Comparative Analysis on Game Design Pattern Collections

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ABSTRACT

Varying methods to support the game design process exist. Researchers of game design have worked on formalizing the experience-based craft by creating game design patterns. However, these patterns are incompatible in their creation, presentation, and usage. They also have strayed away from their original roots. In this paper, we suggest a taxonomy of game design patterns based on their usage during the game design and implementation. Our proposal is based on the literature research on the history of the game design patterns, and analysis of the existing game design patterns and collections of them.

INTRODUCTION

Gaming industry has become one of the largest branches of the entertainment industry, sales worth being over 15 billion dollars in the USA alone during year 2014 (ESA, 2015). Budgets for the large game productions regularly go over 100 million dollars, which makes their production a high-risk endeavor. In the market, the shelf time of a game is short and competition for sales is fierce. During this time, the game competes with experiences aimed to generate gratification in players. These experiences are created by the video game designer.

The art of video game design is a young discipline which has drawn many of its tools from the related fields that are also partly participating in the design and implementation process of the game artifact, e.g. graphical artists with their tools and background knowledge of their craft. Many of the other disciplines participating in this creative process have more formal and mature means of relaying their ideas from person and group to another, e.g. programmers have derived their design tools and methods from the applicable domains of software engineering.

The game designer is responsible for creating the overall structure of the game, planning the player's progression through the game, activities available during the game, and the experience the player has during the gameplay.

Designers' means to achieve these goals are the rules, mechanics, and story. (Smith, 2012) For game designers, movie industry and other entertainment branches have been the source of common tools such as storyboards and scripts, but the tools used in these other branches have been developed for creating passive forms of media. Games are inherently interactive, and thus require elements that the passive media like movies do not offer.

Alongside the growth and maturation of the gaming industry, also the path to become a game designer has been under a change. Schools and institutions on different levels of the education system offer courses and diploma studies for aspiring game designers. Traditionally, game designers learned their craft through personal experience (playing games and analyzing existing games) and experimentation (designing games).

These changes are also reflected on the published game design related literature. In 1984, book by Chris Crawford started the still on-going trend of the game design literature which concentrates on sharing of the wisdom of the experts in the form of experiences, guidelines and taxonomies (e.g. Rollings & Morris, 2003; Rollings & Adams, 2003; Zimmerman & Salen, 2004; Barwood & Falstein, 2006; Schell, 2008). Crawford's book also serves as an example of game design knowledge moving to more formal direction from the roots of self-learning and expertise gained in practice. A decade after Crawford, Costikyan (1994; updated 2002) started work on shared vocabulary for game designers as he saw this as a basic requirement for the analysis and understanding what kind of game design choices work and makes games interesting.

The developmental branch for the game design patterns was started by Kreimeier (2002a), and Björk and Holopainen (2002). Game design patterns are game design tools, but they can also be used as tool for communication between different parties, documentation of the game design, and as a source for automatic code generation from the pattern model in some cases.

In this paper we continue from the work of Almeida et al. (2013), who reviewed systematically the tools and methods developed for game design, by expanding the branch

containing the game design patterns. In the next section we shortly describe the method used to find the key literature and how the material was analyzed. The following section represents the birth and history of game design patterns. After that, we present the current state of the field in a form of a simplified taxonomy and describe its contents to the readers. Then, in the final section we discuss the shortcomings, strengths, and future directions of game design patterns. We conclude the paper with a call for the game design pattern language, which could unify the field, further advancing its maturation as a usable design tool.

METHODOLOGY

Methodology behind this work is a literature review in the form of a systematic mapping of the literature (Grant et al., 2009). The systematic mapping was done by searching databases (e.g. ACM, IEEE, and Web of Science) with the search string "game design pattern". Literature was also searched from game industry sites (e.g. Gamasutra), industry events (e.g. Game Developers Conference) and from known game-related academic conferences (e.g. GameOn, International Workshop on Games and Software Engineering (GAS) at International Conference on Software Engineering (ICSE), and Foundations of Digital Games).

From these sources the relevant articles were identified, based on their content. Content of the articles had to describe game design patterns, either relating to general gameplay or some specific are of game design. The results were further complemented by following the references in these papers. Also, a freeform search were conducted on the popular web search engine Google and its academic counterpart Google Scholar to find out about other potential sources, especially from the practical side of the game design world. This left us with 52 relevant sources for the game design patterns.

The collected material was then analyzed by going through their content. From the content their references to earlier work done on the field was noted with their stated goals and the discipline from where the work originated from. This information was then synthesized to the historical timeline and family tree of game design patterns, and the game design patterns presented in these studies were categorized based on their descriptions and features to form our simplified taxonomy of game design patterns. Other observations relevant to the history, evolution and creation of the game design patters done during this process are stated at the relevants parts of this paper.

BIRTH AND EVOLUTION OF GAME DESIGN PATTERNS

The idea of design patterns came to light in the year 1977 when Alexander et al. published their series of books concerning the architectural design. Especially the volume called *A Pattern Language: Towns, Buildings, Construction* (Alexander et al., 1977) which described 253 "good design practices" that conveyed the common wisdom gathered from the field of architecture has been influential also on other domains. Design patterns were applied on software engineering by Beck and Cunningham (1987), but were popularized on the 1990s when Gamma et al. published their influential *Design Patterns: Elements of Reusable Object-Oriented Software* (1994). Since then design patterns have been applied on a diverse set of aspects in the field of software engineering. These uses range from general software design to games (e.g. Chowdhury and Katchabaw, 2012).

Video game design is a relatively young discipline, and its methods and tools have been drawing influence from other similar fields such as books, movies, and web design. Since the field started to become more formalized, and recognized its own need for maturation, the tools and methods have been surveyed several times (e.g. Kreimeier, 2003; Lindley, 2007; Neil, 2012; Almeida, 2013).

The maturation itself begun by the call for shared and critical language by Costikyan in 1994 (1994; updated 2002). Church (1999) continued this by calling for *"Formal Abstract Design Tools"*. Taxonomies (e.g. Lindley, 2003), game design patterns (e.g. Kreimeier, 2002), frameworks (e.g. LeBlanc, 2004) and ontologies (e.g. Zagal, 2005) soon followed this call. This development has also led to several taxonomies and models which represent different aspects of game design.

One of these is Lindley & Sennersten's (2007) meta-model describing and interrelating different approaches and methodologies for game design. This meta-model has five levels on which different design methodologies are placed depending on their maturity level. Meta-model is presented on the following Figure 1.
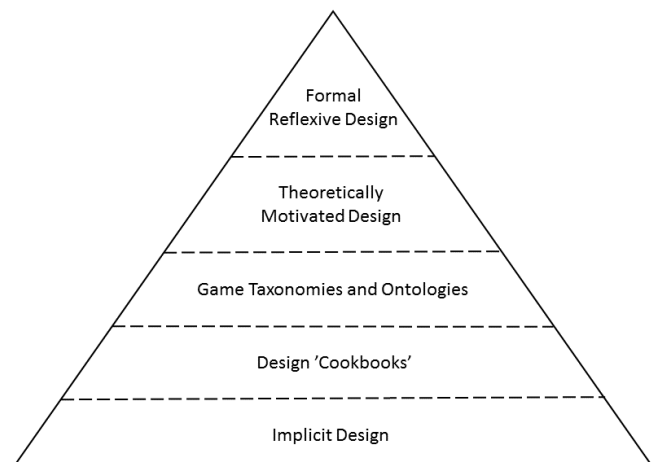

Figure 1. Game Design Meta-Model

On the lowest level of this model are the game design practices based on Implicit Design. At this level the game designs are based on the experience of the designers, which is cumulated from past experiences and from bits of knowledge shared by the peers (e.g. Crawford, 1984). On the second level, the experience is shared in the forms of guidelines, checklists and rules. These collections of knowledge are called Design Cookbooks and they are the simplest form of organization for the cumulative knowledge

present on the craft. (e.g. "The 400 rules project" by Falstein & Barwood, 2002)

Third level includes ontologies, taxonomies and game design patterns which describe game elements and design concepts used in games in a structured manner. But they do not explain why specific design choices are made. This is a requirement for the fourth level, where design tools have to be able to explain why the design choices were made and how effective they might be compared to other choices. The fifth stage is meant for design tools and ideas that potentially allow the designers to create experimental and unique games exploring the nature of games as a medium (Lindley & Sennersten, 2007). In this paper, we concentrate on the third level, and especially on the game design patterns.

In 2002 Bernd Kreimeier called for more formal design methods, namely game design patterns, at the Game Developer Conference 2002 roundtable event in March 2002 (2002a) and in a Gamasutra article on the same month (2002b). These patterns have their roots in Alexander et al.'s (1977) architectural design patterns, and Kreimeier called his patterns "Alexandrian patterns", which were noted to be *"simple collections of reusable solutions to solve recurring problems"*.

He defined game design patterns as follows: *"In a nutshell, patterns are simply conventions for describing and documenting recurring design decisions within a given context, be it game design or software engineering"*. He also classified his patterns as content patterns, differentiating them from the software engineering patterns which are used to describe the structure of the software, not the content.

Simultaneously and independently to the work of Kreimeier, Björk and Holopainen (2002) had started their work on game design patterns, and held the first workshop on them at Computer Games & Digital Cultures 2002 conference in the beginning of June 2002 (personal correspondence with Holopainen, 27.8.2015). To Björk and Holopainen the patterns were *"commonly recurring parts of the design of a game that concern gameplay"* (2004).

As a historical side note, the first identified usage of Kreimeier's pattern style was Ekström (2002) who used them to sketch out multiplayer design patterns for his personal massively multiplayer online game (MMOG) -project. This project has been dormant since 2002.

Kreimeier, Holopainen, and Björk combined their efforts, and held a game design pattern lecture at the GDC 2003 (Kreimeier et al., 2003). Since this, Kreimeier has been concentrating on other topics related to his work as a programmer and software engineer in game industry. From these early steps the work continued, and new authors diversified game design patterns from general gameplay patterns to new directions. This development will be described in the following chapter where different game design pattern collections are presented and classified.

TAXONOMY OF GAME DESIGN PATTERNS

We group the separate game design pattern collections to three main groups, based on the analysis of their descriptions and where they fit on the simplified model of game design process. In this paper, the game design process has been simplified to three aspects, *Guidelines for Intent* which sets the limits and goals of the game development process which steers the Guidelines for Design. *Guidelines for Design*, in turn, provides the groundwork for the activities and experiences offered to the player. *Guidelines for Implementation* contains the game design patterns that have the closest resemblance to the Alexandrian patters as they describe the audiovisual and concrete story related assets (e.g. level design, dialogues, and non-player characters) that converts the design to artefact.

These three aspects are not separate from each other, instead they influence each other during the game design and implementation further complicating the overall process. In the following chapters we keep them separate from each other to simplify the taxonomy.

Guidelines for Intent

These patterns act as guides for the design work and steer the decisions specific to certain types of games and goals that the game design process has.

Patterns belonging to the groups **Design Intent** and **Dark Patterns** (Zagal et al., 2013) have many common features. Both contain intents that game developers want to achieve with the game, be it motivating them in learning a new skill (Kiili, 2010; Kelle, 2012; Dormann et al., 2013), use serious games for education (Plass & Homer, 2009; Hyunh-Kim-Bang et al., 2010; Plass et al., 2010; Ibrahim et al., 2011), or change their behavior in some way (Holopainen & Björk, 2008; Lewis et al., 2012; Lewis, 2013; Ašeriškis & Damaševičius, 2014). Patterns belonging to the Dark Patterns are considered to be ethically problematic. They are defined by Zagal et al. (2013) to be *"a pattern used intentionally by a game creator to cause negative experiences for players which are against their best interest and likely to happen without their consent."* Also, game project might have **Economical patterns** (Zagal et al., 2013) to guide the economic aspects of game design.

Guidelines for Design

Game Type specific patterns are mostly relevant with some types of games, which has led to the development of highly specialized **genre-specific patterns**. Representative of these are the patterns for stealth games (Hu, 2014) that concentrate solely on the aspects of how to create games to use stealth as a game mechanic. Cermak-Sassenrath has been working on patterns that are derived from popular games from the 1980's (Cermak-Sassenrath 2012a, 2012b, 2012c). Also, some platform specific patterns have been developed, e.g. for mobile games (Davidsson et al., 2004).

Another interesting group of specialized patterns are for role playing games (RPGs) by Kirk et al. (2006). As the name states, these patterns describe how to create RPG type of games. Their roots are in the board games, but are applicable also to the computer RPGs. Interesting aspect of these patterns is that they do not share the otherwise common roots to Kreimeier, Björk and Holopainen. Instead they are derived straight from the works of Gamma et al. (1994), as their main creator Kirk has background in programming and software engineering.

Game(Play) design patterns were originally described to be collections of shared design vocabulary. Aim of the shared vocabulary is to enable the designers to communicate efficiently with each other and document their experience in written format for other game designers. Patterns also make it possible to analyze existing games using this same vocabulary, even if games were not designed by using them. (Kreimeier, 2002a; Björk et al., 2003)

Kreimeier created the first published patterns on 2002 (2002a). In this seminal work he describes seven patterns concerning general game design, e.g. Predictable Consequences. Björk et al. published their work shortly after Kreimeier (2003), in which they state that they had so far found over 200 game design patterns. Currently this game design pattern wiki contains 536 patterns and their descriptions (Björk, 2015).

Guidelines for Implementation

Patterns in this group are essentially level design patterns. In this group the patterns range from the scale of the individual objects sized from small rock to massive open worlds (Level Design Patterns, 2015).

Environment patterns are closest to the original Alexandrian patterns as they concern the architectural features of the game's graphical visualization of its world (Hullett et al., 2010; Dahlskog et al., 2012; Dahlskog et al., 2015). There are also sub patterns that aim to guide the player's movement (Milam et al., 2010; Lannigan, 2014) and/or attention (Milam et al., 2012) to certain directions on the game world with these features.

Patterns for Assets are about creating the artefacts that are part of the game world that make the game world and story more life-like, e.g. sounds (Alves & Roque, 2010; Sound Design in Games, 2010), or artefacts that the player can use e.g. weapons (Giusti et al., 2012), and potentially other objects like vehicles (Level Design Patterns, 2015).

Interaction patterns differ from other two subgroups in the sense that they are guidelines to design and implement non-audiovisual elements of the game world that the players experience. These patterns are applicable to quests (Smith et al., 2011), conflicts (Lankoski and & Björk, 2007; Lankoski and & Björk, 2008), dialogue (Brusk & Björk, 2009), NPCs (Lankoski & Björk, 2007; Rivera et al., 2012), behavior (Pellens et al., 2008), social networks in the game (Lankoski and & Björk, 2007), social interaction between player and

NPCs or other players (Bergström et al., 2010; Reichart & Bruegge, 2014; Reichart & Bruegge, 2015), cooperation/collaboration (Rocha et al., 2008; Seif El-Nasr et al., 2010; Reuter et al., 2014) and AIs (Treanor et al., 2015).

Simplified Taxonomy of Game Design Patterns

In this simplified taxonomy, patterns in higher level are grouped according to their role in the game design and implementation process. Inside this broad grouping, there are seven subgroups, based on the aspects of the game design they are related to. This categorization is visualized in Figure 2.
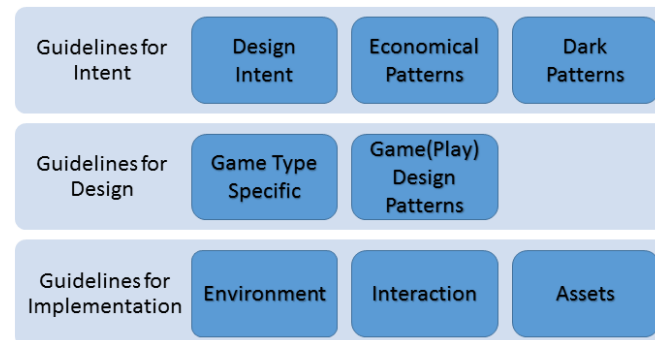

Figure 2: Categorization of game design pattern collections

Game(Play) Design pattern group, which originally started the development of these patterns is the most difficult to break in to smaller groups. Even the original authors have adopted different classifications for the patterns depending on their usage cases (more on these at Björk (2015).

DISCUSSION

In this part we discuss some problems related to the game design patterns that were identified during the search and analysis phase. These problems relate to the fragmentation of the patterns, their current usage, and their maturity in general.

It is cumbersome to go to more detailed level and to properly form subgroups for all the available individual game design patterns from different game design pattern collections. The reason for this is that the authors of these collections do refer to each other's work but create their own separate collections which use their own conventions to describe patterns. This creates a highly fragmented field, leading to overlapping patterns, incompatible naming and, more importantly, incompatible pattern templates and creation styles – (ranging from Alexander et al.'s (1977) notation to Kreimeier (2002a), or Björk & Holopainen (2003), UML based (Ašeriškis & Damaševičius, 2014), or some modified form of Alexander et al. (Björk & Holopainen, 2003) or Björk & Holopainen (Hu, 2014)).

Game design patterns have been criticized notably by Folmer (2006), McGee (2007) and Dormans (2013). All of these authors have critiqued game design patterns for including the term "pattern", but deviating from the Alexander et al.'s (1977) and Gamma et al.'s (1994) problem - solution pairing

principle, in which the pattern is known solution to a known problem. For this reason, Folmer compares the game design patterns to heuristics, and Dormans to design vocabularies and taxonomies. In the words of McGee, *"This expands the original Alexander usage from just problem-solution pairs to include patterns that are less precise or that support creative experimentation"*. In defense of patterns supporting creative experimentation, Alexandrian patterns were not meant to be strict rules, instead they are guidelines to be used when designers encounter a problem.

As a reaction to respond to this criticism, game design pattern creators could look back into the software design patterns where their own roots are. Research of the software design patterns include specific section devoted to the pattern writing and creation (which was noted by Reichart & Bruegge, 2015), e.g. Meszaros & Doble (1998) and Wellhausen & Fießer (2011).

To properly address these problems, game design patterns community should move towards the creation of game design pattern language. Some parts of it have already done it, the most comprehensive of them being the sound design for games (Alves & Roque, 2010). In a smaller scale, Cerman-Sassenrath (2012b) has done the same with "old school action games". In this move, the previous work done by the software design patterns community could be a helpful source. Another example is also the unification attempt started by Zavcer et al. (2014) in the field of patterns for serious games design.

In the issue of maturity, a game design pattern language and unified creation templates for the patterns could be a beginning for the move towards the fourth level of the Lindley & Sennersten's (2007) maturity model, Theoretically Motivated Design. Game pattern language would make it easier to create comprehensive theoretical background and tests for the effectivity of the existing patterns. In this sense, Milam & Seif El-Nasr (2010) and Milam et al. (2012) have already begun this work by testing the effectivity of their patterns.

CONCLUSION

In this paper, we looked at the development history of the game design patterns and their current state. Our methodology was the analysis of the material found on the systematic mapping of the literature. We observed how game design patterns originated from software design patterns, and diversified to cover various aspects of the overall game design.

Also, we observed how this diversification also led to a fragmentation as authors on the different subfields modified the pattern templates to their own needs and created patterns that unnecessarily replicate patterns from other pattern collections and are incompatible with them.

Based on our analysis of the game design patterns and game design pattern collections, we recognized the need for unification of game design patterns. Specifically this field of research and practice as whole could benefit from a common unified game design patterns language to amend the problems created by the current state of fragmentation.

From the material we constructed the simplified taxonomy of game design patterns. On the top level, this taxonomy categorizes the patterns based on their role on the game design process. These top level categories are Guidelines for Intent, Guidelines for Design and Guidelines for Implementation.

Inside these levels, the patterns are categorized based on which aspect of the game design they influence during the game design process. In the Guidelines for Intent, Design Intent, Economical and Dark patterns steer the game design to specific use when the game is created with other motives than pure entertainment.

Guidelines for Design contains the main patterns used in the game design process. Game(Play) Design patterns describe the core mechanics, and goals of the game, while Game Type specific patterns are used to supplement them when game designers' goals is to make a game for specific genre.

Patterns belonging to the Guidelines for Implementation are used when game designers are creating the content for the game world. The audiovisual and story related elements are created with the of the Environment, Interaction and Assets patterns. From the material we constructed the simplified taxonomy of game design patterns. On the top level, this taxonomy categorizes the patterns based on their role on the game design process. Inside this level, the patterns are categorized based on which aspect of the game design they influence during the game design process.

The future work on this matter requires more concentration on assorting the second level pattern taxonomy to more fine grained groups. Currently some of these groups contain diverse assortment of patterns, which might benefit from clearer categorization.

REFERENCES

Alexander, C., Ishikawa, S. and Silverstein, M. (1977). A Pattern Language: Towns, Buildings, Construction. Vol. 2. Oxford University Press, 1977.

Almeida, M.S.O. and Silva, F.S.C. (2013). A Systematic Review of Game Design Methods and Tools. Lecture Notes in Computer Science 8215. Springer, Berlin and Heidelberg, pp.17-29, 2013, http://dx.doi.org/10.1007/978-3-642-41106-9_3

Beck, K. and Cunningham, W. (1987). Using Pattern Languages for Object-Oriented Programs. Technical Report CR-87-43, Tektronix, Inc., September 17, 1987. Presented at the OOPSLA'87 workshop on Specification and Design for Object-Oriented Programming.

Björk, S. and Holopainen, J. (2002). Computer Game Design Patterns. One-day workshop Computer Games & Digital Cultures 2002 conference, Tampere, Finland.

Björk, S., & Holopainen, J. (2004). Patterns in game design (game development series). 1. ed., Charles River Media, December 2004.

Chowdhury, M. I., & Katchabaw, M. (2012). Improving software quality through design patterns: a case study of adaptive games and auto dynamic difficulty. In the Proceedings of the GAMEON'2012, Eds. Antonio J.Fernandez-Leiva, Carlos Cotta Porras and Raul Lara Cabrera. November 14-16, 2012, University of Malaga, Malaga, Spain. ISBN 978-90-77381-74-8.

Church, D. (1999). Formal Abstract Design Tools. Gamasutra (July 1999), http://www.gamasutra.com/view/feature/3357/formal abstract design tools.php

Costikyan, G. (1994). I have no words and I must design. nteractive Fantasy# 2. British roleplaying journal.

Costikyan, G. (2002). I have no words & I must design: Toward a critical vocabulary for games. In F. Mdiyrd (Ed.), Proceedings of the Computer Games and Digital Cultures Conference (pp. 9-33). Tampere, Finland: Tampere University Press.

Crawford, C. (1982). The art of computer game design. Vancouver, WA: Washington State University. Available at http://www.vancouver.wsu.edu/fac/peabody/game-book/Coverpage.html

Dormans, J. (2013). Making design patterns work. In Proceedings of the Second Workshop on Design Patterns in Games, DPG '13, in association with Foundations of Digital Games, FDG'13, Chania, Greece, 2013.

ESA (2015). Essential Facts about the Computer and Video Game Industry. Report, available at: http://www.theesa.com/wp-content/uploads/2015/04/ESA-Essential-Facts-2015.pdf

Falstein, N., Barwood, H. (2002). More of the 400: Discovering Design Rules. Presentation at GDC 2002, available at http://www.gdconf.com/archives/2002/hal_barwood.ppt

Gamma, E., Vlissides, J., Johnson, R., and Helm, R. (1994). Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley.

Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. Health Information & Libraries Journal, Vol. 26, Iss. 2, pp. 91-108.

Hunicke, R., LeBlanc, M., and Zubek, R. (2004). MDA: A formal approach to game design and game research. In: Proceedings of the AAAI 2004 Workshop on Challenges.

Kreimeier, B. (2002a). The Case for Game Design Patterns. Gamasutra.com, March 13, 2002. Available at: http://www.gamasutra.com/view/feature/132649/the_case_for_game_design_patterns.php

Kreimeier, B. (2002b). Content Patterns in Game Design. GDC 2002, March 19-23, Roundtable. Available at: http://www.onearrow.org/game/pattern/

Kreimeier, B. (2003). Game Design Methods: A 2003 Survey. Gamasutra, 2003. Available at: http://www.gamasutra.com/view/feature/131301/game_design_methods_a_2003_survey.php?print=1

Kreimeier, B.; Holopainen, J. and Björk S. (2003). Game Design Patterns. Lecture Notes from GDC 2003 (March 6).

Lindley, C. A. (2003). Game Taxonomies: A High Level Framework for Game Analysis and Design. Gamasutra. Available at: http://www.gamasutra.com/features/20031003/lindley_01.shtml

Lindley, C.A., and Sennersten, C.C. (2007). An Innovation-Oriented Game Design Meta-Model Integrating Industry, Research and Artistic Design Practices. In O. Leino, H. Wirman & A. Fernandez (Eds.), Extending Experiences. Structures, Analysis and Design of Computer Game Player Experiences (pp. 250-271). Rovaniemi, Finland: Lapland University Press.

Neil, K. (2012). Game Design Tools: Time to Evaluate. Proceedings of DiGRA Nordic 2012 Conference: Local and Global Games in Culture and Society (2012).

Meszaros, G., and Doble, J. (1998). A pattern language for pattern writing. In R. C. Martin, D. Riehl, & F. Buschmann (Eds.), Pattern languages of program design, Vol. 3, pp. 529–574. Reading, MA: Addison-Wesley.

Rollings, A., & Morris, D. (2003). Game architecture and design: a new edition. New Riders.

Rollings, A., & Adams, E. (2003). Andrew Rollings and Ernest Adams on game design. New Riders.

Salen, K., & Zimmerman, E. (2004). Rules of play: Game design fundamentals. MIT press.

Schell, J. (2008). The Art of Game Design: A book of lenses. CRC Press.

Smith, G. (2012). Expressive Design Tools: Procedural Content Generation for Game Designers (Ph.D. thesis). University of California, Santa Cruz.

Zagal, J., Mateas, M., Fernandez-Vara, C., Hochhalter, B., and Lichti, N. (2005). Towards an Ontological Language for Game Analysis. Proceedings of the DiGRA 2005 Conference: Changing Views - Worlds in Play, Vancouver, BC, Canada.

Zavcer, G., Mayr, S., and Petta, P. (2014). Design Pattern Canvas: Towards Co-Creation of Unified Serious Game Design Patterns. In 6th International Conference on Games and Virtual Worlds for Serious Applications (VS-GAMES), 2014, 9-12 Sept. 2014.

Wellhausen, T., & Fießer, A. (2011). How to write a pattern. European Conference on Pattern Languages of Programs, EuroPloP '11.

Pattern references

Alves, V., & Roque, L. (2010). A pattern language for sound design in games. In Proceedings of the 5th Audio Mostly Conference: A Conference on Interaction with Sound (p. 12). ACM.

Ašeriškis, D., & Damaševičius, R. (2014). Gamification Patterns for Gamification Applications. Procedia Computer Science, 39, 83-90.

Bergström, K., Björk, S., & Lundgren, S. (2010). Exploring aesthetical gameplay design patterns: camaraderie in four games. In Proceedings of the 14th International Academic MindTrek Conference: Envisioning Future Media Environments (pp. 17-24). ACM.

Björk, S. (2015). Gameplay design patterns collection, available at http://129.16.157.67:1337/mediawiki-1.22.0/index.php/Category:Patterns . Checked at 15.2015.

Björk, S. and Holopainen, J. (2005). Games and Design Patterns. In The Game Design Reader: A Rules of Play Anthology, Salen, K. & Zimmerman, E. (Eds). ISBN 0-262-19536-4. MIT Press.

Björk, S. and Holopainen, J. (2004) Patterns in Game Design. Charles River Media. ISBN 1-58450-354-8.

Björk, S., Lundgren, S. and Holopainen, J. (2003) Game Design Patterns. In Copier, M. & Raessens, J. (Eds.) (2003) Level Up - Proceedings of Digital Games Research Conference 2003, Utrecht, The Netherlands, 4-6 November 2003.

Brusk, J. and Björk, S. (2009). Gameplay Design Patterns for Game Dialogues. Paper presentation at DiGRA 2009: Breaking New Ground: Innovation in Games, Play, Practice and Theory. London, UK.

Cermak-Sassenrath, D. (2012a). Experiences with design patterns for old school action games. In Proceedings of the 8th Australasian Conference on Interactive Entertainment: Playing the System (p. 14). ACM.

Cermak-Sassenrath, D. (2012b). A Design Pattern Language for Old school Action Games. In Proceedings of The 2nd International Conference on DESIGN AND MODELING IN SCIENCE, EDUCATION, AND TECHNOLOGY: DeMset 2012. (pp. 194-9)

Cermak-Sassenrath, D. (2012c). Designing Games with Patterns. In: Colab Journal: Creative Technologies. Vol. 3, special issue on interactivity, 2012.

Dahlskog, S. and Togelius, J. (2012). Patterns and procedural content generation: revisiting Mario in world 1 level 1. In Workshop Proceedings of the 7th International Conference on the Foundations of Digital Games.

Dahlskog, S., Togelius, J., & Björk, S. (2015). Patterns, dungeons and generators. In Proceedings of the 10th Conference on the Foundations of Digital Games

Davidsson, O., Peitz, J., & Björk, S. (2004). Game design patterns for mobile games. Project report to Nokia Research Center, Finland.

Dormann, C., Whitson, J. R., & Neuvians, M. (2013). Once More with Feeling Game Design Patterns for Learning in the Affective Domain. Games and Culture, 1555412013496892.

Ekström, Olkof (2002). Multiplayer Design Patterns. Available at https://www.abc.se/~m10383/Haven/General/Multiplayer_Design_Patterns.html

Folmer, E. (2006). Usability patterns in games. Future Play.

Giusti, R., Hullett, K., & Whitehead, J. (2012). Weapon design patterns in shooter games. In Proceedings of the First Workshop on Design Patterns in Games (p. 3). ACM.

Holopainen, J. & Björk, S. (2008). Gameplay Design Patterns for Motivation. Paper presentation at ISAGA 2008, Kaunas, Lithuania.

Hu, M. (2014). Game Design Patterns for Designing Stealth Computer Games.

Hullett, K., & Whitehead, J. (2010). Design patterns in FPS levels. In proceedings of the Fifth International Conference on the Foundations of Digital Games (pp. 78-85). ACM.

Huynh-Kim-Bang, B., Wisdom, J., & Labat, J. M. (2010). Design patterns in serious games: A blue print for combining fun and learning. Project SE-SG, available at http://seriousgames. lip6. fr/DesignPatterns.

Ibrahim, A., Vela, F. G., Sánchez, J. L. G., & Zea, N. P. (2011). Playability design pattern in educational video game. In Proceedings of the 5th European Conference on Games Based Learning (pp. 282-290). Academic Conferences Limited.

Kelle, S. (2012). Game design patterns for learning. Shaker Verlag, Aachen.

Kiili, K. (2010). Call for learning-game design patterns. Chapter in a book Educational Games: Design, Learning, and Applications, pp. 299-311. Editors: Frej Edvardsen and Halsten Kulle. Nova Publishers, 2010. ISBN: 978-1-60876-692-5

Kirk III, W. J., Cantrell, M. R., & Holmes, M. (2006). Design Patterns of Successful Role-Playing Games.

Kreimeier, B. (2002a). The Case for Game Design Patterns. Gamasutra.com, March 13, 2002. Available at: http://www.gamasutra.com/view/feature/132649/the_case_for_game_design_patterns.php

Lankoski, P., & Björk, S. (2007). Gameplay Design Patterns for Believable Non-Player Characters. Paper presentation at DiGRA 2007, Tokyo, Japan.

Lankoski, P., & Björk, S. (2007). Gameplay Design Patterns for Social Networks and Conflicts. Paper Presentation at Computer Game Design and Technology Workshop, John Moores University, Liverpool.

Lankoski, P., & Björk, S. (2008). Character-Driven Game Design: Characters, Conflicts, and Gameplay. Paper presentation at GDTW, Sixth International Conference in Game Design and Technology, 2008.

Lannigan, R. (2014). Developing Player Movement Design Patterns in Multiplayer Video Games. In the Proceedings of the GAMEON'2014, Ed. Patrick Dickinson. September 9 - 11, 2014, University of Lincoln, Lincoln, United Kingdom. ISBN 978-90-77381-85-4.

Level Design Patterns (2015). Available at: https://ldp.soe.ucsc.edu/doku.php?id=start

Lewis, C., Wardrip-Fruin, N. and Whitehead, J. (2012). Motivational game design patterns of 'ville games. In Proceedings of the International Conference on the Foundations of Digital Games (FDG '12). ACM, New York, NY, USA, pp. 172-179. DOI=10.1145/2282338.2282373. Available at: http://doi.acm.org/10.1145/2282338.2282373

Lewis, Chris. (2013). Motivational Design Patterns. UC Santa Cruz: Computer Science. Doctoral thesis, retrieved from: http://escholarship.org/uc/item/30j4200s

McGee, K. (2007). Patterns and computer game design innovation. In IE '07: Proceedings of the 4th Australasian conference on Interactive entertainment. Melbourne, Australia, RMIT University, 2007, pp. 1-8.

Milam, D. and Seif El-Nasr, M. (2010). Design Patterns to Guide Player Movement in 3D Games. Proceedings of the 5th ACM SIGGRAPH Symposium on Video Games, 2010.

Milam, D., Bartram, L., & El-Nasr, M. S. (2012). Design patterns of focused attention. In Proceedings of the First Workshop on Design Patterns in Games (p. 5).

Pellens, B., De Troyer, O., & Kleinermann, F. (2008). CoDePA: A conceptual design pattern approach to model behavior for X3D worlds. In Proceedings of the 13th International Symposium on 3D Web Technology

Plass, J. L., & Homer, B. D. (2009). Educational game design pattern candidates. Journal of Research in Science Teaching, Vol. 44, Iss. 1, pp. 133-153.

Plass, J. L., Homer, B., & Perlin, K. (2010). Research on design patterns for effective educational games. In Game Developers Conference 2010.

Reichart, B., & Bruegge, B. (2014). Social interaction patterns for learning in serious games. In Proceedings of the 19th European Conference on Pattern Languages of Programs (p. 22). ACM.

Reichart, B., & Bruegge, B. (2015). Serious Game Patterns for Social Interactions. In Proceedings of the IADIS Multiconference on Computer Science and Information Systems (MCCSIS) 2015, Game and Entertainment Technologies 2015, Eds. Katherine Blashki and Yingcai Xiao. July 21 - 24, Las Palmas de Gran Canaria, Spain. ISBN: 978-989-8533-38-8.

Reuter, C., Wendel, V., Göbel, S., and Steinmetz, R. (2014). Game Design Patterns for Collaborative Player Interactions. DiGRA, 2014.

Rivera, G., Hullett, K., & Whitehead, J. (2012). Enemy NPC design patterns in shooter games. In Proceedings of the First Workshop on Design Patterns in Games (p. 6). ACM.

Rocha, J. B., Mascarenhas, S., & Prada, R. (2008). Game mechanics for cooperative games. ZON Digital Games 2008, pp. 72-80.

Seif El-Nasr, M., Aghabeigi, B., Milam, D., Erfani, M., Lameman, B., Maygoli, H., & Mah, S. (2010). Understanding and evaluating cooperative games. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 253-262). ACM.

Smith, G., Anderson, R., Kopleck, B., Lindblad, Z., Scott, L., Wardell, A., Whitehead, J., & Mateas, M. (2011). Situating quests: Design patterns for quest and level design in role-playing games. In Interactive Storytelling (pp. 326-329). Springer Berlin Heidelberg.

Sound Design in Games (2010). Website. Audio Mostly 2011 Conference, September 7-9, 2011. Available at: http://www.soundingames.com/index.php?title=Main_Page

Treanor, M., Zook, A., Eladhari, M. P., Togelius, J., Smith, G., Cook, M., Thompson, T., Magerko, B., Levine, J., & Smith, A. (2015). AI-Based Game Design Patterns. In 10th International Conference on the Foundations of Digital Games, 2015.

Zagal, J.P., Björk, S. and Lewis, C. (2013). Dark Patterns in the Design of Games. Foundations of Digital Games 2013, May 14-17, 2013, Crete, Greece.