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SYSTEMS & DESIGN THINKING – FROM PRACTICE TO THEORY IN GAME DESIGN

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ABSTRACT

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Game design is relatively young and immature as a practice and a field of study. This is clearly evident as a constant turmoil in professional vocabulary, models and education, but also as a frustration in general within the trade and also in the academic research. Especially the common notations and professional (digital) design tools are painfully lacking.
In this concept-centric approach literature review central literature was collected on the topics of game design, systems thinking and design thinking to establish the status of professional discourse and research of the field. In addition, there was efforts to review if there is discussion about more general theory behind game design, and on which topics game studies are focusing at the moment on aforementioned section. Research found out that there isn't established game design models or tools, and of those that have been discussed more broadly are still lacking evidence to support their effectiveness and proper evaluation. However, there is demand for such development while there is some foundational progress on the professional vocabulary and more universal tools for game designers.

Keywords: Game Design, Systems Thinking, Design Thinking, Problem Solving

TIIVISTELMÄ

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Pelisuunnittelu on sekä tutkimuksellisesti, että ammatillisesti vielä suhteellisen nuori ala. Tämä näkyy jatkuvana muutoksena ja tyytymättömyytenä alalla työskentelevillä sekä aihetta tutkivilla. Erityinen pelisuunnittelussa käytettävä ammattisanasto, mallit sekä työkalut odottavat vielä vakiintumistaan ja projektien kaupallinen onnistumisprosentti on hyvin heikko.
Tässä kirjallisuuskatsauksessa tarkasteltiin pelitutkimuksen avaintutkimusta sekä arvostettua ammatillista kirjallisuutta selvittäen, kuinka arvostetut pelisuunnittelijat puhuvat ammatistaan ja työskentelytavoistaan sekä kuinka kokonaisuutta on tutkittu tieteellisesti. Lisäksi tarkasteltiin mitä kognitiivisia ja teoreettisia malleja pelisuunnittelussa on tutkittu sekä mihin suuntaan tältä osalta ollaan pelitutkimuksessa menossa. Tutkimuksessa havaittiin, että vaikka joitakin pelisuunnittelun viitekehyksiä ja malleja on kehitetty, ei niitä olla päästy vertaamaan laadullisesti toisiinsa. Kuitenkin sanasto on vakiintumassa ja kehitys on oikeaan suuntaan. Peliala olisi tahtoa omaksua lisää yhteistä kieltä ja myös digitaalisia työkaluja.

Asiasanat: pelisuunnittelu, systeemiajattelu, ongelmanratkaisu, suunnittelu

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1 INTRODUCTION

Art of design has been serious research field in academia and in practice since devastations of two world wars and the formation Deutscher Werkbund in 1907, Bauhaus in 1919 and others ever since (Buchanan, 2019).

In this research systemic review on literature in concept-centric approach on the concepts of game design, and systems and design thinking. Aiming to take a view on main systems theories, game design research, and how they relate to each other. Emphasis was on primary studies and central work aforementioned theories, going through some key discussions bridging these ideas to modern day research and situation now in the field of practice and research.

For the purpose of this thesis, it was important to start with non-comprehensive look at the discussion around systems and system thinking. Heavy emphasis was not on reviewing the literacy on design thinking thanks to its diversity, however some of the more established concepts were introduced here to bridge the gap between systems thinking and game design. There is no established schools or frameworks for game design thinking thanks to the relatively new and unestablished nature of the art. This could be important finding and future research topic. However, there are valuable work from recent years on the importance of systems thinking in game design (Sellers, 2017), but also learning systems and design thinking using game design (DeVane et al., 2010, Akcaoglu & Green, 2019; Cooke et al., 2020).

It is important to review the current situation of game design research, the framework that is studied with complex design problems and what is the situation of the tools of the trade. The research questions are the following:

1. What are the main frameworks that are studied in context of game design research?
2. What are the current topics in game design research in the context of frameworks?
3. What is the situation of the tools that game designers use for their work?

Research was conducted as a systematic literature review according to Kitchenham (2004) with concept-centric approach (Webster & Watson, 2002). Search strategy was to search most cited academic works with researched concepts and access their primary studies. Primary studies lead the search to latest research on topics where most cited were selected.

Most effective search strings used in Google Scholar to establish the references:

- "game design" AND "design thinking"
- "game design" AND "systems thinking"
- Systems thinking AND design OR design thinking OR game design
- "game design" AND "decision making"

With the selection of sources, the emphasis was on reputable peer review journals. In addition to academic papers, in this research most cited articles and books from reputable game designers were procured for the still establishing nature of the field of game study and practice.

Game designers struggle daily in their work with complex systems and problems. It has been argued that designing games could be seen as wicked problems (Cooke et al., 2020). The creative nature of the work, entertainment side, and interface of player and machine makes the design work tedious. Game designer needs to tolerate uncertainty. Curiosity on the benefit of systems thinking in game design has been discussed amongst professionals and after all the hype, the innovation and progress keeps the professionals waiting. Every designer stays as an island of thinking, vocabulary and tools. Many designers are personally and professionally invested on these matters. Game designers have been calling for common design vocabulary, tools and education (Koster, 2005, 2012; Neil, 2012; Cook, 2006a, 2006b, 2007; Costikyan, 1994).

2 UNDERSTANDING COMPLEXITY

> "System is more than just a concept. It is an intellectual way of life, a worldview, a concept of the nature of reality and how to investigate it – a Weltanschauung." (Ackoff, 1999)

Systems thinking is a mindset to systemically express and dissolve complex problems, whereas design thinking approach the same complex problems with different perspectives in general while addressing those problems (Pourdehnad et al., 2011). Design is act of creative problem solving where less or more complex solutions are evaluated and presented for specific problems (Buchanan, 2019). Concept of a system has been part of design discussion since the beginning of the practice and the study of it, however, is has resurfaced recently in the context of systems thinking and design (Buchanan, 2019). Designing games is "wicked" as the chaotic nature of systems, machines and people make the task intractable. Assignment can be clear, but the process and outcome are uncertain at best (Cooke et al., 2020).

Hypothesis of this thesis is that if there would be practical game design tools game developers would rush to adopt them, thus, there is a reason why game designers still lack shared tools that are considered closely universal and practical.

2.1 Defining a system

It is important to first define system since it is central concept on understanding this thesis. Defining a system is both difficult and simple at the same time. Concept of system is widely understood and shared even in common non-academic language. The wide usage of the word 'system' in many different contexts. Oxford dictionary giving multiple explanations for the word tells the story of widely used, but broadly defined concept (https://www.oxfordlearnersdictionaries.com/definition/english/system).

It is widely accepted that a system can be defined as a relationship of parts working together with synergy for a common goal. (Buchanan, 2019) One simplification is that a system is sum of parts it is made off and the whole is bigger than just mere parts combined thanks to behaviours between the parts like emergency, synergy and coordination (DeVane et al., 2010; Sellers, 2017). In his book professor and game designer Michael Sellers (2017) argues a case about the immense effort humankind has made to reach this metacognitive feat of seeing systems around us. In general people are good at seeing patterns around them and it has been a great evolutionary advantage. Emergency of patterns that are related to each other in less and less obvious ways has taken combined efforts of great minds and creation scientific method. Systems are very useful tool that is difficult to learn (Sellers, 2017).

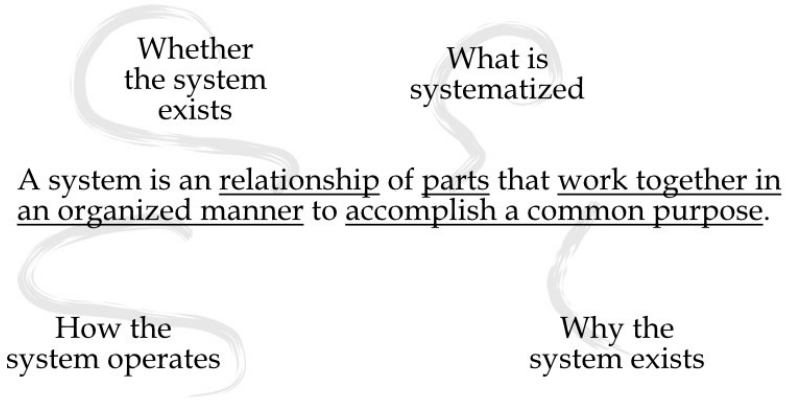


FIGURE 1 Strategic ambiguities in the definition of systems. (Buchanan, 2019, pp. 89)

Professor Buchanan (2019) collected in his recent paper important critique for the systems in his work that help us define the system.

The most fundamental problem about systems is to prove that any of them exists – are systems material or spiritual, organic or artificial, or even arbitrary sets or spiritual? Often the parts of a system can be straightforwardly observable or even tangible as relations between them, but the real evidence for the system as a whole can be difficult to prove. This is the most essential and provocative issues with the study of systems and design. (Buchanan, 2019).

Buchanan (2019) argues that this takes us to the second big problem; dynamic nature of systems makes it really difficult to draw the lines on what is systemized exactly. Possible types of parts in a system are so diverse that different views on separating of parts and their weight in a system can change the outcome or understanding of system drastically.

Previous issue on the parts brings us to next problems with systems; if we have defined parts then *how do they work together in organized manner* exactly? The question is, where to draw the line of system and properties of parts, how does the hierarchy go – which are systems and which are their sub-systems, and what is the process of change and how does the system work. Is the system closed or open to outside influence? How do the parts exactly influence with others – is it mutual, dynamic or something else? Often, this is what is discussed in academical or even daily context when people talk about systems in action – politics, economics or family dynamics for example (Buchanan, 2019).

The fourth most philosophical of the issues is "why the system exists"? This question changes depending on the origin on the system. For example, artificial systems often have a goal and intent, but even they can be real or merely a delusional – sometimes a man-made system does not work as intended. Sometimes such systems can also combine and create new unforeseen problems. This is complex and case sensitive issue that often turns fast into philosophical, ethical or political discourse (Buchanan, 2019).

2.2 Defining Design

Pursuit to research design formally started during design method movement on the 1960's. The Conference of Design methods in 1962 has been seen as a start of design methodology as an academic field. Much of optimistic and establishing research was conducted when science and design was for the first time formally combined during this "design science decade" as it has also been called (Cross, 2001, Kultima, 2018).

Concentrating decades of design research, one definition for design could be formulated as an act to solve problems and situations for human beings for the improvement of human experience. (Buchanan, 2019) Following this definition designer is a person or professional who aims to identify and analyze, research, rank design priorities, test and evaluate solutions for these problems and its parts (Nelson, 2003). While practicing their art designer shuts from their mind parts of the complexity of the environment to focus and solve a specific human problem (Buchanan, 2019). On the importance of design as a skill it is also argued that design thinking is third area in education next to science and arts (humanities) (Cross, 1982).

2.3 Systems Thinking

Systems themselves can be hard to define, but the social sciences have studied systems thinking as a framework for understanding complex phenomena and problems on how parts of a complex whole work alone and together as a system (DeVane et al., 2010).

One common forms of critique towards system thinking and many system thinkers is that when it tries to understand complexity as an arrangement of parts and their relations, they actually create a hard to understand top-to-bottom view of the complex whole. In other words, difficulty of modeling dynamic and complex phenomenon can make systems thinking non-concrete and in worst cases fails to explain its subject in a way that is easy to understand (Buchanan, 2019). Another widely experienced issue of systems thinking is thanks to its somehow artificial nature and innate complexity the difficulty of teaching it (DeVane et al., 2010; Akcaoglu & Green, 2019; Buchanan, 2019).

With practical perspective even with all the criticism towards systems do Buchanan (2019) argues that systems thinking is very useful tool for design and problem solving. Even with situation where existence of systems themselves can be disputed, seeing the world as systems can be useful tool for understanding complexity of human experience, even when those tools are left abstract or incomplete.

2.4 Design Thinking

Design thinking is as a term is broadly contested with different frameworks and models. One way to define the concept is “applying a designer’s sensibility and methods to problem solving, no matter what the problem is” (Pourdehnad et al., 2011).

Design thinking has complicated history where different approaches have been focusing on the study of the designer (human-centric), but also the product (Cross, 2001). In other words, design thinking can be approach and taught with two-part framework separating it to a mind-set of a designer and a process of design (Cooke et al. 2020). One important part of design thinking as a process is the nature of design problems being "wicked” – meaning that the problem might be universal, but during the application or inventing the design the creator must form a specific solution to the situation. General solutions are easy to explain, but particular solutions need exact answers. The nature of cyclic uncertainty of wicked problems is that it needs to be envisioned and designed before the it can be produced. Then once the solution has been produced it can finally be studied. This can be thought as the opposite of science or scientific thinking (Owens, 2007), where something is studied and taken apart to be comprehensive as rules, laws and theories – as Buchanan argues “Design is fundamentally particular, and there is no science of particular.” (Buchanan, 1992, pp. 17). Starting from general aspects of the material in hand and the circumstances a designer can approach the particular design to solve the problem. This is the mind-set and the process of design thinking which is not linear process, but with iteration of refined and adaptive steps designer can get closer to solution that might not even be reachable (Cooke et al. 2020). Owens (2007) would label this creative thinking - combining scientific approach (science thinking) with design thinking.

While systems have been discussed as a part of design since the beginning of the design trade and theory (Pourdehnad et al., 2011; Buchanan, 2019), the systems thinking has become a research and discussion topic more lately in relationship with design and design thinking. According to Pourdehnad and others (2011) the lens of systems thinking has been replacing reductionism with expansionism and analysis with synthesis – basically shifting from reducing everything to parts to seeing everything as sub-systems of bigger systems and not merely understanding the parts but explaining its role in bigger systems.

The problem with systems in practical design work is that often its pressured and improvised by nature which is in conflict with early systems approaches. More deterministic system approaches in all their complexity can encourage rigidity and fail to include complex elements of the system like social, economic or environmental conditions. Systems with high level of abstraction can also lower the resolution and lose individuals and outliers from the model (Buchanan, 2019).

For the purpose of this thesis the breadth of design thinking concepts and approaches are efficiently pulled together by Gaskin and Berente (2011) on their work continuing from Herbert Simons (1996) essential work of the field:

Dimensions	Related Themes	Sources
Generative	Knowledge Creation Learning Cross-community	Alexander, 1964; Avital & Te'eni, 2009; Boland Jr. & Tenkasi, 1995; Boland & Collopy, 2004
Iterative	Generate-test Cycles Abductive Logic	Basili & Turner, 2005; Berente & Lyytinen, 2007; Schön, 1983
Representational	Design Artifacts Models Object Worlds	Bergman et al., 2007; Boland Jr. et al., 1994; Bucciarelli, 1994; Henderson, 1991; Rosenman & Gero, 1996; Schön, 1992
Complex	"Wicked" Problems Intractable	Buchanan, 1992; Checkland, 1981; Churchman, 1971; Yoo et al., 2006

TABLE 1 Dimensions of Design Thinking (Gaskin & Berente, 2011, pp. 105)

In short four dimensions of design thinking are generative as an act of creating new objects or forms for specific purpose or context, Iterative dimensions describes the designing and testing (those) new alternatives, Representational is about describing and communicating different aspects of the design and Complex is about facing uncertainty of not having perfect or final solution (Gaskin & Berente, 2011).

2.5 Game Design

One of the oldest definitions of play comes from the Johan Huizinga (1955, pp. 13) who has been cited widely in game research.

> "Play is a free activity standing quite consciously outside 'ordinary' life as being 'not serious,' but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner."

Defining games and playing has been philosophical effort for decades and for the purpose of this thesis it is not necessary to analyse the discussion in depth. One of the widely recognized definitions of games comes from leading theorists of the field Katie Salen Tekinbaş and Andrew Zimmermann ground defining book:

> "a game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome" (Salen & Zimmermann, 2004, pp. 80)

Game design – "the act of creating playful objects" (Cooke et al., 2020, pp. 4) – has been studied since the turn of 2000's. Game researchers and game designers from both academy and the industry have been trying to establish game design as a science and art.

2.5.1 Problems emerging from practice

One broadly discussed and acknowledged issue is lacking common language or system of notation for game design. In his legendary essay I Have No Words & I Must Design game designer Greg Costikyan (1994) started the discussion about the topic. Soon many other influential game designers including Daniel Cook with his skill atoms (Cook, 2006a, 2006b, 2007) and chemistry of game design (Cook, 2007), and Raph Kosters (2012) work on atomic game design and game grammar have tried to upkeep the conversation and present their solution to the problem. Cook has taken part in organizing Project Horseshoe, an invitation-only game design think-tank that has been organized since 2006 "solving game design's toughest problems" as stated on their site (https://www.projecthorseshoe.com). These renowned game designers have been opening the discussion, but also presenting different models of thinking and different tools to tackle the problems in game design.

In her frustrated blog post in Gamasutra, Katharine Neil (2016) vented her frustration 4 years after her academic collection, evaluation and discussion on Game Design Tools. During those years no real progress was made in establishing game design tools. While game studies can be considered being young academic field (Bem, 2020), she argues that game industry itself should not use the

same excuse for ineffective design practices, lack of tools and working practices in general (Neil, 2016).

2.5.2 Research of game design

As established, game research is still relatively young academic field. First games were studied from the perspective of research of living picture or writing. Soon it was argued that games lack key features from these mediums and add something new that these more studied medias lack. Game research, also called as ludology, or game studies was born from this need as a separate field in the first decade of second millennia (Bem, 2020).

Scholars have tried to present classifications, notations and other methods for game designers and game studies. Some well-known efforts have been MDA framework (Hunicke et al., 2004), Machinations (Dormans, 2009), Carnegie Mellon University's Sketch-It-Up (Karayaka et al., 2009) and Ludocore (Smith et al., 2010), but as Neil (2012) argued there has not been evaluation nor widely known adoption of these tools.

There has been large amount of research in value of games as education tools and making the learner (player) active doing and iterating their mental models and choices instead of merely being the passive consumer (Gee, 2005). Much of this education game research was done around 2010 and the topic has been researched widely in many educational contexts. Harviainen and Meriläinen (2019) summed gamification research having shown great results in some studies but at the same time research is lacking understanding what makes it work when it does. An emerging body of research on using game design as an educational tool of design and systems thinking. When students need to solve problems and make systems as a game, they need deep understanding of the topic and how it's parts work with each other (DeVane et al., 2010; Akcaoglu & Green, 2019).

3 SYSTEMS AND GAME DESIGN

Salen and Zimmermann argue that games are by nature complex systems (Crawford, 1984; Salen and Zimmerman, 2004; Fullerton, 2014) and game designers practice design particularly by making systems. Typical for those systems is that they are interactive by nature to be playable. Game designer Michael Sellers drafts one of central hypotheses in his book around games and systems and argues that game design is system design (Sellers, 2017).

3.1 Academic research on game design and systems thinking

It is hard to discuss about game design without systems. Digital games function as an information system and their sub-systems, but also physical games played with cards, on boards or any other physical form also need interactive and connected systems to create the minimum emergence and feedback loops that any game needs to exist by common definitions (Sellers, 2017).

Earlier research on game-based systems learning focused on observing the interactivity of systems, seeing them live in action and understanding the functionality of parts in prepared systems (DeVane et al., 2010). There has been more research especially on teaching systems thinking and design thinking with game design for children (Akcaoglu & Green, 2019), higher education students alike (Gaskin & Berente, 2011) and professionals of game development and other fields (DeVane et al., 2010).

In Akcaoglu's and Green's (2019) mixed method study they argued that designing games requires using multitude of skills including amongst other systems thinking, problem solving, creative thinking and programming. They studied the interplay of systems thinking as a problem-solving skill in game design course for middle school students and their results showed the effectiveness of game design teaching problem solving and systems thinking.

In earlier study economist were taught systems thinking via playing and design games. DeVane and his research group did not find "magic bullets" but argued that complex topics could be educated more effectively with game design context (DeVane et al., 2010).

In his book Advanced Game Design: A Systems Approach established game designer and professor Michael Sellers presents three-part hypothesis about importance of systems thinking and design for game design: (Sellers, 2017, pp. 6)

1. Game design is system design.
2. A detailed grasp of systemic game design will be informed by – and will itself inform – your ability to think in systems.
3. Systems thinking is as important for the 21st century as basic literacy was for the 20th century.

As many before him Sellers argues that *game design is systems design*. Making emergent, engaging and fun games requires understanding of parts and how they work together. He argues that the better grasp the designer has on systems better games they make.

His second hypothesis is that to combat the ad hoc nature of game design today more informed the game designers become, the better the industry comes as a whole and also the skills of systems and building games will seepage beyond games.

Lastly, he argues that becoming system literate and being able to be creative systems thinker will become as important basic skill as reading in next decades as reading became during last century and he is not alone with this insight as others have paved the way.

3.2 Game Design Tools

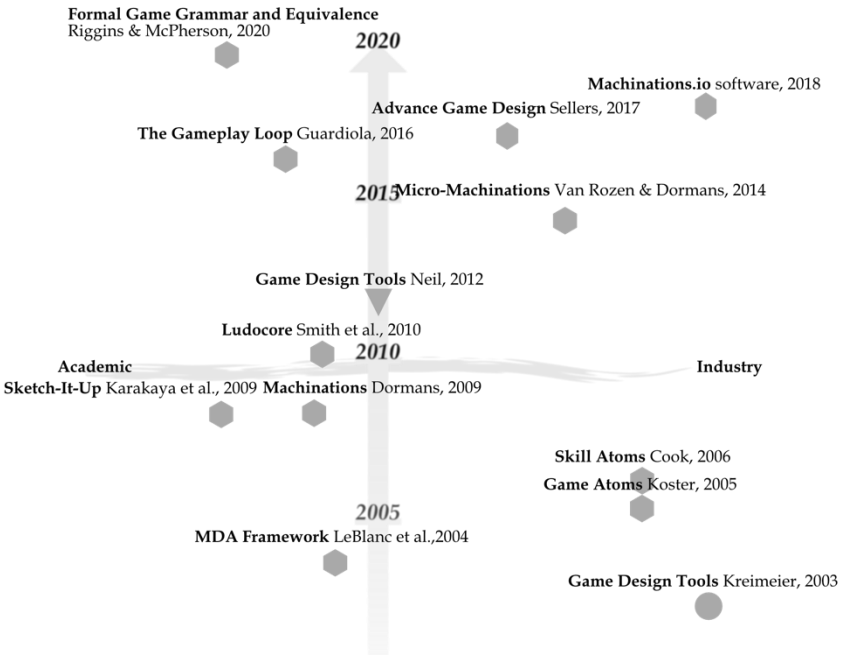


FIGURE 2 Timeline of initiatives around game design

Some important concepts that have emerged from popular work of game designers and researchers. It is imminent that designers lack computer-aided design software, design models and concepts to support their game design efforts (Neil, 2012). Even today most popular tools of game designers are text processors and spreadsheets. Absurdity of the situation can be made clear when these tools are compared to other designer trades - It is hard to imagine same applications could be sufficient as the main tools of architects or product designers. Multitude of explanation for the lack of tools has been presented. Neil argues (2012) that even when game industry widely uses tailored tools for game projects such game

design tools would need the common design tools or graphical notation systems to even developed in-house. In other words, design for game design tools is lacking.

In her 2012 paper Neil presents the main problem with game design research on tools of game design, the point of research of game design praxiology (Kultima, 2015 and 2018), meaning study of the practices and processes of design (Cross, 2007), need to be evaluable so their effectiveness in practice can be confirmed. This data is notoriously hard to get from game companies, but it would be important next step for evaluating the tools.

3.2.1 Game Design Documents

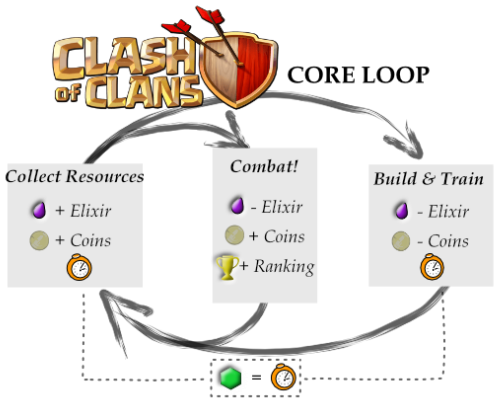
Game design documents (referred later as 'GDD') of different kind have been the basis of professional game design for decades now. Writing everything regarding the game, its goals and design is tedious task and definitely the teams around the designer can't extract enough value of the document (Salen et al., 2004). Human language seems to be too inaccurate for programming the systems games require it describes and there is always too much room for interpretation and human errors in every part of the creation and usage of the GDD. GDDs were the first attempts to formalize game design work professionally, but they have fallen out of grace in professional uses. Different wikis, hypertext solutions and other modern tools have tried to improve the basic concept of essay or small book worth of words, but the tool itself seems flawed. Writing and reading lots of text does just not serve its purpose as a defining communication tool in game teams (Neil, 2012).

There is certainly perceivable value on writing as a design tool and lots of creative work and thinking is done while documenting in different ways. However, usually this product is not the tool that is good in communicating rules, systems, mechanics and relations inside the team (Salen et al., 2004).

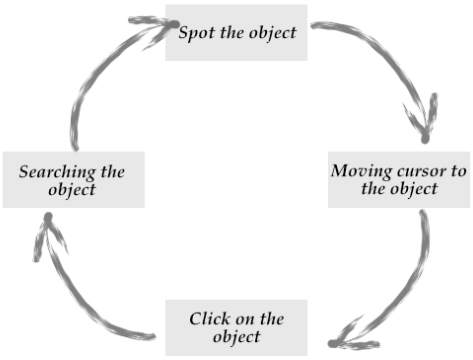
3.2.2 Loops

First attempts in formalizing visual language for game design found in this research were from early 2000's (Almeida & da Silva, 2013).

One of the more established terms in game design acknowledged and used by professionals is the Game Loop. Sellers (2017) defines loops as simplest form of complex systems in games. Loop has parts that interact with each other. Multiple of these loops working together brings the game alive (Sellers, 2017). Game Loop usually, but not always, refers to the representation of the whole game and sometimes includes the player. Industry terms are not too established, and many designers use conflicting terms. Emmanuel Guardiola defined this kind of game loop as Objective Challenge Reward (ORC) model and his academic model from gameplay loop is more atomic in nature when compared to ORC-model (Figure 3).



Core Loop Sellers (2017)
or
Objective Challenge Reward Model Guardiola (2016)



The Gameplay Loop Guardiola (2016)

FIGURE 3 Gameplay Loops (Sellers, 2017, pp. 228; Guardiola, 2016, pp. 3)

3.2.3 Machinations and Simulations

There have been serious attempts to model and simulate the complexity of the games with tools. Joris Dormans and others with his Micro-Machinations graphical notation system (Hunicke et al., 2004; Klint & Van Rozen, 2013; Van Rozen & Dormans, 2014), "logical game engine" Ludocore by Smith, Nelson and Mateas (2010), and more narrative oriented Sketch-It-Up by Karakaya and others (2009).

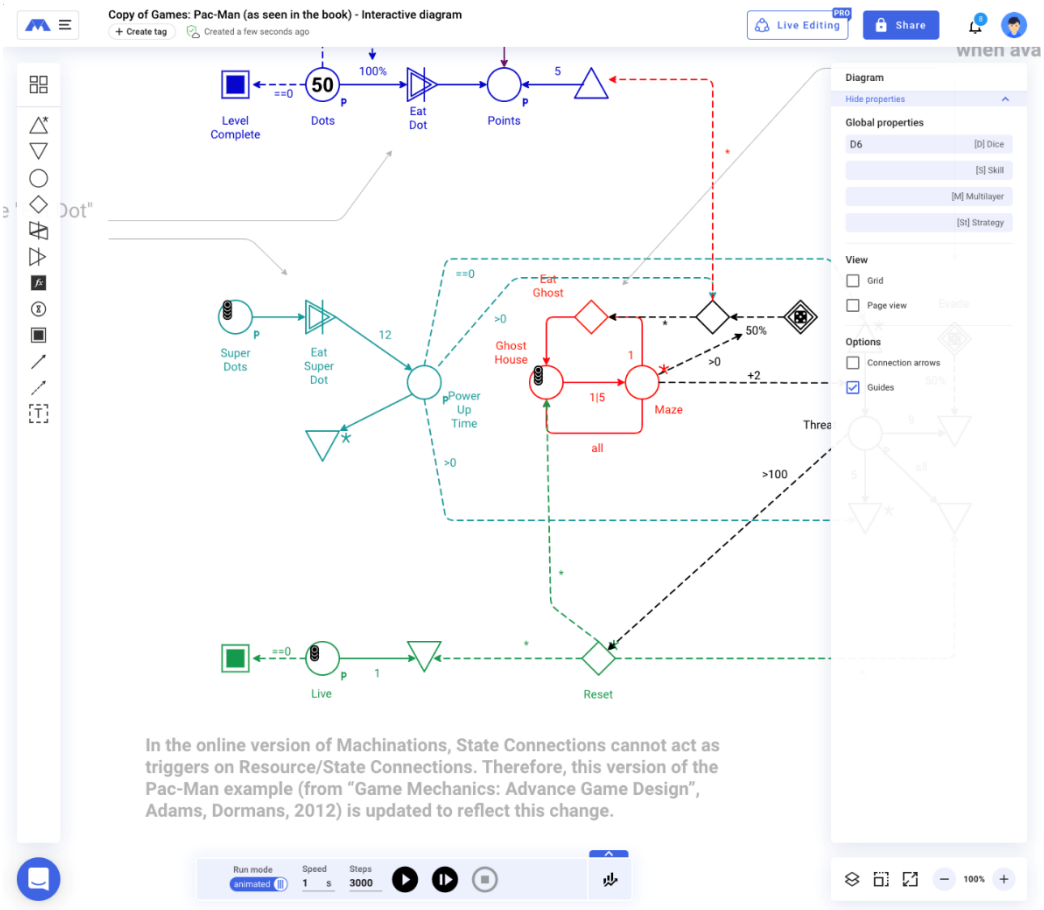


FIGURE 4 Screen capture from Machinations.io

Micro-machinations by Joris Dormans is only professional tool that is available at the moment for game designers as a form of machinations.io. Only time will tell if it reaches popularity. By the end of 2020 it is still developed by a small startup and it is in its beta development phase. On a positive side they are working on the biggest critique of Neil in her 2016 blog post about game design tools not being part of game development flow (Neil, 2016) and trying to integrate the Machinations with Unity game engine and later others.

4 DISCUSSION

Professor Buchanan's critique towards systems resonates with game designers like me and others. On the surface level, the nature of working digitally solves many of the problems in the figure 1, but there is arguably lot to gain from his critique for impending Game Design Thinking.

Buchanan's (2019) approach presented comes more from system analysis side that is only the other side of creating a system. In his paper Buchanan (2019) argues that people might experience their own ability to perceive systems. There is no guarantee it even exists, but it is an attempt to capture the complexity of reality. In other words, every person would probably define a specific system as a reflection of their own life experience and understanding on matter (Buchanan, 2019). This could highlight why game design as an art form is still in its "unself-conscious state" like Neil argued in her essay, and this could even explain why game industry has embraced the "brute-force" design practices like of Data-Driven Design so eagerly (Neil, 2016). Trying to follow Neil's critique and approach game design with more self-conscious creative effort one can turn the Buchanan's insightful critique as a creative tool. Research Questions were the following:

1. What are the main frameworks that are studied in context of game design research?
2. What are the current topics in game design research in the context of frameworks?
3. What is the situation of the tools that game designers use for their work?

Design thinking and systems thinking have been researched around the research of practice of game design, but both are widely under researched (Kultima, 2018). Most game design research has been done around the player and concept game, while game design research – how games are made – is only literally seeing the first papers. In addition to this, game designers still lack graphical notation and common tools for their trade. Tools and practices that other designers in their trades are taught in schools globally are just a dream for designers working to make games.

4.1 New perspectives are needed

Games are made between islands of specialized designers who lack the common language. New research is needed to combine works of design researchers with game studies. Fascinating possibilities can be seen in the realm of systems thinking. It would be trivial to argue that systems do exist in digital mediums. Computer program runs thanks to systems that systems run on systems. They are

literally written open and made to existence with code. In addition to this, it is as trivial to argue that non-digital games are also made out of systems as described earlier in this paper. It seems that it should be more beneficial to turn the order the other way around when actually creating games.

Why does the *game* exist is quite a complex question, that is presented often when starting a new game project. More practical form of this can be seen as a market research. Where variable amount of effort is used to design a product that people actually seek out to play. The opposite of this is passion derived from some other reasons – personal or otherwise – to source the motivation and reasons to start specific game project. In market research founders, product owners, game designers and people in similar roles aim to do backed up clairvoyance to the future to see what kind of mechanics, themes and styles would work for the certain mass of future players. What kind of familiar parts (or systems) should be combined together and innovated in an interesting ways. This is very hard as the success rates of games proves. Most sceptical could argued that it even approaches vanity or wishful thinking. Passion towards the making of the game is not well researched or studied, and I will for now restrain myself taking part of this lively discussion for the clarity of this research.

How the system operates can be seen starting from high-level concepts of the game. Sellers points out in his book that game designer needs to explain all of this first to themselves, next to the team and thirdly to the player – while the last one happens in the chaotic part of gaming. Approaching this from design thinking perspective the designer first taps to divergent thinking to produce a system high-level system of a game. Then they go deeper into the subsystems of that game and finally *try* to create a documentation of sorts of the game. Creating this document or prototype is essential part of design and communicating this design to the possible team that helps to make the project happen. It is argued that further away this design is from functional code, more time is spent on iterating and communicating, which isn't always possible with budgets and time restrains. Finally, the gameplay is taught to the player with the first-time user experience, UI and generally with feedback loops. Balance between holding hand and learning by drowning depends on the target audience and theme off the game.

Next **What is systematized** can be interpreted in many ways. This papers approach comes from the game design work, and the question can be seen as a continuation from where the last question ended – how to establish functional feedback loops to the player. Games can be seen having two kind of systems towards the player – ones that happen in a black-box, outside the players direct perception, and ones that are given to the player as tools. Many UI elements and calculations (for example *damage per second*) can be seen as a later and not all emergence happening in a game is designed to be obvious, clear or even visible to the players. Most visible emergence could be bugs between the systems of a game, but also there is a lot of examples how positive or negative emergence has risen from "non-complete" game design after the games launch.

And finally, the answer to **whether the system exists** needs to be addressed. Frankly, if one has a working game one has a system and by all probability plenty of subsystems. This question could be enhanced with specific meters of success – ranging from business goals like sales or profit to reach and reception of the game by the players. Systems might be something that are only perceived locally in one's head and mind, but games as a form of art and culture don't happen in a vacuum – people play them.

4.2 Limitations and future research

This thesis had a broad scope while trying to bring together both early important and establish work with the latest research on multiple topics.

Goal for collecting literature review was reached, but the vast amount of literature and theories on frameworks of systems and design thinking were omitted while trying to establish a high-level historical and concept-centric view on the topics. Emphasis was on research on game design and other frameworks in the thesis the focus was on the key research about the topics.

To this day, there is not enough research on game design in the academia. A lot of high value blog posts and books were referred in this thesis to support the research. In addition, there is definitely a demand on more research on game design and systems thinking, future tools and education of game design. The broad discussion and research on design thinking was merely glanced in this paper and should be reflected more in the future research.

The demand for this kind of research is clear in the practice of game design. There is body of work for the benefits of systems thinking on designing games, but there is still room for refining models and tools. Lack of these tools or language for game design makes all transfer of knowledge slower and more difficult. This problem persists through the full career and fellowship of game designers. It starts during the education of new game designers as they slow to integrate to their work and every company has to have their own onboarding process'. Frankly, changing employer and onboarding on new company is also a problem with senior game designers for the same reason – all the tools and practices might be widely different. These non-standardized tools and practices also slow down the daily work of game development teams when communication between designers and with other stakeholders with the game. Understanding, communicating and implementing the design are all really complex tasks in themselves and don't need to be made any more difficult.

As a new fascinating topic that emerged during my research was that artificial intelligence research, AI and human collaborative work, and AI's themselves could benefit greatly from strict notations to complexity or "grammar-like formalism to describe finite discrete game systems without hidden information" (Riggins & McPherson, 2020, pp. 8). This is one space of possibility to bring learnings from game studies to broader topics – other industries and other aspects of life as we could understand them better.

5 CONCLUSION

Systems can be criticised for being too abstract, ambivalent and even non-existent, and that they rarely work as a communication tool. Regardless, it is also argued that systems thinking itself can be useful tool for understanding complex phenomena and problems even when the system in hand would be incomplete (Buchanan, 2019). Problem with intangible nature of systems however prevails and learning design and systems thinking has seen valuable or even essential modern life skill that is hard to teach and understand (Sellers, 2017; Akcaoglu & Green, 2019). Game design is systems design (Salen et al., 2004; Sellers, 2017; Akcaoglu & Green, 2019). Designing systems has been shown results of being a valuable tool of developing systems thinking and design thinking skills (DeVane et al., 2010; Sellers, 2017; Akcaoglu & Green, 2019).

There is clear demand in the industry and game studies for more unifying work and practical tools for game design. Game design is only starting to reach some maturity as an art and a trade. There is strong interest in formalizing game design with system design. If there would be practical notation for complex games the designers and industry would be ready to adopt it eagerly. Yet to this day, *the design* of game design tools is still lacking.

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