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Understanding Single Player Computer Games as Experimental Systems

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Introduction

It is a popular opinion that single player computer game play (SPCGP) is deeply intertwined with an element of experimentation. It is possible to claim that the SPCGP arises mainly in the form of experimentation if for instance an unexperienced player engages with a particular computer game, such as *Limbo* (Playdead 2010), for the first time. In order to actually become the implied player (Aarseth 2007) of *Limbo*, the player needs to learn what it is that needs to be done in the game to keep the game in play and to be able to play it (see „gameplay condition" in Leino 2009). Hence, SPCGP implies knowledge gathering practices from the start. In his methodology for game analysis, Espen Aarseth identifies the necessary learning process as a form of experimentation. Aarseth writes "in order to progress through the learning stages of a game, the player must explore various strategies and experiment with different techniques" (2003, 4). In the same text Aarseth relates experimentation with exploration when he speaks of the "experiments of explorers" and thereby classifies the main activities of Richard Bartle's (1996) player type, the explorer, as experimentation (2003, 4). When first playing Bruce Artwick's flight simulator, Game designer Will Wright reports about his engagement with the game in terms of exploration and experimentation, too:

> "The first thing I did was I went in and started exploring the behavior space. Trying all the different things with the airplane. What happens if I go straight up? How far can I go? What happens if I crash? What happens if I do this, that and the other? So I could carry out experiments in this world. And in running those experiments I could get a more accurate view of what the internal model was" (quoted in Pearce 2002).

Wright uses both expressions, exploration and experimentation, to describes his gameplay process as if they were interchangeable or at least indispensable. This element of exploration is also contained in Aarseth's notion of the computer game as an ergodic work, where ergodic is a hybrid term of the Greek "hodos" (path) and "ergon" (work) (Aarseth 1997, 1). In computer game play this element of discovery is often quite literally a form of travelling (see the meaning of exploration as travelling in OED Online 2016). Particularly in first person computer games the player character literally needs to be moved through space and oftentimes to areas which were previously unknown to the player. Likewise the process of scientific research is often metaphorically described in terms of exploration in that a researcher travels into an "unknown area" of their "field" to discover new ground. Accordingly Wright likens his gameplay process to that of "scientific experimentation" (quoted in Pearce 2002).

German historian of science, Hans-Jörg Rheinberger, investigates how researchers in the life sciences actally find out novelties about their subject area. To describe the structure of scientific discovery Rheinberger uses the term "experimental system" (Rheinberger 1997, 1) and even likens this process to that of a game. With Francois Jacob he speaks of the experimental system as a game of possibilities (“jeu des possibles”, c.f. Rheinberger 1997, 76).

Although, computer gameplay is often conceptualized as experimentation and even scientific experimentation is likened to game play there is reason to assume that not all kinds of SPCGP allow to be called experimentation. As such Rheinberger’s theory of the experimental system distinguishes experimental systems from testing devices. Hence the central question for this paper is: Which conditions need to be fulfilled to consider played single player computer games as experimental systems?

This question will provoke answers which are crucial for the field of game hermeneutics which got initiated by Aarseth’s paper on computer game analysis in which he identifies this element of knowledge gathering in SPCGP prominently as “real-time hermeneutics” (Aarseth 2003, 5). In the following this idea has become central to a discourse in the philosophy of computer games which is concerned with the conditions of meaning and interpretation of computer games and goes under the moniker of “game hermeneutics” (Arsenault und Perron 2009; Leino 2010; 2012; Arjoranta 2011; 2015; Karhulahti 2012; 2015; Möring 2013; Vella 2015). This line of thought implies that gathering a certain kind knowledge adds to the *understanding* of how a computer game is and can be played.

To answer this question I will draw on Rheinberger’s concept of the experimental system. I will take on the idea of gameplay as experimenting the game *Limbo* (Playdead 2010) is assumed to support an experimental game play. However, in a short analysis it turns out that the game mainly consists of finding so called “hidden things” instead of true novelties which is necessary in order to speak of experimental systems. Consequently, it will furthermore be argued that games require certain conditions in order to qualify as potential experimental systems. Those are on the one hand games with a certain complexity and openness which allow finding novelties in the gameplay and on the other hand a certain player type who operates with a specific style of gameplay. This distinction furthermore allows differentiating between playing a game and playing with a game (Leino 2010). The latter qualifies as an experimental activity and the further as an ordinary gameplay activity. Eventually, I will discuss four cases differing in degree in which computer games are experimental systems or participate in experiential systems. To come to the conclusion that experimentation happens in games on different levels up to the process of game development and to advance existing knowledge formations like Kriegsspiel advanced knowledge in mathematics.

Rheinberger’s experimental system

I will begin with an introduction of Rheinberger’s experimental system. Hans-Jörg Rheinberger developed the concept of *experimental systems* (Rheinberger 1997) while observing life scientists from the fields of “biomedicine, biochemistry, biology, and molecular biology” at work (Rheinberger 1998, 427). Experimental systems differ from a common sense understanding of experiments. In common sense experiments are considered as “singular, well-defined empirical instances embedded in the elaboration of a theory and performed in order to corroborate or to refute certain hypotheses” (Rheinberger 1997, 27). When Wright says playing Artwick’s flight simulator is “kind of a scientific process. It’s kind of a ‘hypothesize, experiment, change your hypothesis’ type cycle that was going on” (quoted in Pearce 2002), he uses this common sense understanding of experimentation as if the process of playing the game was a “test of hypothesis” or a “theory-driven activity” (Rheinberger 1997, 27) in which praxis is subordinated to theory. Yet, there are at least two problems with the common sense notion of experiment. One results from the point of view of the history of science and one from the point of view of computer gameplay.

Rheinberger refers to Polish biologist and physician Ludwik Fleck who introduced the term "'*system of experiments*'" (Fleck in Rheinberger 1997, 27, italics in original). According to Fleck a single experiment cannot prove a theory; consequently, researchers do not deal with "isolated experiments in relation to a theory" (Fleck in Rheinberger 1997, 27). Instead, "'an entire *system of experiments* and of controls is needed, set up according to assumption or style and performed by an expert'" (Fleck in Rheinberger 1997, 27). Furthermore, experimental scientists often do not work with well-defined research experiments whose outcome is known in advance, but they work with "systems of experiments that usually are not well defined, and do not provide clear answers" (Fleck in Rheinberger 1997, 27).

From, the gameplay point of view there is a problem regarding the primacy of theory over praxis. Gameplay, understood as "the players' actions, strategies and motives" (Aarseth 2003, 2) in a computer game, is not mainly a theory-driven activity in terms of proving hypotheses through theory and testing them through actions. Since it is to a large extent about the player's actions, gameplay has to be understood as a very practical activity as well, which therefore requires a practical hermeneutics rather than theoretical (text) hermeneutics (Möring 2013). Especially fast-paced action games leave sometimes little or no time to shape hypotheses in conscious thought. Hypothesis-building rather takes place during the macro-involvement phase of a computer game which describes player-engagement in moments when the player is not actually operating the game and istead composes strategies (Calleja 2011, 40). Contrary to the common idea of experimentation gameplay does not necessarily begin with theory but rather has to be thought of as a cycle (Arsenault und Perron 2009) with interchanging phases of praxis and theory on equal terms. The same can be said for Rheinberger's concept of experimental systems who refutes "a theory first philosophy of science perspective" (Rheinberger 1997, 26).

Empirically, experimental systems are always determined by their context as for example the institutions in which they take place, the people who work on them, pre-existing knowledge, accessibility of knowledge etc. On the structural level experimental systems consist of a necessarily twofold construction: an *epistemic thing* and a so called *technical object* which are "different yet inseparable" (Rheinberger 1997, 28). An epistemic thing is "an entity whose unknown characteristics are the target of an experimental inquiry" (Rheinberger 1997, 238). A particular characteristic of this scientific object is its implied "vagueness" (Rheinberger 1997, 238) as it incorporates the unknown. This vagueness originates from the paradox that epistemic things are absent while they are at the same time present in the experiment (Rheinberger 1997, 238). Technical objects on the other hand belong to the experimental conditions and to "a wider field of epistemic practices and material cultures, including instruments, inscription devices, model[s] […], and the floating theorems or boundary concepts attached to them" (Rheinberger 1997, 29). The relationship between the epistemic thing and the technical object can be described as complementary; since technical objects "'contain' the scientific objects in the double sense of this expression: they embed them, and through that very embracement, they restrict and constrain them" (Rheinberger 1997, 29). For example a microscope as a technical object determines already due to its materiality and its operational logic the "possible representations of an epistemic thing" (Rheinberger 1997, 29) even before any discovery under the microscope has taken place. The same can be said for games. Everything that is knowable about the logics of a game is always already determined by the game's mechanics, the interface, the game code etc. Rheinberger remarks accordingly "technical objects embody the knowledge of a given research field at a given time" (Rheinberger 1997, 245). Both epistemic things and technical objects have to be seen as two extremes of a continuum which allows for "all possible degrees of hybrids" (Rheinberger 1997, 30) and epistemic things can, if sufficiently stabilized, "turn into the technical repertoire of the experimental arrangement" (Rheinberger 1997, 29). The microscope must therefore be considered as the result of a preceding experimental system than that in which it participates as a technical object.

Limbo: Between Experimental System and Testing Device

One can exemplify and test the concept of the experimental system and its components (epistemic things and technical objects) with the gameplay of *Limbo* by Copenhagen-based game developer Playdead (2010). While it is clear that the gameplay process of *Limbo* supports the common sense notion of experiments, I hypothesize that *Limbo* can be understood as an experimental system because the game mechanics require the player to experiment with the game in order to fulfill the game's gameplay condition (Leino 2009).

At the very beginning of *Limbo* the avatar wakes up on a lawn in a very dark 2D forest in monochrome colors. The game world and the player character are only visible as silhouettes and are therefore difficult to recognize at first. In this initial forest scene no information is given about e.g. why the avatar wakes up, why he is in the forest, what he is supposed to do and so on. Only in the menu the player can access very basic information about possible activities the avatar can perform (moving left and right, jumping, acting on objects). These activities can be considered as technical objects which delimit the space of possible actions in the game and as such the "space of possibility" of the game (Salen und Zimmerman 2004, 66–67). They simultaneously indirectly shape whatever new playstyle can be discovered.

The game's main object should be to find an epistemic thing, an object of knowledge which is not at the player's disposal, yet. One might think the first epistemic thing of the game *Limbo* is to find out "What should the avatar do in the world?" This knowledge, however, is already available to players who have some experience with the platform game genre. Since *Limbo* is a two-dimensional platform game previous knowledge of how to play platform games is present in most game players hence it is likely that the game is approached accordingly. More problematic are the many obstacles (dangerous circular saws, enormous gaps, harmful organisms, etc.) along the way which are often not recognizable at first sight and which require the player to find ways to overcome these obstacles. By using a step-by-step trial-and-error approach the player learns how to avoid a premature ending of the game and how to progress. The epistemic thing – how to overcome the obstacles – shapes only in retrospect, after the avatar passed away several times and the solution becomes clearer which each trial. Rheinberger writes similarly that "epistemic things [...] are recursively constituted and thus intrinsically historical things" (Rheinberger 1997, 76). In the course of a gameplay session some epistemic things, like the usage of a box in *Limbo*, turn into a technical object as this becomes sufficiently stabilized knowledge and thus a method which can subsequently be repeatedly reproduced (Rheinberger 1997, 30).

Limbo builds on knowledge and skills which are successively accumulated through gameplay but the game additionally presents the player constantly with new challenges like for example changing gravity at a later stage of the game. Critics object the game does not support an incremental learning process:

> “Instead of asking you to apply what you learned from your previous deaths, the game keeps changing the rules so it can kill you again. It’s as though it’s making things up as it goes, like a rambling first draft that could use a good revision” (Krpata 2010).

Despite its altering challenges, *Limbo* is no real exception from other computer games which support a more linear learning experience since the interplay of finding an epistemic thing and turning it into a technical object in the process of gameplay is the basis of playing many other computer games. However, the step-by-step trial-and-error character of the gameplay of *Limbo* leads to another critical point. A trial-and-error strategy implies the existence of a correct solution which merely needs to be discovered. Therefore, one could argue that *Limbo*’s gameplay does actually not deal with *epistemic things* but rather with discovering “hidden things” (Rheinberger 1997, 28). Accordingly Rheinberger writes that epistemic things “are not simply hidden things to be brought to light through sophisticated manipulation” (Rheinberger 1997, 28). This description matches the gameplay of *Limbo*. One can argue that the alleged epistemic things in games which are discovered when a player begins playing a game and exploring its gameplay condition, are in fact hidden things. With Will Wright the player tries to “reverse engineer the simulation” (in Pearce 2002) in such a case. Hidden things are characteristic for “testing device[s]” (Rheinberger 1998, 291). Yet, whereas epistemic things are truly unknown, hidden things are characteristics of already known and stabilized mechanics (Rheinberger 1998, 291). In the case of *Limbo* the methods to be discovered by a player were hidden beforehand by the game’s designers. These are meant to be discovered sooner or later. While one can argue that hidden things are at least new to the player who just discovers them, Rheinberger’s idea of innovation refers to knowledge which had not been known to anyone before. Accordingly experimental systems are capable of producing innovations, they are “a game of innovation” (Rheinberger 1997, 31).

Game designers who tend to exhibit strong authorial control tend to design games in a way which is rigid enough to exhibit this control. Yet, if a game is “too rigid”, and produces only “standards or replicas” it is a testing device (Rheinberger 1998, 291). This is the case with *Limbo*: Its limited game world and limited avatar abilities do not allow for many alternative strategies and for each obstacle there is usually only one solution to overcome it. Hence *Limbo* has to be considered a testing device instead of an experimental system. According to Rheinberger for *Limbo* to be an experimental system it “must be capable of differential reproduction in order to behave as a device for producing epistemic things whose possibility is beyond our present knowledge, that is, to behave as a ‘generator of surprises’” (Rheinberger 1998, 287). Differential reproduction means that experimental systems on the one hand have to be partly reproduced in order to be recognizable as the same system and on the other hand they have to be partly changed in order to produce surprises (Rheinberger 1998, 287). The distinction between testing devices and experimental systems is important, since testing devices limit the space of possibility enormously. The notion of testing device is reminiscent of a quality of games which is described as “same-but-different” by Katie Salen and Eric Zimmerman:

“Games possess a quality we call same-but-different. Every time one plays a game, the formal structure remains the same, but the way the rules play out are different. This quality of games makes it pleasurable for players to explore the space of possibility” (Salen und Zimmerman 2004, 361).

At first sight, one might say that experimental systems as well as games imply the same kind of differential reproduction. However, one can argue that in the case of the experimental systems the aspect of the difference stands in the foreground, as its purpose is to produce novelties. In the case of a game like *Limbo* the actualization of different possibilities of the possibility space of the game is known to offer possibilities which have been known before.

The question is now which conditions are necessary for a game to produce real novelties? Which conditions need to be fulfilled so that a game can be considered an experimental system instead of a testing device? The following argumentation is based on the assumption that at least two elements are necessary for a game to be a potential experimental system. On the one hand it needs a specific type of player and a certain type of gameplay in order to be considered an experimental system. On the other hand the game itself must be capable to generate surprises and to reproduce differentially. Therefore the following section argues that to participate in an experimental system a game requires a certain openness and complexity.

Open games of high complexity

In this section I argue that computer games in order to be considered experimental systems need to be sufficiently open and complex. Jesper Juul prominently introduced the distinction between games of progression and games of emergence to the study of computer games (2002, 324). Games of progression are games in which "the player has to perform a predefined set of actions in order to complete the game" and they lend themselves to strong authorial control (Juul 2002, 324). With regard to the concept of the experimental system games of progression like *Limbo* seem to be clear cases for testing devices. Games of emergence, on the other hand, are characterized by a "small number of rules that combine and yield large numbers of game variations", they are thus often attributed with a higher replayability value than games of progression (Juul 2002, 324).

Yet Juul's distinction between games of emergence and games of progression is disputable since both game types are not distinguished by the presence or absence of an element of emergence but rather by their degree of complexity. German computer scientist and software developer Jochen Fromm's taxonomy names four types of emergence: Type I simple intentional/nominal emergence, Type II weak emergence, Type III multiple emergence and Type IV strong emergence (2005).

Juul's game of progression equals the least complex form of emergence: Type Ia Simple/Nominal Emergence without top-down feedback and simple intentional emergence (Fromm 2005). This type of emergence is comparable to "the intentional design of a machine" with specific and fixed roles for each element which never change and are always the same (Fromm 2005). Fromm likens this to the gears of a watch. Thus, the designer controls the game's possibility space in keeping it limited. Type IV emergence represents the highest degree of complexity. Examples for emergence of Type IV are life and culture (Fromm 2005). Comuter games exemplifying this type of emergence are perhaps massive multiplayer games which create their own rules, and economic and political systems on top of the materiality of the computer game such as *Eve Online* (CCP Games 2003) which hence has to be more considered of a culture in its own right than a single player computer game. The game has become so huge and complex that online media which are not dedicated exclusively to news from the field of computer games report about in-game events. For example media and technology magazine *The Verge* reports:

> "EVE Online has its own economics, politics, and trade systems, built almost entirely by players in the 10 years the game has been running. It also has its own wars, as huge alliances vie for control of tracts of space in the massively multiplayer online game. One such conflict came to a head yesterday in the biggest battle in the game's decade-long history. […] The

> resultant damage was valued at more than $200,000 of real-world money" (McCormick 2014).

Juul's observation that "many games can be found on a scale between emergence and progression" (Juul 2005, 71) can be rephrased to "many games can be found on a scale of smaller or greater complexity." Without going to deep into the theory of complex systems and the different types of emergence one can conclude that games with a higher degree of complexity have a better potential for the production of novelties and surprises which qualifies them as potential experimental system as they become less and less predictable the higher their degree of emergence is (I to IV). The degree of emergence and unpredictability equals the degress of openness of a system or game:

> "A complex game, such as Civilization, Deus Ex or GTA3 may be won in a matter of days or weeks, but due to the openness of the simulation and the collective ingenuity of players, the potential for new discoveries is endless" (Aarseth 2003, 3).

Consequently, games which are open in this sense allow for new strategies and tactics to be discovered and developed. In the following new strategies may then change from an initial state of an epistemic thing into a "halfway-hybrid" and later, when sufficiently stabilized, into a technical object or a "method" (Rheinberger 1997, 30). This "method" can then be considered a common way of how to play a specific game. For example, among the plenty different opening strategies of chess some can be considered as sufficiently stabilized that they belong to the standard ways of playing chess.

In addition to the openness of more complex systems, especially "unforeseeable failures and unexpected faults in software and hardware systems" which "are a special undesirable form of emergence" (Fromm 2005) seem to privilege respective games to be potential experimental systems as they enable unintentional surprises to occur during gameplay. Rheinberger argues that experimental systems are productive if they are not well defined as opposed to the classical idea of experiments as well-defined constructions to falsify or prove a hypothesis (Rheinberger 1997, 27). It is therefore possible to distinguish between intended unintentional surprises which occur in complex games (which intentionally are not well defined in the way testing devices are well defined, but well defined in a sense as they enable a certain space of possibilities that is not rigid) and unintended unintentional surprises which could simply be called bugs or glitches. Both kinds of unintentional surprises can be experimentally exploited.

In this sense minor or major bugs present a gap in the game's structure which can be exploited by players to invent new strategies. To give an example let me consider the well-known rocket-jumping trick in *Quake III Arena* (id Software 1999) as decribed by Jesper Juul: "*rocket-jumping* […]is the tactic of jumping into the air, firing a rocket into the ground below, and fluying on the shockwave of the blast. (This is a way of jumping further than you would otherwise be able" (2005, 81). This possibility is exploited as a tactic in the game and provides significant advantages to play the game successfully over a playing style in which this tactic is absent. However, as soon as rocket-jumping becomes a standard tactic, it turns into a stabilized method (technical thing) and a common way of playing *Quake III Arena*. To say it with Heidegger rocket-jumping will no longer be a form of authentic gameplay but become inauthentic (Heidegger 2008; cf. Leino und Möring 2015). With Vilém Flusser one can say that this trick has uncovered parts of the "gameplay competence" ("Spielkompetenz," the sum of all gameplay possibilities a game structure potentially contains) and expanded the "gameplay universe" ("Spieluniversum," the already realized competence of the game structure) (Flusser 1998, 330).

Novelties or surprises can occur in two ways depending on the kind of game. Here Flusser's distinction between open and closed games is useful (1998, 330–331). In open games new game play strategies can be implemented in the game without affecting the game's code or materiality (cf. Leino 2015). In closed games new elements can only be implemented in the game when changing the game's materiality for instance through modifications (cf. Galloway 2006). Open games in this sense are popular games such as *Minecraft* (Mojang 2011), *Kerbal Space Program* (Squad 2011), and *Space Engineers* (Keen Software House 2013). Accordingly these games are often called *open world games.* E.g. *Minecraft* allows for elevators and functional 16 bit computers to be built within the game without requiring a modification of the game software. Yet, both, open and closed game artifacts, can possibly contain bugs and glitches which can be exploited. In these cases novelties are unintentionally already implied in the game structure and need to be discovered in some way (cf. rocket-jumping). Or, novelties are possible by operating on the level of the game structure itself. This would imply the level of game design and of course the level of game modification where the player operates on the threshold of gameplay and game design. Consequently, the aspect of differential reproduction in experimental systems can be found in games which either allows to invent new strategies of play a game in the already available space of possibilities or the game code is modified and opens up a new possibility space on the level of gameplay.

To conclude we can distinguish between closed games with a very weak emergence and high rigidity that are rather testing devices instead of potential experimental systems on the level of gameplay. These games can only be considered as potential experimental systems on the level of game code which requires modifying the game or in case of bugs and glitches. Open games with a stronger emergence can be potential experimental systems on the level of gameplay as well as on the level of the modifiable game structure. Yet, for games to be experimental system requires apart from openness and complexity of a game also a certain type of player or a style of play since these novelties, no matter if on the level of the game code or on the level of game play require to be discovered by somebody.

Innovative player

For a game to be an experimental system requires to also looking at those who play game's and who possibly are capable to operate a game in a way that novelties are disclosed. With Richard Bartle's player types one might argue that for a game to be a functioning experimental system requires somebody who is simultaneously an advanced achiever, killer, socializer, and explorer (Bartle 1996). All these types are to some extent interrelated and can therefore all be important to reveal novelties and surprises. For instance finding out about the rocket-jumping exploit requires a player of *Quake III Arena* to be an achiever, a killer, a socializer *and* an explorer. It seems the explorer type is the most important in this example since explorers can be considered the "experimenters" among the players: "Explorers delight in having the game expose its internal machinations to them. They try progressively esoteric actions in wild, out-of-the-way places, looking for interesting features (ie. [sic!] bugs) and figuring out how things work" (Bartle 1996). For an explorer all other play activities are subordinated to the exploration of a game's inner workings.

It seems Bartle's four player types are a necessary but not a sufficient requirement for a game to be an experimental system. Rheinberger highlights the level of the experimenter's experience: "the more he or she [the experimenter] learns to handle his or her own experimental system, the more it plays out its own intrinsic capacities" (Rheinberger 1997, 24). Aarseth (2003) mentions seven types of game play which reflect different degrees of game play experience. They describe a continuum from very little experience to great experience: 1) superficial play, 2) light play, 3) partial completion, 4) total completion, 5) repeated play, 6) expert play, and 7) innovative play (Aarseth 2003, 6). Clearly, for games to be experimental systems innovative play is the most significant form of play.

In order to regard computer gameplay as part of an experimental system it has to be capable to generate surprises much like Rheinberger's experimental system produces "scientific novelties" and is a "generator[…] of surprises" (Rheinberger 1997, 3). I thus argue Aarseth's types of play from superficial play to expert play focus on exploring hidden things to different degrees of sophistication which represents different degrees of experience as well. This implies all exploring activities which all the non-explorer player types of Bartle do alongside their actual goals, too. As such they can be considered as gameplay activities on different levels. Innovative play, though, takes a step further. Aarseth writes innovative game play "is seen when players invent totally new strategies and play the game not to win, but to achieve a goal by means that are not previously recognized as such by other players" (2003, 6). Hence, innovative game play requires the player to go through all other stages of game play experience in order to gain the expertise essential for an experimental system to function as such. Rheinberger marks this as an "intellectual quality" and kind of "acquired intuition" or "tacit knowledge" (Rheinberger 1997, 77). So, the innovative player deals with the gameplay condition intuitively or tacitly and can pursue her own projects in relation to the game without being stuck in dealing merely with its gameplay condition or with improving her expertise in dealing with the gameplay condition.

Previously, Olli Leino and I referred to this as authentic gameplay, as the highest form of gameplay expertise a player can perform since she manages to transcend the gameplay condition in that her goal is no more to satisfy this condition but to make it work in her own interest (Leino und Möring 2015). With Dreyfus' reading of Heidegger (Dreyfus 1991, 26) we distinguish between three degrees in which a the game artifact can be encountered by a player 1) on the level of materiality, 2) level of the game, and 3) meta-level of materiality/game. The first level is derived from the "undifferentiated mode" (Dreyfus 1991, 26) of being-in-the-world. Accordingly, similar to a new born child a player is thrown into a game but purely encounters its materiality or software by trying to operate it and make it work against the resistance of the gameplay condition. The second level refers to the inauthentic being-in-the-world. This means the player plays a game as it is commonly played including standard skill rules (Suits 2005, 31). On this level she might master playing the game to an extent where the gameplay condition is no longer perceived as resistance. Still she is playing the game in an inauthentic way (the They) or "disowned mode" (Dreyfus 1991, 26) since she does not realize herself in the game but only possibilities which had been revealed already. In this mode the player encounters the game object as game. Only the third level equals authentic gameplay and the "owned mode" (Dreyfus 1991, 26) of being-in-the-world. In this mode the player not only masters the game but manages to transcend the game by playing it in ways which had not been discovered before. On this level the player encounters the game either as material or well as game but contrary to the first two modes the player has the freedom to decide in which mode she encounters the game. *Minecraft* is played in the undifferentiated mode when the player just encounters the game for the first time from whichever place in the game world her avatar has literally been thrown (aka spawned) to. In the inauthentic mode the player discovers different ways of engaging with the gameplay condition like levelling up the character, killing mobs, growing crops, etc. and quite literally does what one does when being in the survival mode of *Minecraft* up until the level of mastery. The authentic mode of being in *Minecraft* then means to "transcend the gameplay condition and the everyday inauthentic being-in-Minecraft" and to "play the survival mode as if it was the creative mode" (Leino und Möring 2015).

Earlier, Leino distinguished two modes of game play which he calls “playing a game” and “playing *with* a game” (Leino 2010, 133). They equal the second and the third level of the triadic model of gameplay just described. Playing a game means to play according to its “gameplay condition” (Leino 2010, 133). E.g. in *Minecraft* (Mojang 2011) this means to avoid a premature ending by letting the avatar get killed. The player’s success in this effort is evaluated by the game. Imagine, a shooting game where the player avatar is under constant fire. In such a game the player cannot simply do what she likes but is pretty much limited by the game’s materiality which provides the gameplay condition. Even if the game world of *Minecraft* might be rich and vast, her wish to explore the world is limited to the extent that she first of all needs to ensure the game’s continuation.

Leino’s idea of “playing with a game” regards “the materiality of the game” (Leino 2010, 133). Leino explains this with the train table mode of *Sid Meier’s Railroads* (Firaxis Games 2006) which is comparable to the creative mode in *Minecraft* as it suspends the gameplay condition. In this mode the player can freely do as she pleases within the possibility space of the game and does not need to pay attention to the gameplay condition. In standard game play mode, the player can only build as many tracks as her budget allows, a limitation imposed by the game’s materiality or its gameplay condition respectively. In the train table mode this does not apply. Though, there is not always a train table mode in many games. The condition of the possibility to play with a game and finally to experiment with a game instead of “only” playing it is consequently to master the game to such an extent that the limitations imposed by the game’s materiality can be overcome and do not have the same limiting effect as they might have for a novice player. On the other hand one could play with a game without respecting the limits imposed by the game’s materiality. For example, an explorer can accept possible game overs and simply ignore the gameplay condition. In the case of a game over she could restart with the last saved game.

On the level of game play it is now possible to distinguish between playing a game according to the gameplay condition (standard game play) and playing with a game as experimenting with the game play condition through innovative exploring game play (game play as experimenting). A second form of playing with a game would be to experiment with the game on the level of its game scripted structure which is possible thanks to game editors which are either developed by devoted gamers or provided by the game developer and which even allow closed games (in the Flusserian sense) to be open on the level of the game structure.

Four ways how computer games can be regarded as experimental system or participate in experimental systems

From this exposition of computer games as experimental systems – provided these are played by innovative, authentic players playing games which are complex enough that these allow for intended unintentional surprises – it follows that there are four different cases, in which computer games become true generators of surprises and thus qualify themselves as experimental systems or participate in experimental systems.

Two of these cases were already elaborated in passing. The first case regards glitches exemplified with example of rocket-jumping in *Quake III Arena*. In line with the idea that games in order to allow for surprises to happen require a certain openness in how their structures play out in the process of gameplay a glitch can be considered a temporary “opening” leading to a temporary “vagueness” of the game artifact which allows discovering a surprising new way of playing the game. The moment though this playing style becomes a standard way of playing the game it has turned from an epistemic thing into a stabilized method or technical object in Rheinberger's terms or a rule of skill (Suits 2005, 37). Hence, this way the rocket-jumping trick becomes a standard approach in dealing with the gameplay condition and becomes part of the gameplay universe. Most players, however, never experience this openness in first person. To them playing *Quake III Arena* for that matter already comes with the built-in rule of skill which is the rocket-jumping trick so that for them it is eventually just about finding out how to perform this method which turns it into a "hidden thing" (Rheinberger 1997) and a "kinesthetic challenge" (Karhulahti 2013). In terms of Möring and Leino's three-layered existential ludological model of gameplay expertise the player to discover the rocket-jumping trick performs authentic gameplay. Yet, the players to follow in playing the game turn it into inauthentic gameplay.

The second case regards computer games of sufficient complexity which are capable of producing novelties by their own means and which do not rely on bugs or glitches to create of surprises. Such games have been described as games of emergence by Juul. I have argued before that these should be considered games of a higher level of emergence than level 1 emergence as suggested by Fromm. These games contain a high level of contingency and which allows them to be generators of surprises. Certainly, *Minecraft* is a prime example for this as it allows engineering machines which were not originally planned by the game's designer(s). Yet, the game's desiger(s) created the game to allow for intended unintentional surprises to happen. Consider also *Kerbal Space Program*. The evidence for this game to be a huge generator of surprises is the large amount of Youtube videos produced by enthusiasts of physics, astronomy, computer games etc. presenting the many different ways in which airplanes and rockets can possibly be engineered (cf. Leino 2009) while having before tested out the many different flying vehicles which can be possibly be built to fulfill the game's goals in the career mode of game and which are hence subjected to the gameplay condition. Like *Minecraft* and *Sid Meier's Railroads*, *Kerbal Space Program* features a creative mode which is not subjected to the gameplay condition and in which experiments can be performed without consequences with regard to the gameplay condition. If my rocket in creative mode explodes this has no effect for the space agency I am setting up in the career mode of *Kerbal Space Program* where each failure has an effect on my budget and future possibilities for what I can do in the game. Like for *Minecraft* the complexity and openness of *Kerbal Space Program* led the player community to produce a Wiki in which new findings are continuously written down. Each creative mode makes sense in light of the existence of the survival mode (*Minecraft*) or the career mode (*Kerbal Space Program*) which both feature a gameplay condition. The creative modes are to the gameplay condition mode what a scientific laboratory environment is to the application of newly gained scientific knowledge and hence human condition in a given society, except for that the creative mode in *Minecraft* and *Kerbal Space Program* equals a laboratory with endless funding. Nevertheless, new findings which help to play *Kerbal Space Program's* career mode in new ways will eventually stabilize and become technical objects which are left to be found by novice players. To understand the second case it is furthermore useful to point out the life cycles of contemporary computer games which have to be considered an ongoing process rather than a fixed object (Aarseth 2001; Taylor 2006; Malaby 2007; Calleja 2011, 9–10). According to Malaby "every game is an ongoing process. As it is played, it always contains the potential for generating new practices and new meanings, possibly refiguring the game itself" (2007, 102). This processuality is not only rooted in developing game player cultures but also in the phenomenon of ongoing game development after publication of the game. This culminates in the current trend of "early access" games which are published although they are still in development and continuously updated. *Minecraft* was first released as "a developmental release" in 2009, version 1.0 was released on November 18 in 2011 (Wikipedia 2016). The game has seen numerous updates and alterations since. Hence, the game is never really fully defined but rather fed with new "vagueness." The same can be said for *Kerbal Space Program.* In the realm of software development this is known as "permanent beta" (Neff and Stark in O'Donnell 2014, loc. 702). Simultaneously, when the gaming community adds functionalities by creating game modifications a game stays vague and can present the player with novelties. But these novelties are only novelties in the sense of an experimental system if they have not been implemented as hidden things to the game awaiting to be discovered. Apart from modifications and designer updates *Minecraft* also features procedural content generation (Shaker, Togelius und Nelson 2016). This means parts of the game world only get generated when the player navigates her avatar to the limits of the existing game world. This is a way how an ongoing vagueness is implemented in the game which potentially allows for new surprises to happen. Game designers can only account for the possibility of such surprises but not for the actualization of such surprises.

This leads to the third case which regards the process of game development. Before a game is released to the public the whole game artifact – including the question of how it should behave, what it should be capable of doing etc. – is an unknown thing which requires a yet unknown answer in the beginning of the development process. Accordingly the game development process has been addressed as an experimental system by anthropologist Casey O'Donnell (2014). Here, however, the game artifact plays a different role. Whereas it *is* the experimental system in the first two cases just described, it only is *a part* of the experimental system in the process of game development. Logically and ideally it should first have the status of an epistemic thing which becomes more and more stabilized and refined before it is turned into a shippable game. O'Donnell observes: "Until a project reaches production, and frequently even after that, almost every aspect of the game development process must act like an experimental system. It must be open, or capable of providing unknown answers" (O'Donnell 2014, 1153–1154). In his book O'Donnell analyzes the structures, stages, practices, technologies, standards, roles (e.g. tools engineer, technical artist, engineers, and game designers) etc. of the production process (cf. O'Donnell 2014, loc. 481-482) which altogether form the experimental system. Without going in too much detail with O'Donnell's analysis it can be imagined that even an open and intentionally vague game can become the epistemic thing and eventually the goal of the production process. How is it then possible to think of an open game like *Minecraft* or *Kerbal Space Program* which are games in permanent beta as being the desired outcome of the game development process as experimental system if the games themselves are potential experimental systems? Intuitively, one might assume that a shippable computer game is a sufficiently stabilized (technical) object in the way that *Limbo* provides the same gameplay over and over again. It is imaginable that at some point in the production process the prototypes of *Limbo* recreated reliably and repeatedly the same way of being played within a small space of possibility and deviation. The game artifact provided *known* answers as it was turned into a testing device before it got shipped. There are also game franchises such as the *Assassin's Creed* series (Ubisoft Montreal 2007) which repeatedly produce new instances of a game by adding a small amount of new features with each new iteration of the game. This is a slightly different form a game being in permanent beta. Each game instance is a technical object in itself which gets opened up for each succeeding version and requires a new iterative process of game development and play testing (cf. Fullerton 2008, 248–276) until the new epistemic thing has been found and stabilized enough. For a complex and open game like *Kerbal Space Program* it must then be assumed that its continued openness derives from a large space of possibility but simultaneously a continuous capacity of providing unknown answers to unknown questions; the latter being the actual goal of the production process. However, parts of the game have to be sufficiently stabilized, too, for it to be identifiable as *Kerbal Space Program* and not some other game. Hence, such games contain a paradox of stability and instability or vagueness and certainty. Furthermore the third case incorporates the first and the second case or versions thereof during the playtesting phase of iterative design. When game design gets implemented into a game prototype and it comes to playtesting, game developers get to know their system and decide which characteristic they aim to stabilize. These elements of the game artifact are then elements in the game which qualify as testing device. Hence if we consider case 1, 2, and 3 as different levels of the game design process, then the testing device parts must be considered level zero. On the second level designers work out which bugs and glitches can be turned into "features." Eventually, for an open game like *Kerbal Space Program* developers decide which elements in the game artifact stay on the testing device level and allow for the recognizability of the game artifact, which open and contingent characteristics they implement, and to which extent the game stays open to allow for future unknown answers to come up. Games understood as permanent beta are then in constant "change and flux" (O'Donnell 2014, loc. 706), constantly oscillating between technical objects and epistemic things. A game like *Limbo* however is not meant to ever reach the third level merely through gameplay as opposed to *Kerbal Space Program* and *Minecraft*.

The fourth case zooms out even more and regards computer games as a) resulting from experimental systems of different fields than games and as b) experimental systems deriving from games but influencing other fields of knowledge. As opposed to the first three cases which focus on the extension of gameplay as the outcome of an experimental system, this case refers to a wider context regarding the relation of computer games to knowledge outside of individual game artifacts. In his dissertation German media philosopher Claus Pias (2000) pursues the argument that computer games ("games which require a computer" (Pias 2000, 6)) required certain knowledge to exist beforehand before there was even a possibility for them to become a potential epistemic thing, a goal of discovery in an experimental process. While Pias identifies three idealtypical kinds of computer games (strategy games are configuration critical, adventure games are decision critical, and action games are time critical) particularly action games required knowledge from fields like experimental psychology with its methods of "measurement of sensorimotor capacities", "functionalism and behaviorism" with its "learning and behavior tests", "work sciences" and their "standardization of options of actions as well as the sequencing of time and space" (for example when working at the assembly line) and the "visibility and commensurability of the computer" (Pias 2002, 11). Paradoxicallty, the fields whose knowledge, technologies, and practices enable the possibility of action games simultaneously bring across what Rheinberger refers to as testing devices. The anecdote of how one of the first computer games came into existence is an example of an experimental system producing a side product today known as *Tennis for Two* (Higinbotham 1958). It is widely known that *Tennis for Two* is the result of the Brookhaven National Laboratory's (BNL) need to demonstrate its work to the public on "Visitor's Day." The inventor of *Tennis for Two*, William Higinbotham, used to develop systems for air-to-ground targeting of B-29 Bombers (Pias erroneously refers to B-28 Bombers) and the Manhattan-Project before he started to work at BNL where he was concerned with the "civil impact of nuclear technology" (Pias 2000, 9). Faced with the pragmatic problem how to demonstrate the research on "ballistics and timing" to the audience Higinbotham used the laboratory's computer and the oscilloscope to create the game which today is known as *Tennis for Two* to make the work of BNL visible and graspable (Pias 2000, 9–10). Hence one of the precursors of action computer games was itself a surprise and an answer to an unkown question deriving from an experimental system intended to calculate problems of ballistics and timing.

Whereas *Tennis for Two* resulted from an experimental system designed for physics von Reisswitz' Kriegsspiel was part of an experimental system which advanced knowledge of war, or more specifically the "battlefield and mathematics" (Hilgers 2012, ix). Phillip von Hilgers' book *War Games* (2012) demonstrates that another direct ancestor of contemporary computer games, the Kriegsspiel (a battlefield simulation between two opposing parties featuring a kind of neutral player whose task is to compute the outcomes of the participant's moves) of the Prussian generals from the early 19th century. The game itself was designed with the goal to being able to teach and evaluate war tactics. Within the experimental system devoted to the epistemic thing regarding how to gain military advantages on the battlefield the Kriegsspiel can be considered a technical object. The comparison between actual battlefield scenarios and the game's capacity to reliably represent those scenarios leads to turning the Kriegsspiel as technical object back to the state of an epistemic thing with the goal to stabilize it again into a technical object accounting for new knowledge gained on the battlefield. Hence, one can say that the Kriegsspiel was in permanent beta as long as it was used to train generals and to lead to useful tactics on the battlefield and even to new war games with an entertainment purpose which in turn were used again for instance to calculate strategies regarding the invasion of Kuwait in the 1990s (cf. Hilgers 2000). For the purpose of this paper I can only provide a very reductive account of von Hilgers' argument and urge everybody who wants to retrace it to turn to von Hilgers' book. The Kriegsspiel was not only instrumental to gaining knowledge on strategies and tactics on war, in line with knowledge from war theory by e.g. Carl von Clausewitz it historically participated in the advancement of mathematics. Von Hilgers points out that among other knowledge formations one of the central problems of von Clausewitz' theory of war were

> "the frictions of war and the 'fog of war' which prompted him to reject the postulate of general calculability. In so doing, he explicitly outlined a concept of probability […], which would first become an epistemological tool of mathematics and physics with thermodynamics" (Hilgers 2012, x).

While "Clausewitz's military doctrine anticipates this development in a theoretical vein" and grasped the necessity to deal with contingency in theaters of war, "the power of command is actually implemented for the first time in the medium of the tactical war game" (Hilgers 2012, xi). George Leopold von Reißwitz developed the tactical war game, taktisches Kriegsspiel, in the beginning of the 19th century. When the Kriegsspiel is put to use, the contingency becomes a "double contingency": once on the level of the game artifact and once again in real war situations for which the game is used to try out the best strategies. Von Hilgers then concludes that the knowledge produced in this process lead to von Neumann's game theory which had a large impact on the calculability of war but also on the way how contingency can be calculated (Hilgers 2012, xii). It is in this regard that the Kriegsspiel was first an epistemic thing resulting among others from Clausewitz' theory of war and which fed back as a technical object into the development of a mathematical theory which ironically has become known as game theory used to make contingency calculable.

Conclusion

This paper provides a different understanding of experimentation in computer gameplay which allows distinguishing between standard gameplay which is often understood with a common sense notion of experimentation and experimentation in the sense of the experimental system. This makes it possible to identify computer games which qualify as mere testing devices whose gameplay has hitherto been described as experimentation.

It has been argued that a certain openness of games is a necessary condition for them to potentially be experimental systems. This openness can occur in different ways: games are open in that they are systems allowing for a high level of emergence, they can be open in that they contain bugs or glitches, and they are open in that they are in permanent beta. In addition to this openness these games also require an innovative player type who plays a game authentically or in an owned mode in that she manages to transcend existing and already discovered styles of gameplay of a given game.

Despite a degree of openness and vagueness also open games need to have stabilized elements which account for their identity and recognizability despite the possibility that the ways of how they are played can potentially change over time.

The four cases discussed of how games are or participate in experimental systems can be regarded as four layers of experimentation which are hierarchical and different in degree rather than in quality. The lowest layer would be games which are so stabilized that these qualify as testing devices. The layer above this consists of games which are mostly stabilized but contain bugs or glitches that lead to temporal opening and vagueness which can lead to new ways of playing them. The following layer consists of computer games which are so complex and open that they allow for intended unintentionalities or surprises of gameplay to occur. These three layers are contained in the process of computer game development. No matter which kind of game developers aim to produce their iterative design requires them to go through singular or all of the lower three layers repeatedly to find out the epistemic thing of their design process. Eventually there is the highest order in which computer games result from new knowledge of different knowledge domains or which help new knowledge be uncovered in non-game knowledge domains. The final layer shows how knowledge practices on very low levels of computer game play are eventually contained in larger knowledge cultures if specific games are relevant for these. This however is historical and does not count for each computer game.

The findings of this paper are relevant for the domains of game hermeneutics since approaching computer gameplay from the theory of experimental systems allows to distinguish different computer games for their potential to bring new knowledge across even though this knowledge is primarily related to knowledge of the game system itself. I believe these findings are also of interest for the research domain investigating games and learning since it shows that games do not always create knowledge just by way of their design. It seems more important that they are embedded in broader research cultures who coming from a specific history of knowledge make use of games at a certain point in their trajectory of investigation.

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