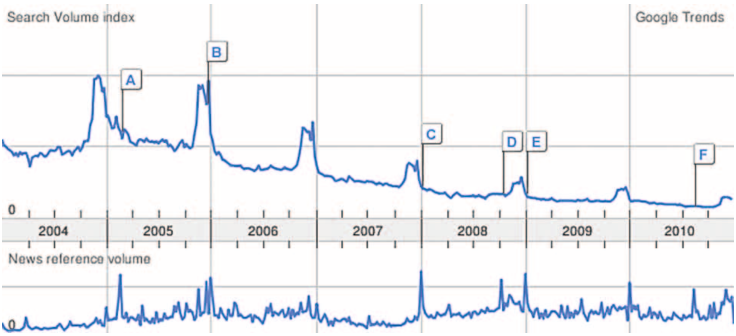

Fig. 8: "mp3 players"-Search by Google Trends, 2010 (www.google.com)

However, the same visualization could have simply used labels attached directly to the lines – without different colors. In this case, color ads readability but it does not add new information to the visualization.

The privileging of spatial over other visual dimensions was also true for plastic arts in Europe for a number of centuries: a painter first worked out the composition for a new work in many sketches; next, the composition was transferred to a canvas and shading was fully developed in monochrome; only after that was color added. This practice assumed that the meaning and emotional impact of an image depends most of all on the spatial arrangements of its parts, as opposed to colors, textures and other visual parameters. In classical Asian 'ink and wash painting', which first appeared in the 7th century in China and was later introduced to Korea and then Japan (14th century), color did not even appear. The painters used black ink exclusively, exploring the contrasts between objects' contours, their spatial arrangements, and different types of brushstrokes.

It is possible to find information visualizations where the main dimension is color – think, for instance, of a common traffic light which 'visualizes' the three possible behaviors of a car driver: stop, get ready, and go. This example demonstrates that we need to fix the spatial parameters of visualization in order for a color to become the salient dimension. Thus, it is crucial that the three lights have exactly the same shape and size. Apparently, if all elements of the visualization have the same values on spatial dimensions, our visual system can focus on the patterns represented by colors, or other visual variables.

Why do visualization designers – be they the inventors of graph and chart techniques at the end of the 18th and early 19th century, or millions of people who now use these graph types in their reports and presentations, or the authors of more experimental visualizations as featured on infoaesthetics.com and visualcomplexity.com – privilege spatial variables over other kinds of visual mappings? In other words, why are color, tone, transparency, and symbols used to represent secondary aspects of data while the spatial variables are reserved for the most important dimensions? Without going into the details of the rich but still very incomplete knowledge about vision accumulated by neuroscience and experimental psychology, we can still make a simple guess. The creators of visualizations follow human visual perception that also privileges spatial arrangements of parts of a scene over its other visual properties. Why would the geometric arrangement of elements in a scene be more important to human perception than other visual dimensions? We can assume that this has to do with the fact that each object occupies a unique part of the space. It is therefore crucial for a brain to be able to segment a 3D-world into spatially distinct objects which are likely to have distinct identities – people, sky, ground, cards, buildings, etc. Different object types can also often be identified with unique 2D-forms and arrangements of these shapes. A tree has a trunk and branches growing out of it; a human being has a head, a torso, arms and legs; etc. Therefore, identifying 2D-forms and their arrangements is also likely to play an important role in object recognition.

An artist or a designer may pay more attention to other visual properties of a scene such as textures and rhythms of color – but for most people, spatial properties are what matters most. How close are two people to each other; the expression on their faces; their relative size which allows the observer to estimate their distance from them; the characteristic shapes of different objects – all these and many other spatial characteristics which our brains instantly compute from the retinal input are crucial for our existence.

I think this is the reason why all standard techniques for making graphs and charts developed in the 18th–20th centuries use spatial dimensions to represent the key aspects of the data, and reserve other visual dimensions for less important aspects. However, we should also keep in mind the evolution of visual display technologies, which constrain what is possible at any given time. Only in the 1990s when people started using computers to design and present visualizations on the screen became color the norm. Color printing is still significantly more expensive – so even today science journals are printed in black and white. Thus, the extra costs associated with creating and printing color graphics throughout the history of visualization was probably an important factor responsible for the privileging of spatial variables.

When color, shading, and other non-spatial visual parameters were used in visualizations created in the 19^{th} and most of the 20^{th} century, they usually represented only a small number of discrete values – i.e. they acted as 'categorical variables.' However, today the fields of computer-based scientific visualization and geovisualization often use such parameters with much larger scales. For example, the common 24-bit format for color allows computers to represent 16 million different colors. Therefore in these fields, color, shading and transparency are now commonly employed to show continuously varying qualities such as temperature, gas density, gravity waves, etc. But does this not contradict my statement that spatial arrangement is a key to information visualization?

We can solve this puzzle if we take into account a fundamental difference between information visualization and scientific visualization or geovisualization, which I did not mentioned yet. Infovis uses arbitrary spatial arrangements of elements to represent the patterns in the data. Scientific and geovisualization typically work with an a priori fixed spatial layout of the real physical objects such as a brain, a coastline, a galaxy, etc. Since the layout in such visualizations is already fixed and can't be arbitrarily manipulated, color and/or other non-spatial parameters are used instead to show new information. A typical example of this strategy is a *heat map*, which uses color hue and saturation to overlay information over a spatial map.

The two key principles that I suggested – data reduction and the privileging of spatial variables – do not account for all possible visualizations produced during the last 300 years. However, they are sufficient to separate infovis (at least as it was commonly practiced until now) from other techniques and technologies for visual representation: drawing, painting, photography, video, film, radar, MRI, infrared spectroscopy, etc. They give infovis its unique identity – identifying its core, which remarkably remained the same for 300 years.

Visualization without Reduction

The meanings of the word 'visualize' include "make visible" and "make a mental image." This implies that until we 'visualize' something, this 'something' does not have a visual form. It becomes an image through a process of visualization.

If we survey the practice of infovis until the end of the 20th century, the idea that visualization takes data that is not visual and maps it into a visual domain indeed works quite well. However, it seems to no longer adequately describe certain new visualization techniques and projects developed since the middle of the 1990s. Although these techniques and projects are commonly discussed as "information visualization," it is possible that they actually represent something else – a fundamentally new development in the history of representational and epistemological technologies, or at least a new broad visualization method for which we don't yet have an adequate name. – Consider a technique called 'tag cloud.'

Fig. 9: Tag Cloud (manyeyes.alphaworks.ibm.com)

The technique was popularized by Flickr in 2005; besides its classical form used on numerous web pages today it also exists in new forms such as the Word Tree. In its standard version, a tag cloud shows the most common words in a text in the font size corresponding to their frequency in the text.

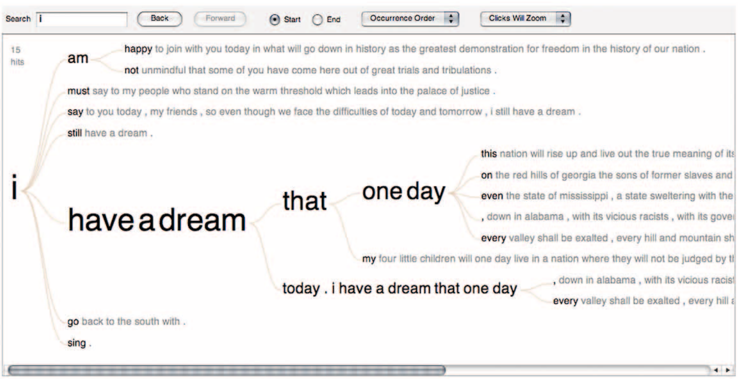

Fig. 10: Word Tree (manyeyes.alphaworks.ibm.com)

While we can use a bar chart with text labels to represent the same information, which in fact may work better if the frequencies are very similar, if the frequencies fall within a larger range, we don't have to map the data into a new visual representation such as the bars. Instead, we can vary the size of the words themselves to represent the patterns of their use in the text.

Tag cloud exemplifies a broad method that can be called media visualization: creating new visual representations from the actual visual media objects, or their parts. Rather than representing text, images, video or other media through signs such as points or rectangles, media visualizations build new representations out of the original media.

In view of our discussion of the data reduction principle, I am going to refer to this method as direct visualization, or visualization without reduction. Direct visualization takes the existing data and builds visualization out of this data preserving its original form.

Not all direct visualization techniques such as a tag cloud originated in the 21st century. If we project this concept retroactively into history, we can find earlier techniques that use the same principle. For instance, a familiar book index can be understood as a direct visualization technique. Looking at an index, one can quickly see if particular concepts or names are important in this book – they will have more entries than the concepts that take up only a single line in the index.

While both the book index and the tag cloud exemplify the direct visualization method, it is important to consider the differences between them. The older book index technique relied on the typesetting technology used to print the text of the book. Since each typeface was only available in a limited number of sizes, the idea that you can precisely map the frequency of a particular word into its size was counter-intuitive – so it was not invented. In contrast, the tag cloud technique is a typical expression of what we can call 'software thinking' – i.e. the ideas that explore the fundamental capacities of modern software in general, and also its particular areas such as computer graphics. The tag cloud explores the capacities of software to vary every parameter of a representation and to use external data to control it (The data can come from a scientific experiment, from a mathematical simulation, from the body of the person in an interactive installation, etc.). If we take these capacities for granted, the idea to arbitrarily change the size of words based on some information – such as their frequency in a text – is something we may expect to be 'actualized' in the process of cultural evolution (In fact, all contemporary interactive visualization techniques rely on the same two fundamental capacities).

The rapid growth in the number and variety of visualization projects, applications, and web services since the late 1990s was enabled by the advances in computer graphics capacity of PCs including both hardware (processors, RAM, displays) and software (C and Java graphics libraries, Flash, Processing, Flex, Prefuse, etc.) The computer graphics developments both popularized information visualization and also fundamentally changed its identity by foregrounding animation, interactivity and also more complex visualizations that represent connections between many more objects. (As an example, open source data visualization software Mondrian 1.0 running on my 2009 Apple PowerBook laptop with 2.8 Ghz processor and 4 GB of RAM takes approximately 7 seconds to render a scatter plot containing 1 million points.) But along with these three highly visible trends, the same advances also made possible the direct visualization approach – although it has not been given its own name so far.

Direct Visualization: Examples

Cinema Redux was created by interactive designer Brendan Dawes in 2004. The project uses a selection of frames arranged in a grid to reveal the patterns in cinematography and narrative in a number of feature films.

Fig. 11: Cinema Redux: Vertigo, 2004 (www.brendandawes.com)

Dawes wrote a program in Processing that sampled a film at the rate of one frame per second and scaled each frame to 8x6 pixels. The program then arranged these frames in a rectangular grid with every row representing a single minute of the film. Although Dawes could have easily continued this process of sampling and remapping – for instance, representing each frame though its dominant color; instead, he chose to use the actual scaled down stills from the film. The resulting visualization represents a trade-off between the two possible extremes: preserving all the details of the original artifact and abstracting its structure completely. A higher degree of abstraction may make the patterns more visible, but it would also remove the viewer further from the experience of the film. Staying closer to the original artifact preserves the original detail and aesthetic experience, but may not be able to reveal some of the patterns.

What is most important in the context of our discussion are not the particular parameters which Dawes used for *Cinema Redux*, but that he reinterpreted the previous constant of visualization practice as a variable. If previously infovis designers mapped data into new diagrammatic representation consisting from graphical primitives, now it became possible to select any value on the dimension between the data in its original form and its abstract representation. In other words, a designer can now chose to use graphical primitives, or the original images exactly as they are, or any form in between.

Before software, visualization usually involved the two-stage process of first counting, or quantifying data, and then representing the results graphically. Software allows for direct manipulation of the media artifacts without quantifying them. As demonstrated by *Cinema Redux*, these manipulations can make visible the relations between a number of these artifacts. Of course, such visualization without quantification is made possible by the a priori quantification required to turn any analog data into a digital representation. In other words, it is the “reduction” first performed by the digitization process which paradoxically now allows us to visualize the patterns across sets of analog artifacts without reducing them to graphical signs.

Fig. 12: Preservation of Favoured Traces by Ben Fry, 2009 (benfry.com)

For another example of direct visualization, let's turn to Ben Fry's *Preservation of Favoured Traces* from 2009. This web project is an interactive animation of the complete text of Charles Darwin's *Evolution of the Species*. Fry uses different colors to show the changes made by Darwin in each of the six editions of his famous book. As the animation plays, we see the book sentences and passages deleted, inserted and re-written. In contrast to typical animated information visualizations which show some spatial structure constantly changing its shape and size in time reflecting changes in the data (for example, the changing structure of a social network over time), in Fry's project the rectangular shape containing the complete text of Darwin's book always stays the same – what changes is its content. This allows us to see how over time the patterns of the book's additions and revisions become more and more intricate as the changes from all the editions accumulate.

What is also crucial for our discussion is that at any moment in the animation we have access to the complete text of Darwin's book, as opposed to only diagrammatic representation of the changes. At the same time, it can be argued that the *Preservation of Selected Traces* does involve some data reduction. Given the typical resolution of computer monitors and web bandwidth today, Fry was not able to actually show all the actual book text at the same time. – I have created a few visualizations which show a whole book in a single image. To display the whole text of Tolstoy's Anna Karenina in a smallest font which can be read, I had to make the image 14 000 x 6 000 pixels – well beyond the normal screen resolution today.

Fig. 13: AnnaKarenina_string_text_over_rectangles by Lev Manovich, 2009

Instead, in Fry's project sentences are rendered as tiny rectangles in different colors. However, when you mouse over any part of the image, a pop-up window shows the actual text. Because all the text of Darwin's book is easily accessible to the user in this way, I think that this project can be considered a direct visualization.

Finally, let's add one more example – *Listening Post* by Ben Rubin and Mark Hansen from 2001. Normally, this work is considered to be one of the most successful computer-driven installations in the whole history of this genre rather than an example of infovis. *Listening Post* pulls text fragments from online chat rooms in real-time based on various parameters set by the authors and streams them across a display wall made from a few hundred small screens in a six-act looping sequence. Each act uses its own distinct spatial layout to arrange dynamically changing text fragments. For instance, in one act the phrases move across the wall in a wave-like pattern; in another act words appear and disappear in a checkerboard pattern. Each act also has its distinct sound environment driven by the parameters extracted from the same text that is being animated on the wall.

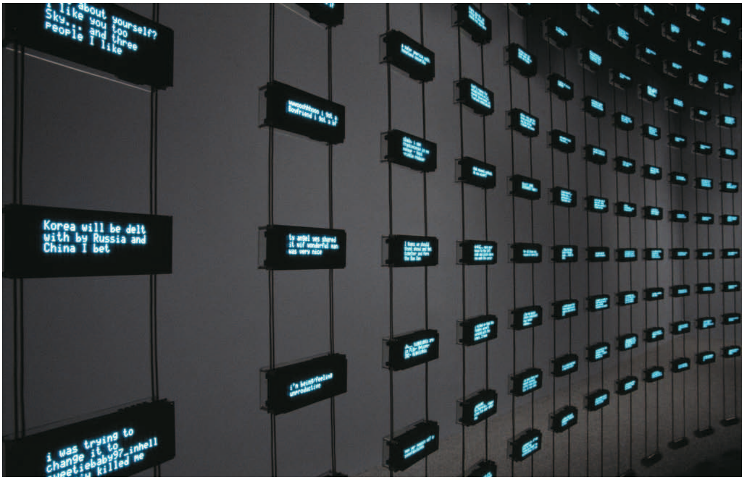

Fig. 14: Listening Post by Ben Rubin and Mark Hansen, 2001 (www.earstudio.com)

One can argue that *Listening Post* is not a visualization because the spatial patterns are pre-arranged by the authors and not driven by the data. This argument makes sense – but I think it is important to keep in mind that while layouts are pre-arranged, the data in these layouts is not. Instead, it is a result of the real-time data mining of the web. So while the text fragments are displayed in pre-defined layouts (wave, checkerboard, etc.), because the content of these fragments is always different, the overall result is also always unique.

Note that if the authors were to represent the text via abstract graphical elements, we would simply end up with the same abstract pattern every time the same act is repeated. But because they show the actual text, which changes all the time, the pattern that emerges inside the same layout is always different.

This is why I consider *Listening Post* to be an example of direct visualization – the patterns it presents depend as much on what all text fragments which appear on the screen wall actually say as on their pre-defined composition. We can find other examples of info projects that similarly flow the data into pre-defined layouts. Manuel Lima identified what he calls a 'syntax' of network visualizations – commonly used layouts such as radial convergence, arc diagrams, radial centralized networks, and others. (To see his taxonomy of network display methods, select "filter by method" on www.visualcomplexity.com/vc/.)

The key difference between most of these network visualizations and *Listening Post* lies in the fact that the former often rely on the existing visualization layout algorithms (and thus implicitly accept the ideologies contained in these) in particular the tendency to represent a network as a highly symmetrical and/or circular structure. The authors of Listening Post wrote their own layout algorithms that allowed them to control the layouts' intended meanings. It is also important that they use six very different layouts that cycle over time. The meaning and aesthetic experience of the work – showing both the infinite diversity of the web and at the same time the existence of many repeating patterns – derive to a significant extent from the temporal contrasts between these layouts. Nine years before Bruno Latour's (2010:159) article where Latour argues that our ability to create "a provisional visualization which can be modified and reversed" allows us to think differently since any "whole" we can construct now is just one of numerous others, and *Listening Post* beautifully staged this new epistemological paradigm enabled by interactive visualization.

The three influential projects I considered demonstrate that in order to highlight patterns in the data we don't have to reduce it by representing data objects via abstract graphical elements. We also don't have to summarize the data as it is common in statistics and statistical graphics (think of histogram which divides data into a number of bins). This does not means that in order to qualify as a "direct visualization" an image has to show all 100% of the original data – every word in a text, every frame in a movie, etc. Out of the three examples I just discussed, only *Preservation of Selected Traces* does this. Both *Cinema Redux* and *Listening Post* do not use all the available data – instead they sample it. The first project samples a feature film at the rate of 1 frame per second; the second project filters the online conversations using set criteria that change from act to act. However, what is crucial is that the elements of these visualizations are not the result of remapping of the data onto some new reduced representation – they are the actual data objects selected from the complete data set. This strategy is related to the traditional rhetorical figure of synecdoche – specifically its particular case where a specific class of thing refers to a larger, more general class. (For example, in *Cinema Redux* one frame stands for a second of a film.)

While sampling is a powerful technique for revealing patterns in the data, *Preservation of Selected Traces* demonstrates that it is also possible to reveal patterns while keeping 100% of the data. But you already have been employing this strategy – if you ever used a magic marker to highlight important parts of a text. Although text highlighting normally is not thought as visualization, we can see that in fact it is an example of 'direct visualization without sampling.'

Cinema Redux and *Preservation of Selected Traces* also break away from the second key principle of traditional visualization – communication of meaning via spatial arrangements of the elements. In both projects, the layout of elements is dictated by the original order of the data – shots in a film, sentences in a book. This is possible and also appropriate because the data they visualize is not the same as the typical data used in infovis. A film or a book is not just a collection of data objects – they are narratives made from these objects (i.e. the data has a sequential order). Although it is certainly possible to create effective visualizations that remap a narrative sequence into a new spatial structure (see, for instance, the gorgeous *Writing Without Words* by Stefanie Posavec or *The Shape of Song* by Martin Wattenberg), *Cinema Redux* and *Preservation of Selected Traces* intentionally preserve the original sequence.

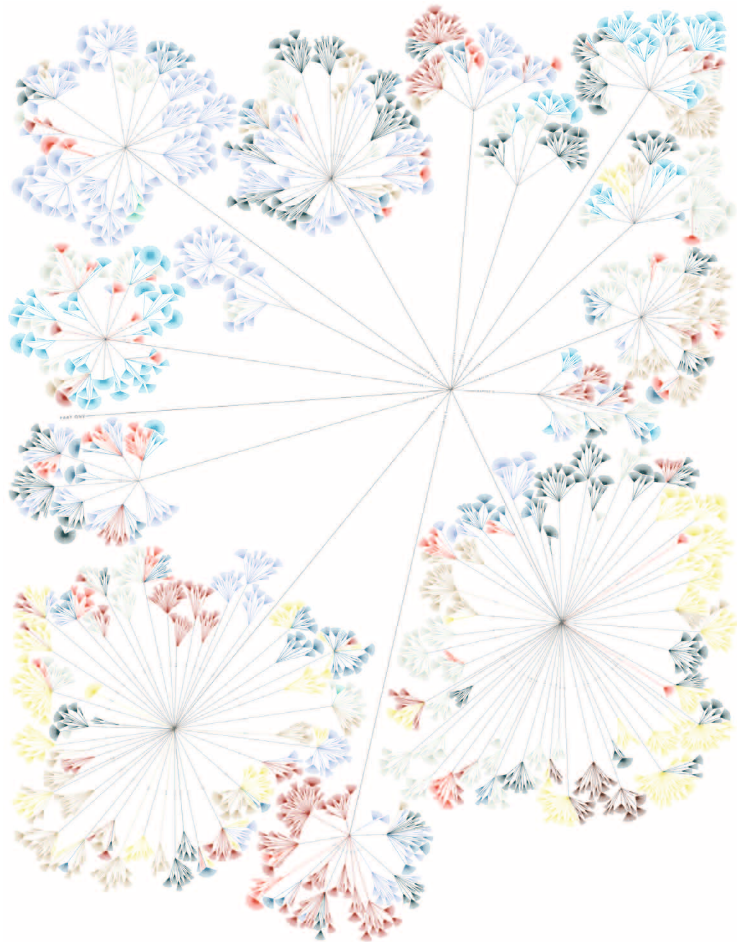

Fig. 15: Writing Without Words by Stefanie Posavec, 2007 (www.itsbeenreal.co.uk)

Fig 16: The Shape of Song (Madonna: "Like a Prayer") by Martin Wattenberg (www.turbulence.org)

Preserving the original order is particularly appropriate in the case of cultural data sets that have a time dimension. We can call such data sets "cultural time series." Whether it is a feature film (*Cinema Redux*), a book (*Preservation of Selected Traces*) or a long Wikipedia article (*History Flow*), the relationships between the individual elements (i.e., film shots, book's sentences) and between larger parts of a work (i.e. film scenes, book's paragraphs and chapters) which are situated in different points in work's timeline are of primary importance to any narrative. While we consciously or unconsciously notice many of these patterns during watching / reading / interacting with the work, projecting time into space – laying out movie frames, book sentences, and magazine pages in a single image – gives us new possibilities to study them. Thus, *space* turns out to play a crucial role in direct visualization after all: it *allows us to see patterns between media elements that are normally separated by time*.

Let me add to this discussion two more examples of direct visualization that my students and I created at *Software Studies Initiative* (lab.softwarestudies.com/2008/09/cultural-analytics.html). Inspired by the artistic projects which pioneered the direct visualization approach as well as by the resolution and real-time capabilities of super-visualization interactive systems such as HIPerSpace (35,840 x 8,000 pixels, 286,720,000 pixels total) developed at Calit2 where our lab is located, my group has been working on techniques and software to allow the interactive exploration of large sets of visual cultural data.

Fig. 17: Supervizualizaiton on HIPerSpace (vis.ucsd.edu)

Some of the visualizations we created use the same strategy as *Cinema Redux* – arranging a large set of images in a rectangular grid. However, having access to a larger resolution display allows us to include all 100% of the data as opposed to using its samples. For example, we created an image showing all 4 553 covers of every issue of Time magazine published between 1923 and 2009. (We also compared the use of images in Science and Popular Science magazines by visualizing all pages of every issue published between 1872 and 1922 in *The Shape of Science* by William Huber, Tara Zapel, and Lev Manovich in 2010).

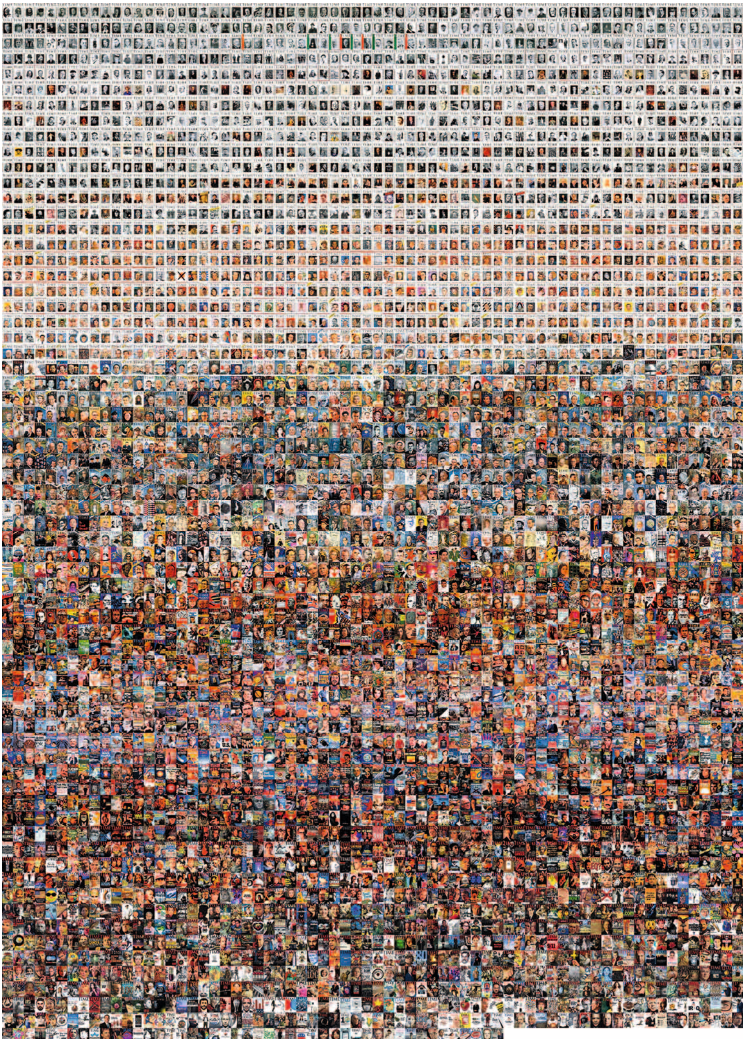

Fig. 18: Time-covers-all by Jeremy Douglass and Lev Manovich, 2009

Cinema Redux and the *Time*-covers visualization (as well as *The Shape of Science*) make equal the values of spatial variables to reveal the patterns in the content, colors, and compositions of the images. All images are displayed at the same size arranged into a rectangular grid according to their original order. However, it is also possible to create direct visualizations where spatial layout communicates additional information. Consider a different visualization of *Time*-covers.

Fig. 19: Time_covers_1923_to_2008, Jeremy Douglass and Lev Manovich, 2009

The horizontal axis still follows the original image sequence: time runs from left to right, and every cover is arranged according to its publication date. This allows us to use the vertical axis to represent new information. In this case, it shows the average saturation (the perceived intensity of colors) of every cover which we measured using computer image analysis.

Such mapping is particularly useful for showing variation in the data over time. We can see how color saturation gradually increases during Time publication, reaching its peak in 1968. The range of all values (i.e., variance) per year of publication also gradually increases – but it reaches its maximum value a little earlier. It is perhaps not surprising to see that the intensity (or "aggressiveness") of mass media as exemplified by Time gradually raises up to the 1970s as manifested by changes in saturation and contrast. What is unexpected, however, is that since the beginning of the 21st century, this trend is reversed: the covers now have less contrast and less saturation.

The strategy used in this visualization is based on the familiar technique – a scatter graph. However, if a normal scatter graph reduces the data displaying each object as a point, we display the data in its original form. The result is new graph type, which is literally made from images – that's why it is appropriate to call it an 'image graph.' (A number of computer scientists have explored a related technique for browsing image collections where a part of a collection is displayed in a similar 'image graph' form (Marchand-Maillet/Bruno 2006:5). In most of the reported research, images are organized by visual similarity which is calculated via computer image analysis. While this strategy is often useful for the analysis of cultural patterns, in many cases, such as the *Time* cover analysis, we want to see how visual features vary over time. Therefore, we use original metadata – i.e dates of publication – for one axis and measurement of one or more visual features – in this case, saturation – for the second axis.)

What is Visualization?

In an article on the then emerging practice of artistic visualization, I defined visualization as "a transformation of quantified data which is not visual into a visual representation" (Manovich 2002:2) At that time, I wanted to stress that visualization participates in the reduction projects of modern science and modern art, which led to the choice of the article's title: *Data Visualization as New Abstraction and Anti-Sublime*. I think that this emphasis was appropriate given the types of infovis being created at that time (Although I used a somewhat different formulation for the definition that appears in the beginning of the present article – "a remapping from other codes to a visual code" –, the two definitions express the same idea). Most information visualization today continues to employ graphical primitives. However, as the examples we looked at demonstrate, alongside this "mainstream" infovis, we can find another trend – projects where the data being visualized is already visual, such as text, film frames, magazine covers. These projects don't use the reduction typical for infovis from its beginnings in the 18th century until today. They also often break away from the second key principle of infovis – the mapping of the most important dimension in the data into spatial variables.

So does 'direct visualization' actually constitute a form of infovis, or is it a different method altogether? We have two choices. Either we need to accept that this is something new and different, or we can revise our understanding of what infovis is.

Given that all direct visualizations we looked at aim at making patterns and relations in the data visible, this aim certainly aligns them with infovis as it developed during the last 300 years. It is also relevant to note that a number of the most well-known infovis projects of the 2000s – including *Cinema Redux* and *Preservation of Selected Traces* – follow the direct visualization approach. This means that people intuitively identify them as visualizations even though they do not consist of vector elements but of media such as text and images. Similarly, a recent Phrase Net technique developed by Frank van Ham, Martin Wattenberg, and Fernanda Viégas (2009) that was awarded "Best Paper" at *IEEE InfoVis 2009*-conference also operates within a direct visualization paradigm.

Does this mean that what we took to be the core principle of information visualization during its first three centuries – the reduction to graphic primitives – was only a particular historical choice, an artifact of the available graphics technologies? I think so. Similarly, the privileging of spatial variables over other visual parameters may also turn out to be a historically specific strategy, rather than another essential principle of visualization practice. The relatively new abilities brought by computer graphics to control color, transparency, texture, and any other visual parameter of any part of an image allows us to start using these non-spatial parameters to represent the key dimensions of the data. This is already common in scientific and geovisualization – but not yet in information visualization.

Why has infovis continued to rely on computer-generated vector graphics during the 1990s and 2000s when the speed with which computers can render images has been progressively increasing? Perhaps the main factor has been the use of the web as the preferred platform for delivering interactive visualization. The web technologies made it relatively easy to create vector graphics and stream video – but not to render large numbers of continuous tone (i.e., raster) images in real-time. During these decades, this required a graphics workstation, a high-end PC with a special graphics card or a game console with optimized graphics processors. It also took lots of software development. Although video games and 3D-animation programs could render impressive numbers of pixels in real-time, this was achieved by writing code that directly accesses hardware – something that very high-level media programming environments such as Processing and Flash/Flex could not do. However, as processing power and RAM size keep increasing, these differences between platforms and programming environments gradually disappear.

Fig. 20: ImageGraph by Lev Manovich, 2009

For example, the ImageGraph program which I wrote in 2009 using the high-level programming environment *imageJ* (an open source application for image processing commonly used in the sciences), can render a 30 000 x 4 000 pixels image which shows 4 535 Time covers in a few minutes on my Powerbook laptop (processor: 2.8 Ghz Intel Core 2 Duo; memory: 4GB 1067 Mhz DDR3).

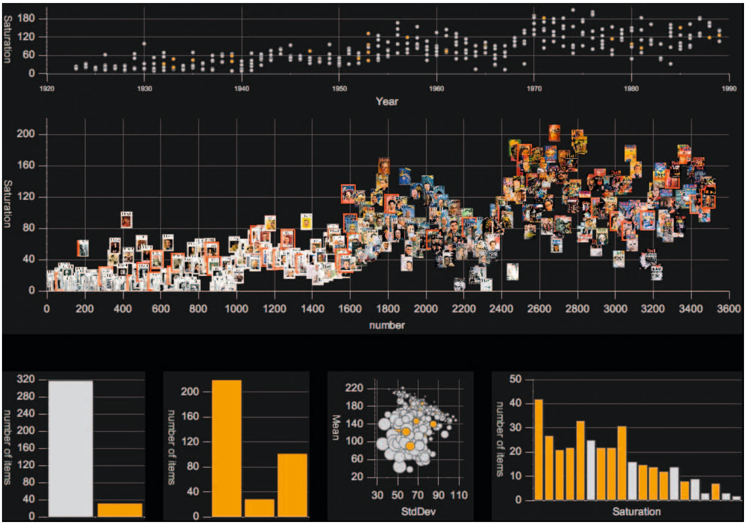

Fig. 21: Cultural analytics chart selection 2 (with VisualeSense) by Lev Manovich, 2010

VisualSense software that we developed in 2009-2010 at National University of Singapore's *Multimodal Analysis Lab* using Flash/Flex allows a user to define a number of graphs and change their positions and sizes. The graphs can use vector primitives (points, circles, rectangles) or they can show the actual images – thus allowing for the interactive construction of direct visualizations if we keep the number of images and their size small.

Finally, the *HiperView* application we developed together with *Calit2 Center of Graphics, Visualization and Virtual Reality* (GRAVITY) takes advantage of the 286 megapixel resolution and significant memory of HIPerSpace to enable interactive manipulation of image graphs which can contain up to 4000 images of *any* size.

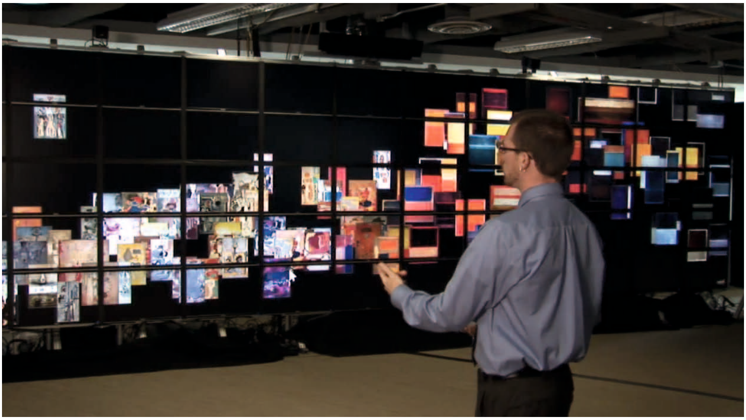

Fig. 22: Mark Rothko Paintings on the 287-Megapixel HIPerSpace-Wall at Calit2, 2009

I believe that direct visualization methods will be particularly important for humanities, media studies and cultural institutions which now are just beginning to discover the use of visualization, but which eventually may adopt it as a basic tool for research, teaching and the exhibition of cultural artifacts – the first conference on visualization in humanities took place at the MIT in May 2010 (hyperstudio.mit.edu/h-digital). Humanists always focused on analyzing and interpreting details of the cultural texts – be they poems, paintings, music compositions, architecture, or, more recently, computer games, generative artworks, and interactive environments. This is one of the key differences between humanities and sciences – at least, as they were practiced until now. The former are interested in particular artifacts (which can be taken to exemplify larger trends); the latter are interested in general laws and models.

If humanists start systematically using visualization for research, teaching and public presentation of cultural artifacts and processes, the ability to show the artifacts in full detail is crucial. Displaying the actual visual media as opposed to representing it by graphical primitives helps the researcher to understand meaning and/or cause behind the pattern they may observe, as well as discover additional patterns. Therefore, creating visualization out of media is not just a nod to humanities tradition – it is an approach to visualization which is perfectly suited to particular methods and data of the humanities, i.e. cultural artifacts, and, more recently, peoples' communication and social activities related to these artifacts happening on social networks.

While graphical reduction will continue to be used, this is no longer the only possible method. The development of digital computers and the progress in their media capacity now makes a new type of visualization possible that I call 'direct visualization' – i.e., visualization without reduction. (It is possible however that our interactive interfaces to visualizations are effective precisely because they do provide certain reduction functions. I am thinking in particular about zoom command. We zoom into direct visualization such as Time covers to examine the details of particular covers. We zoom out to see the overall trends. When we do that, the images are gradually reduced in size, eventually becoming small color dots.)

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References

Ball, Philip (2004): *Critical Mass. How One Thing Leads to Another*, London: Arrow Books.

Chen, Chaomei (2005): "Top 10 Unsolved Information Visualization Problems", in: *IEEE Computer Graphics and Applications* 25/4, 12–16.

Friendly, Michael/Denis, Daniel J. (2009): *Milestones in the History of Thematic Cartography, Statistical Graphics, and Data Visualization*, http://www.math.yorku.ca/SCS/Gallery/milestone.

Ham, Frank van/Wattenberg, Martin/Viégas, Fernanda B. (2009): "Mapping Text with Phrase Nets", in: *IEEE Transactions on Visualization and Computer Graphics* 15/6, 1169–1176.

Keim, Daniel A./Mansmann, Florian/Schneidewind, Jorn/Ziegler, Hartmut (2006): "Challenges in Visual Data Analysis", in: *Tenth International Conference on Information Visualisation*, 9–16.

Latour, Bruno (2010): "Tarde's Idea of Quantification", in: *The Social after Gabriel Tarde. Debates and Assessments*, ed. by M. Candea, New York/London: Routledge, 145–162.

Manovich, Lev (2002): "Data Visualization as New Abstraction and Anti-Sublime", http://www.manovich.net/DOCS/data_art_2.doc.

Marchand-Maillet, Stéphane/Bruno, Eric (2006): *State of the Art Image Collection Overviews and Browsing*, http://www.multimatch.org/docs/publicdels/D1.1.2.pdf.

Purchase, Helen C./Andrienko, Natalia/Jankun-Kelly, T. J./Ward, Matthew (2008): "Theoretical Foundations of Information Visualization", in: *Information Visualization. Human-Centered Issues and Perspectives*, eb. by A. Kerren, J. T. Stasko, J.-D. Fekete and C. North, Berlin/Heidelberg: Springer, 46–64.

Tufte, Edward (1983): *The Visual Display of Quantitative Information*, Cheshire: Graphics.

— (1990): *Envisioning Information*, Cheshire: Graphics.

— (1997): *Visual Explanations. Images and Quantities, Evidence and Narrative*, Cheshire: Graphics.

— (2006): *Beautiful Evidence*, Cheshire: Graphics.

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