

# ***Do playful systems know that they play?***

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## **Introduction: Reconstruction vs. Reiteration**

If the currently observable tendency to reintroduce play as a fundamental subject of discourse persists, the game studies will be joining established disciplines that traditionally have been concerned with play. This would be, I argue, an important development for three reasons.

First of all, it would provide opportunities to gradually decouple the field from predominant debates about the distinction between (computer) games and other media<sup>1</sup>. As argued before (Straeubig 2016a; Straeubig 2016b), this development would expedite the emancipation as a discipline by emphasizing the role of games beyond media artifacts, while avoiding to reiterate the same discussions over and over again (Quandt et al. 2015).

Then, it is hard to conceive how games can be understood without an equal development in understanding play. While some of the texts considered classics in game studies literature - from (Groos 1901), (Huizinga 1955), (Caillois 1961) to (Sutton-Smith 1997) - have been leaning towards play, a great deal of research on play has taken place outside the discipline (Henricks 2008). Just recently, a rediscovery of play seems to be taking place (Sicart 2014; Stenros 2015; Mäyrä et al. 2015; Mäyrä et al. 2016; Bogost 2016).

Finally, while fields such as psychology, pedagogy, sociology, cultural anthropology and ethology have been contributing a great amount to the present understanding of play, each of them observes play from a specific disciplinary angle. A psychologist may look at play from a developmental or functional perspective, while an ethologist finds evolutionary value in play and a sociologist looks out for intersubjective understanding. I would warn against a situation where the only information on play to arrive at the gates of game studies is provided by these other disciplines. In that case the game studies would become the passive, feeble receiver of original research on play done by others. Its remaining task would then consist in re-interpreting original results produced elsewhere. What would be lacking is a transdisciplinary approach to games and play that relies on its own, independently evolving fundamentals<sup>23</sup>.

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<sup>1</sup> It should be noted that the systems-theoretic approach outlined in this article does not imply a position in this debate. It rather serves as a second-order observation by observing different groups of observers.

<sup>2</sup> "Transdisciplinarity extends the scope, methods and perspectives of existing disciplines whilst at the same time respecting and using the existing disciplinary frameworks." (Punt and Blassnigg, 2013: 2) One could debate the claim to transdisciplinarity after a discipline of game and play studies would have integrated previous perspectives on play. On the contrary, such a discipline would remain transdisciplinary from a traditional (social) sciences and humanities standpoint, while further developing its own methodologies (Lankoski 2015).

<sup>3</sup> For an attempt at a transdisciplinary approach to play see Straeubig et al. (2016).

That said, a renewed focus on play does not reduce the role of games. Observing games from different guiding distinctions allows for further differentiation of the discipline. Through observing the distinction between play and games, both sides of the distinction gain relevance for each other. The question is, what is the character of this distinction? Both games and play can exist without each other, as free play and purely mathematical or structural analysis of games may demonstrate. As suitable distinction I would suggest the one between medium and form (Luhmann 2000: 20-29). By construing games as media for play, we can ask about the properties of the respective medium that enable certain forms of play to take place<sup>4</sup>. We can then additionally take the computer as a medium for games into account, and both games and play can be analyzed by reconstructing epistemological issues that are discussed within the media studies (Krämer 1998). We can also ask about play as a medium (Silverstone 1999: 59-67).

In summary, I am arguing for empirical and theoretical diversity in the game studies and propose to establish the distinction between games and play as subject of study<sup>5</sup>. The aim of this article then is to outline an attempt at a theory based on the notion of "playful systems" and to apply it to a concrete epistemological question. In preparation of this endeavor, its systems-theoretic background must be established first.

## Playful Systems

Both games and play have been discussed in relation to a variety of central concepts, e.g. space (Aarseth 2007), metaphor (Möring 2013), fun (Koster 2013), culture (Huizinga 1955), ethics (Sicart 2009), rhetoric (Frasca 2007), hermeneutics (Vilhauer 2010; 2015), persuasion (Bogost 2010), or function (Burghardt 2005). Other approaches suggest a multitude of perspectives, in theory (Sutton-Smith 1997) or through practice (Schell 2015).

A common characteristic of these endeavors is that they operate based on identities, such as definitions, comparisons, metaphors or relations. Famously, Wittgenstein's solution for the lack of precise definitional boundaries that characterizes games was to soften the strength of the identity relation through the notion of "family resemblance" (Wittgenstein 1968). However, the connective possibilities<sup>6</sup> seem to be limited: we can merely assert that games form a family and play forms a family<sup>7</sup>. Not many impulses for further discourse appear to arise from these observations.

With regard to the phenomenon of play, numerous definitions and explanations have been proposed in various disciplines such as psychology, anthropology, ethology and the

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<sup>4</sup> This perspective is especially relevant for the practice of game design where a canonical intention is to enable meaningful play (Salen and Zimmerman 2003).

<sup>5</sup> Deterding (2016) argues - in much more detail - in a similar vein, while arriving at a different set of recommendations.

<sup>6</sup> This term used in Luhmann's systems theory, "Anschlussmöglichkeiten" in the German original, denotes the autopoietic system to continue its operations by reproducing its elements. The (social) system referred to here is the discourse about games and play.

<sup>7</sup> On closer reading, Wittgenstein considers play to be part of the games family: "In ball games there is winning and losing; but when a child throws his ball at the wall and catches it again, this feature has disappeared." (Wittgenstein 1968: 32)

humanities (Henricks 2008). In the course of these efforts, play has revealed its paradoxical nature and conflicting qualities. Play, as an activity serving no other purpose than itself is considered to be a pleasant pastime. Yet scientists have been eager to comprehend play through functional explanations (Ellis 1973). Being in a playful state does not warrant extrinsic motivation or being conscious of a meaningful purpose. Yet, play creates meaning, as play scholars have emphasized (Salen and Zimmerman 2003; Sicart 2014). Even for animals, fun appears to be central to play (Bekoff 2015; Zylinski 2015). However, the equation of play with fun has been challenged by artists and scholars alike (Mortensen, Linderoth and Brown 2015).

The quest to discover the "nature" of play becomes increasingly difficult in an interdisciplinary context, especially when even fundamental methodology can not be agreed upon. An example from the debate between the sciences and the humanities illustrates the situation. After summarizing the shortcomings of various previous attempts to define play behavior - "many meanings, few answers" - the ethologist Gordon M. Burghardt arrived at the following set of characteristics: incompletely functional, voluntary, modified from its regular form, repeated but not stereotypic and initiated under stress-free conditions (Burghardt 2005). The play theorist Brian Sutton-Smith had met the same challenge by acknowledging the inherent ambiguity of play and had been casting play in terms of cultural rhetorics like progress, fate, power, identity, imaginary, self and frivolity (Sutton-Smith 1997). For Burghardt, the practitioner, who was explicitly interested in a working definition, this approach "does not solve any real issues about play" (Burghardt 2005: 9). The sciences and the humanities stare at each other in disbelief and again, the connective possibilities seem to be limited.

I suggest that the issue behind these findings is not located within the subject but within identity-based approaches per se. A way to overcome the situation is to keep looking for suitable theories. What would a general theory of the ludic necessarily include? It would have to account for games as social situations, as expressions of artistic intent, as rule systems, as commercial products, as living room decorations and as media for play, among others. It also must be able to observe play both as progress and as purposeless activity. It must be able to describe play within the context of a game, as diverse as "[...]the intellectual dueling of two players in a well-met game of Chess, the improvisational, team-based balletics of Basketball, the dynamic shifting of individual and communal identities in the online role-playing game EverQuest, the lifestyle-invading game Assassin, played on a college campus" (Salen and Zimmerman 2003: 33). Still beyond that, it has to account for the rough-and-tumble play of animals, for a toddler playfully exploring its surroundings and for the imitative play of native tribes. It should also explore the edge cases where conceptual and linguistic boundaries are at play. In summary, it must provide a comprehensive description of play, of games and of the relations between the two, and provide a level of abstraction suitable for the observation of a wide range of different phenomena.

I suggest that a theory that is sufficiently abstract, complex, and universal is likely to be found in the area of general systems theories (Arnold 2014; Baecker 2016). As the effort to describe a comprehensive theory for games and play in sufficient detail is beyond the scope

of this contribution, I am merely sketching the outline of my approach<sup>8</sup>. It takes its departure from the distinction between distinction-based and identity-based approaches (Derrida 1973; Luhmann 1984). My project attempts a reorientation towards theories that are grounded in distinctions and their logical (Spencer-Brown 2008), epistemological (Maturana and Varela 1980) and meaning-constitutive (Luhmann 1996) roles. In particular, I propose distinctions as a suitable methodology for describing play (Straeubig 2015).

It is important to note that the term "system" is used from this point on in the sense developed by Luhmann (1996). That meaning of the term departs from its common language usage that is predominantly found in game design and game studies literature. Thus, a system is not observed through its elements that are related or connected to act in a specific way, like in the description of a game as a system of rules (Salen and Zimmerman 2003: 48-55). It is also not construed as a classical cybernetic loop that works through feedback and control (Salen and Zimmerman 2003: 212-229). Neither is it understood by deriving its meaning from the notion of physical ergodic systems (Aarseth 1997). These older concepts of systems cannot provide the sufficiently complex systems-theoretic background that is required for the endeavor outlined above. Only with the introduction of the observer into the cybernetic system, we are able to observe systems observing systems (Glanville 2002)<sup>9</sup>. Another difficulty may lie in the fact that the denotation "general systems theory" is not specific enough to denote a particular theoretical position<sup>10</sup>. To introduce some necessary terminology, I will therefore give a brief account of the theoretical fundament of my reasoning, which is based on general ideas taken from the German sociologist Niklas Luhmann.

Luhmann sketches out a general systems theory, in which he distinguishes biological, psychic and social systems, among others (Luhmann 1996). Biological systems operate with transcription of DNA, transport of pheromones and electric activation potentials, psychic systems with thoughts, intentionality and meaning. Social systems operate with communication, and Luhmann focuses on them in the development of his work. Examples for social systems are: a game, a mailing list, a scientific publication including its production, dissemination and reception, a game studies research group, a religious community, art, economy, law (as subsystems of society), and society. Distinct systems may be structurally coupled, as in an ongoing game of chess (a social system) between two players, whose minds (psychic systems) and bodies (biological systems) are necessarily involved.

Those systems are autopoietic, which means they are operationally closed; they are re-constructing their own elements. In contrast to theories of complex (physical) systems, autopoietic systems are not characterized through the relation between system and element, but through the one between system and environment. Systems cannot be controlled or

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<sup>8</sup> A step towards the development of this theory is subject to my forthcoming thesis, a summary of which can be found here: (Straeubig 2014).

<sup>9</sup> The introduction of the observer marks the distinction between "classical" cybernetics (Wiener 2007) and "second-order cybernetics", or "cybernetics of cybernetics" (Mead 1968; Foerster 1995).

<sup>10</sup> Arnold (2014) and Baecker (2016) provide overviews over different strands and directions of systems theories.

determined by other systems in their environment, rather they mutually perturb each other<sup>11</sup>. In particular, those kinds of systems are not "totalizing structures" as Bogost claims (2006: 6).

This thinking is fundamentally based on distinctions in place of identities. In particular, Luhmann incorporates George Spencer Brown's (2008) concept of distinctions as the basic operation of observation. Each observation divides a current, observer-dependent conceptual space into two sides and selects one side. The observer may then either cross the distinction, introduce another distinction within it, or re-start from unmarked space. Thus systems, located in their respective environments, observe each other by drawing distinctions and denoting sides. In this way, there is neither an observer-independent truth nor a position from which such a truth can be established.

Luhmann (2009) describes knowing as autological: knowledge pre-supposes knowledge. The main system reference he selects to observe knowledge is the social system, i.e. knowledge is located within communication (as opposed to located within minds or brains). As a consequence, being human is not a prerequisite for knowledge, nor is knowledge located inside the head. Instead, it is construed as "[...] regardless of the corresponding mental state, a structure that contributes to the facilitation of the autopoiesis of communication."<sup>12</sup> Thus, knowledge requires the participation of systems that are of sufficient complexity to operate with meaning. A system is complex when it cannot actualize each of its elements simultaneously; some of them must be potential. Meaning is construed as the medium in which a system can observe the distinction between actual and potential. This distinguishes psychic and social systems, which operate with meaning, from biological ones, which do not.

The notion of a "playful system" (Straeubig 2015) is based on these specific systems-theoretic foundations. It allows to query games and play through a large number of distinctions such as play vs. work, internal purpose vs. external purpose, playful vs. serious, play vs. fun, dark play vs. play (Mortensen et al. 2015), play vs. flow (Schrank 2010), playful play vs. play (Bateson and Martin 2013), play vs structure (Salen and Zimmerman 2003), play vs. game, games vs. art (Schrank 2014), or imaginary vs. real. Therefore it observes the phenomena related to games and play while avoiding anthropocentrism, however not at the expense of metaphysical object speculation<sup>13</sup>. In particular, its own inquiry is based on the method of distinctions. In the following section I aim to apply the theory and its inherent method - observing phenomena through distinctions - to the epistemological question posed in the title of this article.

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<sup>11</sup> This does not preclude some types of systems to rely on each other: if in the chess example one of the minds stops operating, the social system also ceases to exist. The same applies to the biological systems.

<sup>12</sup> "[...] was immer der korrespondierende Bewußtseinszustand sein mag, eine Struktur, die zur Ermöglichung der Autopoiesis von Kommunikation beiträgt." (Luhmann 2009: 134)

<sup>13</sup> Compare Bogost (2012).

## Does Nathan Drake know he is playing?

For the sake of the present discussion I will translate the abstract question "how does a playful system distinguish between play and non-play?" into a concrete, albeit somewhat speculative query: Assume you are playing the latest installment of Uncharted<sup>14</sup>; would Nathan 'Nate' Drake, protagonist of the series, in this situation know that he is playing?

To get a hold on this question, while avoiding to introduce the systems-theoretic construction of knowledge as a prerequisite, let us stipulate that a system S knows a proposition P iff A believes P, A is justified in doing so, and P is true<sup>15</sup>. From here we could draw a number of ontological and epistemological distinctions, such as the one between true and false, knowing and believing, justified and non-justified belief, and so on. The aim of our discussion suggests different distinctions: the one between play and work (i.e. which prior knowledge would Nate need to possess in order to make this distinction), between autotelic and heterotelic (is Nate doing what he is doing for its own sake or are his actions guided by external purposes), between intradiegetic and extradiegetic (would Nate be able to reason about the world outside of the game), between Nate and a human player (which mental capacities would be required of Nate, construed as a psychic system) and between the first-person and third-person perspective (observing Nate vs. being Nate)<sup>16</sup>.

## Does Nate play?

I begin with the distinction intradiegetic versus extradiegetic. Within the game world, it seems obvious that Nate, as a fortune hunter, is at work. "I am a man of fortune and I must seek my fortune."<sup>17</sup> (Sony Computer Entertainment 2016) From this motto and from the nature of Nate's profession we might reach the opinion that he conceives it more as a calling than a mundane job, ascribing higher meaning to his activities. These include driving, climbing, diving, fighting, shooting, collecting items, exploring the surroundings, and interacting with the other game characters. While play in Burghardt's definition is characterized as "incompletely functional" and "initiated under stress-free conditions", Drake's actions appear goal-oriented and the conditions under which he operates are often the opposite of what we would denote as "stress-free". Moreover, in his motivations he is clearly driven by external purposes, namely the hunt for treasure.

If Nate plays within the game world, he does so twice during Chapter 4 of the game<sup>18</sup>, where he first shoots with a toy gun, thereby imitating usual work behavior, and later plays the video game classic Crash Bandicoot on a virtual Playstation 1<sup>19</sup>. In the toy gun scene, play is also signaled to the player by the denotation "Toy Gun" in the overlay on the screen, and by the appearance of the weapon, its actions shooting soft bullets, and the targets in the scene,

<sup>14</sup> (Sony Interactive Entertainment 2016).

<sup>15</sup> This schema is originating from Plato's Theaetetus dialogue. The epistemological tradition has been criticizing this classical characterization of knowing, discussed in detail by Rescher (2003).

<sup>16</sup> (McGinn 1996)

<sup>17</sup> This quote from the game trailer and the game introduction, which has been ascribed to the pirate Henry Avery, is a nice play with the double meaning of the word "fortune" as fate and as financial wealth.

<sup>18</sup> A playthrough of this chapter is available online at (Martin 2016).

whereas Nate's utterances, the dramatic music and the movement animations are imitating "real" shootings inside the game world. During the dialogue between Nate and his wife Elena in the second scene, we learn that Nate plays for a prize (who of them has to wash the dishes), and also to impress Elena. Thus we could analyze this particular situation further through the distinction between playing with and without external rewards and discuss phenomena like e-Sports (Sky and Sunrise 2016) and Let's Plays (Ackermann 2016) on this background. Following these connective possibilities would imply crossing the distinction to the extradiegetic, however <sup>20</sup>.

We can imagine a second way in which Nate could play within the game world, exemplified by a phrase like "he is playing with his enemies". For example Nate could - controlled by the player - try to "exhaust" his adversaries in a playful manner. Whereas this behavior appears to be playful in animals, it is likely to be purely functional (Tabor 2003). As before, following this direction might open up interesting questions, here about the observability of play behavior, especially from an ethological perspective (Held and Špinka 2011).

Again we have crossed to the extradiegetic side, where we now observe Nate as a virtual artifact. Here we can analyze Nate's relationship to the player through other distinctions like the one between a toy and a playmate. Yet, in contrast to both of them we would not say "we play with Nate", "but we play (as) Nate", with Nate acting as an avatar. Although the avatar represents the player in the game world, or even embodies the player in the game world (Klevjer 2012), its intradiegetic status in respect to play is contingent on the player's behavior, as we have just established: while the player plays, the avatar may be at work or playing.

Finally, by crossing the distinction between play and game into the side of the game, we could argue that Nate is actually working. The purpose of Nate's work is to entertain the player, not unlike an actor in theatre, who however might be trained to experience play from the first person perspective (Stanislavsky 2010; Csikszentmihalyi 1991) while he is at work from a third person perspective. It is the observer who selects the respective system reference. The question if Nate might have a first person experience will be discussed below.

By introducing the distinction between a game as a phenomenon observed by the scientific system and an economic commodity, Nate also represents a means to an end - him being an artifact created to generate revenue for the publisher and creators of the game. Nate's fortune, in a quite literal sense, depends on the economic success of the game, as the code of economy as a subsystem of society are payments (Luhmann 2008), and connective possibilities therefore depend on sales figures. And indeed, Nate's prospects appear to be bright in this regard (VGChartz 2016).

### **Are Nate's beliefs justified?**

To return to the question if Nate knows that he is playing, we now look at the second criterion, namely the question if Nate has reasons to believe that he plays; we will suspend the question if Nate actually believes that he plays to the following section. At this point, we

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<sup>19</sup> The avatar in the Crash Bandicoot in-game game is controlled by the player, so in effect the player plays one virtual character through another virtual character.

<sup>20</sup> Following up with the distinction between intra/extradiegetic and transdiegetic that Jørgensen (2007) applies to game sound seems a promising alternative route.

have identified two different possible meanings for the statement "Nate plays", an intradiegetic one in respect to specific scenes of the game, and an extradiegetic one in the sense that the player plays Nate as an avatar, which applies to the interaction during the whole game. If we analyze Chapter 4 of "Uncharted 4 - A Thief's End", we can conclude that inside the game world, Nate has all reasons to believe that he is playing. The context and scenery in both situations, the information he receives from Elena, the toy gun, the game console and the game itself that Nate is interacting with, they all point to play<sup>21</sup>. If Nate had the ability to reflect on Burghardt's criteria for play mentioned before, he would notice that literally all of them are fulfilled.

In the second case, with Nate's role as an avatar, we again have to "bracket" the question if Nate is actually able to hold beliefs until the next section. Therefore the question is, presumed Nate is able to believe and he does believe that he plays, would he have justification to do so?

Distinguishing character-play from embodied presence, Klevjer (2012) argues on the background of Merleau-Ponty's (1962) body-oriented phenomenology that within the game world an avatar acts as a proxy for the player's own body through what he calls "prosthetic telepresence". The avatar and the body of the player are separate, yet structurally coupled systems: "[...] the avatar does indeed re-locate our body into screen-space, not as fiction but through a re-configuration on the level of the phenomenology of the body." (Klevjer 2012: 28)

In observing this phenomenon, we are re-introducing the distinction intradiegetic vs. extradiegetic within the extradiegetic side<sup>22</sup>. For the avatar we can assume the same phenomenological situation as before - nothing has changed. But would Nate on the extradiegetic side of this inner distinction find justification for the belief he is playing? For Klevjer, Nate is related, via the prosthetic telepresence, to the body of the player, within whose environment we have to look for evidence corroborating the belief that Nate plays. And what do we find here? It is "the core prosthetic element, which plugs into our body in order to disappear under the radar [...] the controller interface." (Klevjer 2012: 25) The interface alone does not tell us if play is happening. What else is there? We assume there is a psychic system coupled with the body, so we might want to interrogate the player through a social system, for example by asking: "Do you play?". The answer may be yes or no. As we have seen before, avatar and player are not determining each other regarding their play status. The player could move the controller mindlessly or do so systematically in order to test the hardware; the avatar could work or play inside the game world. This means that there is no answer a priori, so we have to relate it to the respective concrete situation that we observe.

### **Does Nate believe that he is playing?**

The remaining question to be discussed is if Nate believes he is playing. Let us tackle the intradiegetic case first. After toying around with the Nerf gun and being called for dinner, Nate utters the phrase "Well, play time's over", clearly demarcating (and crossing) the boundary of an intradiegetic magic circle (Huizinga 1955). A short while later he plays the in-game video game, and from the dialogue taking place during that scene it is justified to infer that Nate here also believes that he is playing. In summary, we have established for Nate's

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<sup>21</sup> As mentioned above, we may interrogate the idea of playing for prizes, yet we probably would conclude in this particular case that playing about "who washes the dishes" could be considered as play.

<sup>22</sup> In terms of Spencer-Brown (2008), what we attempt here is an re-entry into the distinction.

phenomenological perspective within the game that - based on the Theaetean criteria - Nate knows that he is playing.

Now the remaining case to be investigated is the thorny one - stepping out of the game world we need to ask ourselves if we can ascribe beliefs to Nate. Here, "Nate" refers to a virtual entity that is in principle observable through inspection of its source code. Metaphysical ontologies a la Bogost (2012) aside and even without precise knowledge about his current implementation, we would be hard pressed to ascribe human-level reasoning or even self-awareness to Nate. To hold a belief means to have a propositional attitude, that is a mental state which is directed towards phenomenological content (McGinn 1996: 8). To believe that he is playing, Nate must be capable of self-reference, he must be able to distinguish play vs. non-play and must be able to ascribe play to himself.

In total, these capabilities seem to be out of reach for a present Nate, yet considering recent developments in artificial intelligence and machine learning, we can expect that in the future, an artificially intelligent Nate might have access to extradiegetic information, possess cognitive functions and and be capable of metacommunication (Bateson 2000).

The first prerequisite, drawing a distinction between the self and the other might require less complexity than previously assumed (Cammaerts and Cammaerts 2015). Considering the distinction between play and work and re-introducing it in form of the distinction between autotelic and heterotelic experience, we can subscribe to the following thought experiment: If Nate (or any machine for that matter) was aware what it is doing, would it be more likely that it would be aware of being working or playing? Observations of animal play (Burghardt 2005), some evidence from neuroscience (Panksepp 2010) and the characterization of flow as absence of self-consciousness (Csikszentmihalyi 1979) would let us lean towards the latter. However, this answer is rather appealing to formal argumentation than drawing strength from strong evidential corroboration. Therefore it must be regarded speculative in the context of the larger debate about consciousness (Chalmers 1995). And even with a good deal of speculation, the question whether the extradiegetic Nate knows, remains undecidable from the third-person perspective.

### **Conclusion: Crossing System Boundaries**

Despite recent glimmers of hope, research on play is still lacking a firm trans-disciplinary grounding. While the praxis of creating playful experiences naturally lends itself to interdisciplinary collaboration, the theoretical treatment of games and play has not yet found an adequate approach - especially regarding the fact that the game studies have been entangled in categorial debates, while trying to differentiate themselves from the existing field of media studies. As play itself, the study of play has demonstrated a healthy resilience against definitory attempts.

In this article I have presented a modern systems-theoretic approach derived from constructivist and second-order cybernetic roots. I argue that it is characterized by conceptual precision while avoiding getting stuck in definitional disagreements. I have applied this approach to an epistemological question and discussed the resulting observations through different distinctions.

Finally, I believe that a system-theoretic approach to play and games will be of general benefit for the game studies. To reach this goal the body of the theory has to be developed in greater detail in future work. One proposed strategy is to explore computational approaches. For example Zook, Magerko and Riedl (2011) have implemented an architecture for modeling play. Other researchers are training machine learning algorithms on game interfaces (Mnih et al. 2013; Schrum, Karpov and Miikkulainen 2012). They are joined by translations of constructivist approaches into concrete implementations (Perotto 2013; Roesch et al. 2013). The actual creation of a playful system that is based on systems-theoretic principles, however, has yet to be completed<sup>23</sup>.

## Games

CRASH BANDICOOT. Sony Computer Entertainment, Sony Playstation 1, 1996.

UNCHARTED 4 - A THIEF'S END. Sony Interactive Entertainment, Sony Playstation 4, 2016.

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<sup>23</sup> A first step into that direction is attempted in my forthcoming thesis (Straeubig 2014).

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