Holodeck as a Medium for Future Enacted Narrative Experiences

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Abstract. This paper describes how the fictional concept of Holodeck can be seen as a new medium for future enacted, narrative experiences. The paper tackles the medium through the holonovel writing activity and pursues its design process within the art education context. After introductory literature review, the paper presents important terminology for the holonovel design process, including the setup, important stakeholders (holodeck characters) and those critical units and entities that are needed for defining the settings.

Keywords: Holodeck, Holonovel, Science Fiction Prototype, Art education, 4D/AR/VR/MR experiences

1   Introduction

This paper describes how the fictional concept of Holodeck can be seen as a medium for future enacted, narrative experiences. In general, Holodeck may be understood as a plot device used in stories set within the *Star Trek*[2] ® universe [1]. This fictional technology permits stories with locations and characters that could not otherwise exist in the settings of *Star Trek*. In the television series, Starfleet personnel use Holodecks, e.g., for leisure activities, training, diagnostics or scientific experimentation.

From the technological side the origins of the medium can be traced back to Gene Dolgoff, whose holography laboratory in New York City, built in 1964, stood as the background for the conversations with Star Trek creator Gene Roddenberry[3]. Since those days, the technological redevelopment has been slow, as even today the Holodeck technology still remains fictional. It is anticipated, however, that similar virtual reality tools may become consumer-ready products in the reasonably near future. Contemporarily,

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[1] In co-operation with Aalto ARTS, Department of Film, Television and Scenography, Production Design.

[2] STAR TREK ® is a science fiction television and film franchise, http://www.startrek.com

[3] Gene Dolgoff's Keynote in the first CSf Holonovel Workshop, hosted by the European Association for Innovation (EAI) at the conference 'Technology, Innovation, Entrepreneurship and Education (TIE'17)'.

2

the technology may find reference e.g. from the emergent 4D/VR/AR/MR environments.

When considering the ingredients of a Holodeck in more detail, the technological aspect includes different simulation types, which change their status seamlessly as the person interacts with the environment[4] (see Fig 1). For example, if the person inside Holodeck sees a distant tree, the projection is created in the walls of the environment. Then, if the person decides to approach the tree, the image of it will be projected into the space as a hologram. These holograms can further be augmented with "force beams" that simulate solid, tangible objects, which is the case if the person, for example, leans on the tree. When s/he breaks off a branch, the simulation type changes for the "Holodeck matter". Holograms and force beams can be augmented with replicator technology to provide actual substances like food, which is the case if the person picks and eats an apple off the tree. In ccurrent mixed reality environments, the projected reality may be referred to in the Virtual Reality (VR), whereas the force beams and transported matter may be seen as the visual layer of Augmented Reality (AR) technologies. The metaphor for the replicated matter may further be seen to present the Real or Mixed Reality, or in some cases, 3D printing technology.

Fig. 1. If an object's status changes, the simulation type will change seamlessly as well in the Holodeck (Fig. left and centre: courtesy of Paramount Pictures/CBS Studios).

As the Holodeck technology remains fictional, this paper takes a stance that more important than the material aspect is highlighting how the medium may be used as a means to explore the aesthetic, philosophical, sociological and ethical questions it promotes. As for that, the medium requires a design perspective, which, in the *Star Trek* franchise, has been described by the authoring process for creating the *holographic novels*. This writing process has been explained in the episodes more explicitly as an activity pursued by *holonovelists*. These holographic novels, i.e., *holonovels*, have been described including at minimum a narrative story with a protagonist, characters and a plot, and the holographic program that runs the narrative. If the role of the protagonist and characters are considered more closely, most Holodeck programs seem to run in the first person "subjective mode" and the other characters are usually computer-created holograms or other personnel onboard the spacecraft.

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[4] How does it really work? Holodeck and Computers FAQ, Joshua Bel, Retrieved: April 23 2018: http://www.calormen.com/star_trek/FAQs/holodeck-faq.htm

The material for this paper has been studied and introduced within the art education context (at Aalto ARTS, Department of Film, Television and Scenography, Production Design) with the main intent to create "scientifically credible" myths around the concept of Holodeck. The main methodology to carry out the holonovel writing activity was the study and creation of science fiction prototypes (SFPs) [2-6], that was carried out within a formal art education course.

2   Key Theory and Applications

The concept of Holodeck, from the theoretical aspect, has been most thoroughly introduced by Janet Murray,1997, in her seminal work "Hamlet on the Holodeck – the Future of Narrative in Cyberspace" [7]. Murray's ideas are in great debt for Brenda Laurel's earlier work "Computers as Theatre", 1991, which focused on the different type of interactive forms and, in particular, first person, computer-enabled storytelling [8]. Basically, Laurel explains how Aristotelian dramatic experience is the model toward which interactive computer experience designers should aspire. She extricates how the dramatic, Aristotelian stories can be distinguished from narrative stories by three tension properties: 1) enactment vs. description, 2) intensification vs. extensification, and 3) unity of action vs. episodic structure. In essence, Laurel introduces the concept of interactive drama, whereas Murray uses the term Cyberdrama, and explains that it is an attempt to marry the structures of games and stories. The most profound idea in both is to turn the attention towards those new media artifacts that resemble theater, cinema and television, and emphasise the enactment of the story in the particular fictional space of the computer-enabled environment.

Murray's work elaborates Laurel's ideas by explaining three important concepts that are vital for experiencing the holistic narrative form: *agency, immersion and transformation.* Agency is described as the pleasure of interactivity, which "arises from the two properties of the procedural and the participatory". Agency is the feeling of empowerment that comes from being able to take actions in the world whose effects relate to the enactor's intentions. In research that combines human psychology and computer science, the agency model has been described most profoundly by Bratman [9]. His Beliefs-Desires-Intentions (BDI) model describes how the person will commit to his/ her goals, formulate plans and, consequently, execute the intentions. According to Murray, the most important aspect of experiencing the agency, in an interactive story world, is that it can be intensified by the dramatic effect. Rendering that, Murray's second concept, the immersion, can be seen as the feeling of being present in another place and engaged in the action therein. This is highly related to Coleridge's "willing suspension of disbelief", which suggests that when the spectator is immersed in a narrative experience, s/he is willing to accept the internal logic of it, even though this logic deviates from the logic of the real world. The third concept Murray introduces is transformation, which can be seen as the most difficult one to interpret. Mateas (2001), who considers Murray's concepts from a gaming standpoint, has elicited three distinct and expletory meanings for it: transformation as masquerade, transformation as variety and personal transformation [10]. Transformation as masquerade means that the game experience

4

allows players to transform themselves into others for the duration of the experience. Transformation as variety means that the game experience offers a multitude of variations on a theme and players are able to exhaustively explore these variations and thus gain an understanding of the theme. Personal transformation means that the game experience takes players on a journey of personal transformation. The transformation as masquerade and variety can be thus seen as a means to effect this personal transformation.

The first applications for the Holodeck has been pursued in parallel with the theoretical research. One of the first experiments was conducted within the Oz Project, by Carnegie Mellon University (Bates, 1993), in which the focus was on the interactive characters and story [11]. The inspiration for the application came from a contemplation that traditional storytelling media, such as cinema and television, draw much of their emotional power from the characters and story. In essence, the aim of the Oz Project was to help artists to create high-quality interactive drama, based in part on artificial intelligence (AI) technologies, which in this case meant building believable agents in dramatically interesting micro-worlds. A Parallel Ray-caching Rendering System (Larson,1998) was a much more technical research endeavor than was stated to resemble the *Star Trek* Holodeck both by its form and function [12]. The project studied technical data structure for light field rendering, in which a "Holodeck server" coordinated separate ray evaluation and display processes, and the grid on the Holodeck section acted as a four-dimensional rendering target for a ray-tracing algorithm. Cavazza et al. (2000) introduced an immersive storytelling environment, Intelligent Virtual Environment, in which the participants were able to interact with artificial actors through speech, while sharing the same physical environment [13]. In addition, they were able to participate in the generation of the story by influencing the virtual actors, by altering the common environment and by leaving the set to watch how the story unfolded in their absence. Façade (by Mateas and Stern) introduced a first-person, real-time and one-act interactive drama [10,14,15]. The process involved three major research efforts: designing ways to deconstruct a dramatic narrative into a hierarchy of story; engineering an AI system that responded and integrated the player's moment-by-moment interactions; and the study of writing an engaging, compelling story within the Holodeck framework. In University of California (2006), the Holodeck was entangled by creating an interactive story experience with pedagogical goals [16]. In this application, the participants were immersed in an environment where they could encounter sights, sounds, and circumstances of real-world military scenarios. The application included virtual humans that acted as characters and coaches in the simulation environment. In Teesside University, there was an immersive interactive storytelling environment that was labeled Madame Bovary on the Holodeck [17]. It was constructed on top of an AI-based storytelling system, which relied on explicit plot representations. The main idea was to include excerpts from Madame Bovary and investigated the concept of interactive storytelling in a fully immersive context.

3   Terminology

As the literature review demonstrates, the referenced research has used a colorful mixture of terminology when describing the interactive experiences of the Holodeck. This can be seen as evitable when the research combines multidisciplinary efforts covering such disciplines as dramaturgy, screenwriting, game design, VR-, AR-, AI- and other engineering research domains. Although previous research has defined several important concepts relating to the Holodeck, the lack of a theoretical framework for guiding the design exploration created a gap in the art education context. Based on the previous research, it was clear that the future medium required more unison and contemporary terminology for the holonovel writing activity. The solution was to make a list of used terminology, units and entities, in the earlier literature for defining what would best suit the purpose. The investigations included the following, topical research questions:

- What should the overall (Holodeck/holonovel) experience be called?
- What should the protagonist be called?
- How should the side characters be named?
- How can the units and entities be defined, and at the same time address the temporal considerations of the experience?

3.1   The H experience

Murray called the enactment of the story in the particular computational fictional space *Cyberdrama* [7]. As described above, she explained that this definition provided the human participants an experience of agency, immersion and transformation. Murray described Cyberdrama as an attempt to marry the structures of games and stories in which case the participant's actions would have an appropriate impact on the computer-generated world. The other terms in research literature that aimed to describe the holistic, interactive experience were:

- Interactive Drama (Laurel 1986, Mateas, 2001)
- Interactive Experience (Laurel 1991)
- Interactive Cinema (Bates, 1992)
- AI-based Interactive Experience (Bates 1992)
- Emergent Narrative (Cavazza et al., 2000)

For the context of the holonovel course, the most suitable term was defined as the *H experience*. In this conceptualization, 'H' stands equally for the Holodeck and the activity of writing the holographic novel. During the writing process, it soon became evident that as the students were not actually creating holonovels (but science fiction prototypes), there seemed to be a redundant double effort of explaining both the Holodeck concept and the holonovel activity, even though a fluent story seemed to require no further explanation. As for the semantic meaning of the word, the H experience seemed

6

suitable to contain a reference to most of the above-mentioned previous literature contemplations. Perhaps the most appropriate definition for the H experience is presented in the "narrative practice hypothesis" by Huitto (2008) [18]. In this assessment, the experience should include various different embodied practices, including emotional, sensory-motor, perceptual, and non-conceptual. These practices lie in the embodied action or expressive behavior that are represented in, e.g., bodily movements, facial gestures or, for example, gaze direction. The essential division for defining the most suitable interaction metaphor for the H experience, is also presented in the hypothesis. According to the narrative practice [13], the interaction can occur:

A. Through physical interactions with objects in the environment
B. Through on-stage conversation with artificial actors
C. Through off-stage intervention (through advice, interjections, etc.)

3.2   The protagonist, the Enactor

In previous literature, there were equally several options for defining the role of the H experience protagonist. The first-person experiencer was labeled, as:

- User (Cavazza et al., 2000)
- Player (Mateas and Stern, 2000)
- Interactor (Mateas and Stern, 2005)
- Spectator (Cavazza et al., 2000, Bates, 1992)
- Enactor (Murray 1998; Marek 2010; Carney et al. 2014)

Murray's consideration of the Enactor seemed most suitable for the H experience context, because enacting, as an activity, refers delicately to the "sense-making" process. This finds justice from the contemporary enactive literature, in which the enacting refers to "sense-making" instead of taking the perspective of a spectator/user presented with a world. Enactive relation suggests to the larger concept that "a living organism enacts the world it lives in" [19,20]. Furthermore, as Murray explains, the effective, embodied action in the world actually constitutes its perception and thereby grounds its cognition. Although Cavazza et al. use the term "user" and "spectator" instead of enactor, they also see the protagonist as "an active on-stage participant or spectator that is able to manipulate objects in the environments" [13]. In this sense, they also refer to the enacting aspect that includes embodied interaction, which, in turn, includes, e.g., the act of moving from one location to another, picking up an object, or touching another character. Although the first-person experience is highlighted in most literature, it is by no means mandatory, as Mateas and Stern have clarified [10]. They emphasize that during the experience, the enactor's perspective may occasionally automatically shift to a third-person perspective.

3.3   Side characters, VAs= Virtual Actors & Virtual Avatars

In the H experience, the enactor is usually surrounded by some other richly interactive, intelligent and emotionally behaving characters or creatures. Bates (1993) see that the

central requirement for "users be able to suspend disbelief" demands that these creatures are highly competent [11]. Mateas and Stern understand that the primary mechanism by which an enactor interacts and influences with the story is a dialogue with the other characters [14]. These autonomous characters are described, e.g., as real-time animated figures that can emote, have personality and who are able to speak. In previous research, they have been called:

- Interactive Characters (Bates, 1993)
- Animated Characters (Mateas and Stern, 2001)
- Autonomous Characters (Mateas and Stern, 2001)
- Virtual Actors (Cavazza et al., 2000)
- Intelligent Agents (Swartout et al. 2006)
- Artificial intelligence (AI) (Cavazza et al., 2007)
- Virtual Avatars (Cavazza et al., 2007)

The most suitable term for the characters that exhibit rich personalities, emotions, and social interactions were chosen to be Virtual Actors and Virtual Avatars (VAs) (see Fig. 2.).
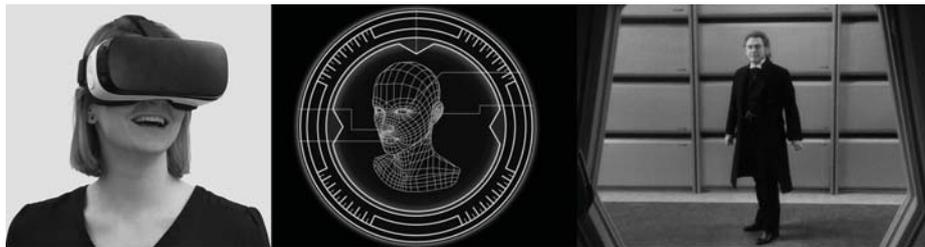

Fig. 2. The side characters are called VAs, which presents equally (human) Virtual Avatars (left) or/and the (non-human) Virtual Actors (centre). For the enactor, it might be sometimes confusing to recognize which one the hologram actually is (right). (Fig. right: courtesy of Paramount Pictures /CBS Studios).

The distinction here is important as the Virtual Actors can be understood as completely artificial personalities, whereas Virtual Avatars are real-life persons (for which a contemporary reference can be found from, e.g., simultaneous online players). Although in earlier research the characters' dialogue and "intelligence" were narrowly focused around some specific topic of the story, in this context the Virtual Actors are understood to be highly autonomous and have a large variety of responses to off-the-wall remarks from the enactor.

3.4   Scene, State and Triggering Event

The holonovel narrative is constructed of some units and entities that are completely different as compared to, e.g., screenwriting principles. In order to adequately describe the Holodeck affordances, the following units should essentially be described:

8

- The scene (available affordances of the Holodeck environment)
- The state (the extant status of the Holodeck environment)
- Trigger/triggering event (which initiates the change in the state of the scene)

The term *scene* has been commonly used in dramatic literature as well as within the studies relating to computer vision and pattern recognition. Oliva and Torralba (2001) define an environmental (real world) scene as mainly characterized as "a place in which we can move and most of the objects are within reach" [21]. In this context, the scene represents the combination of selected preconditions, triggering event(s), and the intended state of the environment. A scene thereby consists of:

- Preconditions, i.e., the available affordances of the environment
- A category of triggering event(s)
- A category of the value(s) intended to be changed by the scene
- The success and failure of the conditions

In short, the precondition tests whether the scene is appropriate given the current story (or character) state. This is constant as the next scene tests whither it is suitable to be the next scene.

The state is the current status of the environment constructed by the state of an individual device or aggregate state of a group of devices as defined by Kymäläinen et al. (2015) [22]. Mateas and Stern describe that the (story) state consists of the current story values and other global state such as active conversational topics, physical locations occupied by the characters, etc. [14]. Triggers, triggering event/story event changes the states of the scenes. For example, in the case where action is being carried by a dialogue, the trigger may simply consist of one character speaking a line of a dialogue. McKee (1997) calls these triggers "story events" that will change the story values [23]. Accordingly:

- A story event is precisely any activity that turns a value [23].
- A value can be a property of an individual or relationship, such as trust, love, hope, hopelessness, etc. [14].

Mateas and Stern find that to delivering an engaging H experience, a major value change should occur in each scene, which can then be seen as a large-scale story event. Thus, one of the primary goals of the H experience should be to confirm that all activity turns values, and thus the story event(s).

3.5   Temporal considerations

Cavazza et al. remark that, as compared to traditional media, the full H experience is likely to be episodic in nature [13]. This means that the enactor is practically only present in the H experience some of the time. This is vital because all activity is not intrinsically interesting and, in in this case, it is better suited to happening offstage. This leads

to a problem where an enactor, who is not permanently present, must have an "in-character" method for joining and leaving the world. However, and this is strongly emphasized, they can only be able to leave the world in a justifiable fashion.

Another important remark is that the holonovel is inherently a bottom-up interactive narrative, which means that the enactor cannot 'turn the clock back' as in traditional media. The ability to return to earlier (saved) states and make different choices is characteristic in games, but in the case of the H experience, it would be expected to be a destroyer of narrative coherence [17]. This leads to the concertation of 'onstage' and 'offstage' action, i.e., such action that the enactor does not see or directly participate in, or, for example, one that may involve only the VA's actions. The main possibilities for the enactor to influence the H experience would be thus:

- The modification of the parameters or states of the settings
- Action bearing on key objects within the scene
- Modification of the cognitive state of Virtual Actors
- Influencing Virtual Actors to take or stay away from specific actions.

4   Conclusion

This paper presented the design process for creating science-fiction prototyping-driven holonovels that can be associated with the fictional Holodeck-technology that still does not exist.

An important contribution of the paper has been to define the basic terms and elements for the holonovel construction process. These were:

- The *H experience*, in which the H stands equally for the Holodeck technology and holonovel activity
- The protagonist of a holonovel is called *an enactor*
- The side characters are called *VA*s, which presents equally (if not specified) the (non-human) Virtual Actors and (human) Virtual Avatars
- The most important units and entities of the holonovel are the scene, the state and the trigger/triggering event/story event

The defining of terminology has been based on literature research and this contribution deforms the minimum set of components that are needed for structuring the design process of a holistic H experience. There is certainly more research needed, especially for those units and entities that are based on existing terminology from several different disciplines.

10

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