nARratives of Augmented Worlds

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ABSTRACT

This paper presents an examination of augmented reality (AR) as a rising form of interactive narrative that combines computer-generated elements with reality, fictional with non-fictional objects, in the same immersive experience. Based on contemporary theory in narratology, we propose to view this blending of reality worlds as a metalepsis, a transgression of reality and fiction boundaries, and argue that authors could benefit from using existing conventions of narration to emphasize the transgressed boundaries, as is done in other media. Our contribution is three-fold, first we analyze the inherent connection between narrative, immersion, interactivity, fictionality and AR using narrative theory, and second we comparatively survey actual works in AR narratives from the past 15 years based on these elements from the theory. Lastly, we postulate a future for AR narratives through the perspective of the advancing technologies of both interactive narratives and AR.

Index Terms: H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities—Evaluation/methodology;

1 INTRODUCTION

> "If interactive narrative is ever going to approach the emotional power of movies and drama, it will be as a three-dimensional world that opens itself to the body of the spectator but remains the top-down design of a largely fixed narrative script"
> – Marie-Laure Ryan, Avatars of Story

Augmented reality (AR) is an emerging platform in the scene of computerized interactive narratives, with a vast and promising technological front that is already pushing into the homes of many in the shape of games and devices. In this paper we examine AR as a form of immersive interactive narrative that intentionally tries to obfuscate the boundary between reality and fiction. With an aim to inform future design of AR narratives, we turn our attention to narratology, the theory of narrative, focusing on the work of Marie-Laure Ryan, to discuss virtual story worlds, immersion, agency vs. scripted action and perception of fiction vs. reality.

In the quotation above, what Ryan wishes for might be the perfect digital interaction experience, not only for interactive narratives. While this view may be contested, her words pose the problem (and a solution) of compelling interactive narrative in a very succinct manner [31]: interactive narrative longs for the completeness of the "three-dimensional world" while keeping the coherence of the "fixed narrative script". This extremist outlook for the future of interactive narratives raises important discussion points on realism and agency in narration, however in this paper we will focus on the suggestion arising from this view that interaction both on a spatial level and a story level, which are potentially embodied in AR narratives, brings about a unique new experience.

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In the following section we take a look at *interactivity* and scripted behavior; how can interaction occur when the result is already known and pre-written in the text? We also look at *immersion* in a virtual world or a story world, and of the perception of *fiction and non-fiction* in different media, which are of particular interest to narration technology that looks to mix real and virtual objects.

We focus our discussion around the concepts of *metalepsis*, a blurring of the levels of narration, and *remediation*, borrowing conventions from other media, to propose that existing narration conventions can be used to strengthen the feeling of a blurred boundary between reality and fiction, instead of relying on picture-perfect computer renderings to increase the sense of immersion.

Section 3 presents a survey of existing projects that implement AR-based narratives and shows how AR supports the delivery of narratives, based on the elements presented in section 2. We then conclude by projecting AR-supported interactive storytelling to a foreseeable future, informed by current trends in interactive narrative and AR technology.

2 NARRATIVE, METALEPSIS AND INTERACTIVITY

> "Interactivity describes the collaboration between the reader and the text in the production of meaning ... reading is never a passive experience"
> – Marie-Laure Ryan, Narrative as Virtual Reality

AR is a new medium for narrative, however it was not conceived out of thin air. In the next sections we will show that AR presents great similarity to preexisting media, chiefly computer games but also theatre, documentary film and others. With some of these media AR shares specific traits that we wish to focus on from a narratology point of view: metalepsis, interactivity, immersion, fictionality and remediation. Each element presents a different aspect of narration that occurs in AR, thus we explain their definition, origins, similarities to other media and how they impact the readers.

Before going deeply into sub elements of narrative, we should find a grounding foothold in narrative itself. H. Porter Abbott defines: "story is an event or sequence of events (the action), and narrative discourse is those events as represented" [1]. According to Abbott, narrative is comprised of two elements: *story* and *discourse – events* and their *representation*. Ryan adds that narrativity (how well a story can be told) is not a binary feature but a continuous scale, and narratives should contain: a story-world, intelligent characters, a timeline, and meaningful events [31]. We can think of narrative as any medium-independent text which is used with intention to reconstruct mental images of a fictional world in the mind of the reader [11].

Note that the concept of "text" is used in a very broad sense throughout this paper, so it may mean actual written text, but may nevertheless be pictures, paintings, videos, plays, computer games, AR applications and even buildings, in fact anything that can hold symbolic meaning can be a "text". Similarly, "readers" may be people who actually read written words, but under our broad definition can be theater spectators, computer users, or generally people who are exposed to a "text" through any medium.

By definition AR is about blending the real physical world with an embedded, sometimes fictional, computer generated world. In narratology, a blending of narrative levels, such as the narrated events and the narration itself, is named *metalepsis*, and is quite

widely explored in conventional media. Metalepsis occurs, for example, when the characters are suddenly aware of the narrator, the medium, the fact they are part of a story, or when they speak directly to the readers, and many other types of metalepsis yet exist. In the case of AR, the boundaries of the world of narration and the narrated events may be blurred [11], as fictional objects and characters are transported into the world where they are narrated, our reality.

However, metalepsis should be viewed in the context of its medium. It is not surprising to see a fictional computer game character guide and approach the real world player, and we do not consider it a transgression of a level in narration. Similarly in AR, we will not be shocked to see a creature of fiction appear in the real world by using AR, quite the contrary, we would expect it. The AR medium itself does not make a conspicuous transgression of narration boundaries, rather the real and fictional blurring is the convention in the medium.

Once AR characters break into our world and the metalepsis is obvious, we may expect them to then be fully aware of objects in our world, be responsive, reactive and interactive. The matter of interactivity on its own is of utmost interest in narratives, as the most common types of narrative (think of regular stories) are not interactive. Interactivity may be simply described as a situation where the user's input is used, but it need not be binary, one can use a continuous scale to mark the degree of freedom the user has to act within or upon the text. Ryan claims "the fullest type of interactivity [is when] the user's involvement [...] leaves a durable mark on the textual world." The level of authority a user has can range from standard written and non interactive books, texts with multi-paths and hypertexts with binary choices, and up to open-ended online multiplayer games with vast virtual worlds to (almost endlessly) explore and also impact [30].

Immediately visible, one possible clash between the definition of narrative, metalepsis and interactivity is that in a metaleptic-interactive environment, as in AR, events are no longer told or represented, but are as reactive and continuously occurring in real life, where the rigid definition of narratives restricts it to the representation of *pre-known* events in a *story-world*. How then can an interactive narrative exist? The next two sections, which discuss the matters of interactivity, metalepsis and computer games narrative, will give us clues to such a compromise.

2.1 Interactive narratives

Insofar as AR is regarded an interactive experience it shares key features with interactive narratives. AR gives the user control at the level of the point-of-view (what Ryan defines as an Exploratory experience,) or at the level of manipulating virtual objects (which she defines as Ontological [31]). However interactive narratives with reader involvement at multiple levels existed long before computers allowed humans to explore virtual or augmented worlds, and we may learn from these when designing new interactive narratives.

A number of pre-digital forms of interactive narratives exist: Children games of make-believe, adult fantasies or role-playing games, amusement parks, religious rituals, some forms of drama and even architecture. All of these allow for corporeal participation in an immersive, many times imaginative, environment in which the rules or events are presupposed and the plot often cannot be changed [30]. Another non-digital form of interactive narrative is the multi-path narrative, where the audience may, at specific branching points, determine the continuation of the story. In written form these are "Choose your own adventure" books, in cinema these are films that offer a choice of one or more endings to the movie [11], and some dramatic performances incorporate the audience as part of the show [30] or in deciding the fate of a character (for example the modern play "Sheer Madness".)

The home-computing revolution did not skip the world of interactive narratives, and one of the earliest kinds of computerized interactive narrative manifested as interactive fiction (IF) systems, which offer text-based exploration and interaction within a story-world via typed-in commands. With the advent of the World Wide Web, Cybertexts that utilize hypertext appeared, which allow users to follow hyperlinks and in this way interact and explore the story world. Such Ergodic texts, those that change with dependence on the reader's choices, are questioned for being narrative or simply narrative fragments put to form a playful experience [11] and also for their limited re-readability [24].

The history of interactive narration, which was discussed in this section, demonstrates a plethora of ways to incorporate the reader in a fictional world without usage of screens, computers or graphics. Authors invited the reader to freely explore in an immersive story world without being able to affect the story or characters, gave shallow control over the story via branching, or simply made way for imagination. The proliferation of computer graphics rendering and real-time animation capabilities, brought upon a new medium for interactive narratives: video games. Arguably, they hold the highest resemblance to AR in terms of graphics and interactivity out of the computer-based interactive narratives.

2.2 Computer games as Interactive Narratives

> "Reality has always been too small for human imagination."
> – Brenda Laurel, PhD Dissertation

If taken at face value, modern computer games seem to elegantly solve the problem of situated interactive narrative. Naturally, games allow interactivity for the player, but very much like traditional narrative media they: provide a fictional but realistic story-world, constrict the story to a scripted path of events, and even contain actual narrated cut-scenes. Should we then consider them to be the epitome of computerized interactive narrative?

Theorists try to come up with a formulation for the relationship of games and narrative. Jesper Juul once argued that games are not narrated but experienced in real-time and have varied outcomes, thus they are not stories [14]. On the other hand, games, the same as stories, have a well-defined beginning and end, and a series of meaningful events and resolution of conflicts in the middle; even if they do not make use of an obvious narrator, narratee and storyline they are probably perceived by players as some form of narrative [11].

Another point of view on games is that they do not pertain to be narratives in the first place, but simply fictional worlds, whose content is selected to be narratively rich. Some computer games excel in creating those rich fictional worlds that allow exploration, such as quest games and online collaborative role-playing games [11]. AR experiences share this feature of exploratory games, by letting the user walk around the augmented world. Especially interesting are AR platforms that allow an essentially endless capture of more and more augmentable and interactive space [12] similar to real life.

Metalepsis in computer games is in many cases a tool for blending the fictional with the real, used to heighten the suspense or realism of the game. At times characters of the game are aware of the player that controls them, or even directly instruct the player in how to play, forming a temporary metalepsis [31]. Furthermore, gaming platforms that extend beyond the screen and reach into the player's living room [13] or body [32, 34] are considered a welcome addition to the gaming experience as long as the metalepsis remains at the appropriate level of physicality (ontological [31]) and fictional characters do not spring out of the screen to raid the kitchen cabinets for food.

Games and AR experiences create an ontological metalepsis by fusing the real world with the world of the narrated, but even the best efforts still fall short of a deeper kind of transgression, a total, immersive experience that narratologists and technologists alike are

calling for. This leads us to a discussion of the nature of immersion in a virtual world, whether imaginative or sensory, in the next section.

2.3 Immersion in narration

> "Immersion is the experience through which a fictional world acquires the presence of an autonomous language-independent reality populated with live human beings"
> – Mary Laure-Ryan, Narrative as Virtual Reality

Immersion happens when readers are absorbed in a mental state or activity induced by a text[1] to a point when they treat it as an actual situation. By sensing the real environment we are immersed in it, conversely, many texts such as books, do not offer our senses much or any information at all, but even those can deliver a high sense of immersion in a fictional world. Immersion therefore is not purely sensorial, it is supported by our ability to suspend our visceral grasp of the real world, and consciously and intentionally join the narrated world [11].

AR poses a great potential for immersion, since it uses the real world as a basis to project fiction. A world is not a bounded space or a quantifiable amount of things, but an infinitely interconnected totality, as Michael Heim claims [30], and this brings about the sensation of immersion. In AR, the sensation of immersion is intensified because users already know how to move about the world and its physical effect on them, however the computer generated augmentations require some work so not to break this sensation [16].

If we define AR as a duality of *reality+augmentation*, we could think of immersion in AR as dual as well. Reality itself is immersive, but the level of immersion of the augmentation is dependent on the technology and capabilities of the programmers. On the other hand, AR can be viewed as jointly immersive, where the presented augmented world is altogether a different world than the real world, but one that happens to contain all of the objects in the real world with extra computer generated objects. This phenomenon is explained in narratology by the concept of *minimal departure*, where a completely fictional story-world is comprehensible to readers because it resembles or derived from their own real world, from which they fill in the gaps [11].

We therefore make a distinction between a joint, dual and hybrid outlooks on AR, that may depend on the type of devices that implement it: those that *replace* reality (virtual reality devices equipped with cameras), those that *overlay* reality (using transparent-screens technology or projection) [27], and those that *combine* the last two with other, may be non-technological, means (e.g. live actors or tangible props). Devices that hide or replace reality by letting users see it only through a screen, like in virtual reality, can be considered ones that create a new world for the user to explore, which is an amalgam of reality as captured by a camera and augmentation provided by the computer. This new augmented world, on its fictional and non-fictional elements, will be the center of the next section's discussion on the perception of fiction and the role of technology therein.

2.4 Walking the border of fiction and non-fiction

AR brings fiction to our non-fictional world. It intentionally strives to blend the border between real and graphic to a point where we feel immersed in an augmented world. Nevertheless, convincing images of seemingly real objects do not mean a real existence of the objects, but offered for us to make-believe they are real, as in other man-made images such as paintings [31]. Moreover, the proliferation of digital tools, and motivation, to alter images of real objects has undermined even factual discourse, where we now see non-fictional images (e.g. photos in fashion magazines) as altered and fictional [29]. But there are images, or illustrations, that we do not consider fictional: technical drawings in reference books or utilitarian AR as an aid to manufacturing or repair [10]. We should therefore look at AR in the context and intention of the author to determine whether the augmentation should be considered fictional or non-fictional, however the context or intentions are not always available to us.

There is another distinction to be made, which involves the notion of the *unreliable narrator*, one that is not explicit about the validity of the depictions in the text or one that is known to not be telling the truth. Depending on the context in which we approach the text, we have a preconception of the validity of facts it presents. Such is the case of documentary films or news broadcasts, where we assume the authors and editors will provide us with checked and neutral facts [29], the same goes for AR experiences in which we expect to be given truthful additional information. But the authors are not obligated to provide a neutral truth, if such a thing even exists, and in some cases they are even motivated to use these preconceptions in order to trick the readers into believing something is true even if it is not. This is the case in films of the Mockumentary (Mock-documentary) genre, which make use of preconceptions on Documentary movies and the conventions of presentation of facts to deliver non-factual information, in many cases to ridicule the subject of the movie or the documentary format itself [29].

In AR the problem of fictionality is magnified. While AR is a new medium and preconceptions have not or are right now being formed [16], there is evidence that future conceptions of the capabilities of AR are mostly regarded as positive and factual: gaining knowledge, extending human capacity, etc. [15]. Unlike traditional media where fictional discourse is established and widely welcomed (for example books or cinema,) there is much less discussion on fiction within AR outside the gaming domain. However we see this as an opportunity, instead of striving for a perfect augmentation to achieve an effective blend between reality and fiction, we may use the preconceptions, similar to mockumentaries, to emphasize that boundaries are overstepped.

2.5 AR as a new medium for storytelling

A medium transcends technology, not defined by it; it is a set of conventions, practices and design approaches that authors make use of to create a familiar and meaningful experience for the user [16]. AR, similar to cinema, makes use of technology that spans complete disciplines in engineering, sciences and design (from a plethora of tracking systems to artistic modeling tools), and it cannot be thought of as homogenous, but it does have a shared goal of presenting information to the user in a meaningful way.

The last section discussed how an established medium, such as film, with its preconceptions, could help readers in approaching the text with the right expectations, as well as for authors to design the experience using well-known practices. In the case of the documentary film, the readers expect a factual discourse and a reliable author that will present the narrative in a way that evokes the feeling of untouched truth. AR strives to do the same but still has no globally accepted conventions on how to deliver the content. One way to circumvent this is by using *remediation*: the borrowing of conventions from older media into a new medium.

AR naturally borrows elements from film, such as situated characters and props, however the control of the camera and attention is not up to the director but the user-spectator. To cope with that theatrical staging techniques may help: lighting, actor staging and motion to help draw attention to the relevant parts of the narrative and its advancement, and away from the parts where nothing happens. Since sometimes the user is an active character in the AR story-world, a convention on the level of plot is also required, and in this case AR can benefit from the idea of plot cul-de-sacs of interactive narratives, where the plot does not advance until a user-driven event

[1] Remember our broad definitions for 'text' and 'readers'

or choice occurs [16, 25, 17].

Beyond conventions that can be borrowed from older media, researchers have come up with common practices specific to AR that attempt to create a welcoming experience for the user and single out AR as a unique medium. Henchoz et al. suggest sidestepping the lag problem in AR by showing the augmentation on a separate screen and maintain a 1:1 aspect ratio of real and augmented objects [9]. Using environment-embedded augmentation (e.g. audio speakers, actuated surfaces) in combination with worn or held devices is claimed to enhance immersion in the augmented story-world and user's belief in the virtual elements [35, 37].

3 Survey of AR narratives

In contrast to the general research in AR, which is already vast and comprehensive, AR narratives are a minor field of research, so examples of fully realized experiences are scarce. Nevertheless, the potential of incorporating stories into our reality in an AR experience is encouraging researchers and industry to pursue this goal. As we are about to see, the challenges are great both from a technology and narratives point of view, and implementations take either an engineering approach, where technological solutions are integrated, or a soft approach that relies more on our ability to understand narratives in many and abstract ways.

In 3.2 and Table 1 we present 14 example systems implementing an augmented narrative that show different degrees of interactivity, level of narrativity, scale and technology. This entire section discusses how these implementations face some of the challenges in creating an interactive augmented narrative and the solutions they have come up with, as well as their usage of metalepsis, remediation, immersion and the level of permitted user agency. The end of this section contains our postulated projection for the future of AR in general, and an outlook for AR narratives in particular.

3.1 nARrative Worlds and Conventions

We propose to examine augmented narratives by the type of worlds they invite the readers into (see the 3rd column of Table 1). Situated augmented narratives are more local in nature, typically taking place in a single room, and they usually run at a time period of a few minutes and up to an hour. Location-based narratives augment the real world with a story-world that is accessible only through sparsely located portals rather than a continuous sensory connection; on the other hand they have the advantage of augmenting a far bigger area in the physical world. World-level augmented narratives are experienced on a near-global scale, i.e. a city or neighborhood, they also usually run for a longer period of time, even up to whole months.

We may also make a distinction between implementations of AR narratives based on their usage of storytelling or remediated conventions to perform a number of tasks: deliver the story itself, strengthen the immersion, enhance the drama and interact with the system. The next section will reveal how these conventions were used in practice in the research into AR narratives.

3.2 The Surveyed Work

Hereby we present the AR narrative works studied in the creation of this paper. We briefly describe the interaction scheme and purpose of each work, however the main focus is on the level of immersion, agency given to the reader (on the plot, characters and point-of-view), metalepsis and usage of conventions when applicable.

3.2.1 Situated Augmented Narratives

Façade is an interactive narrative system developed by Michael Mateas and a number of other researchers in the Georgia Institute of Technology. We see Façade as an elaborate experiment in creating a full-blown computational interactive drama system. It incorporates interactive graphics, artificial intelligence (AI) engine for believable characters, natural language processing and a drama manager that determines the progression of the plot. In a later project, Façade was ported to an AR experience to become AR/Façade, allowing users to inhabit the same physical/virtual space as the drama's main characters, Tripp and Grace, while wearing an AR headset and a portable computer. Façade pushed the boundary of interactive narrative by giving the user a very high level of agency, and in AR/Façade even more control by letting them control the point of view (POV) to create a true ontological-exploratory experience. Interestingly, the creators chose to deliberately avoid metalepsis by not allowing the virtual characters to respond with administrative sentences such as "Invalid input" or "Illegal command" (thus making them aware of the user being from a world external to the story,) to maintain the illusion of real dramatic action. Mateas defines Façade both as drama, and at the same time as an open-ended simulation, which conflicts with the definition of narrative, but he concludes by defining it as a middle ground between the two [21, 7].

Three Angry Men (TAM) is an AR narrative experience that is not interactive on the level of plot but allows the users to explore the story from different physical points of view [17]. Change in location changes not only the visual point of view on the characters but also the characters behavior, without interrupting the predetermined plot. The experience makes use of the social situation, a meeting in a profession setting, to guide the user in interacting appropriately with the system. A similar project that preceded TAM was the Mad Tea Party (MTP), which was similar in terms of setup; the user sits at a table and interacts with the augmented characters that also inhabit the table. MTP differed from TAM in not allowing a change in the behavior of the characters or the plot [25].

The "[inbox]" AR narrative installation invites the users to enter a shipping container with a hand-held device capable of reading AR markers, and hear the story of the container itself and of the shipping containers industry at large. The narrative is non-linear and decentralized, which reflects, in a meta discussion, on the vast decentralized world of shipping containers. Readers are free to explore the story-world in any order by performing mini-tasks at each interaction node, all of which contribute to the grand story [2].

Scott Snibbe and Hayes Raffle experimented with a number of low-narrativity approaches in their Social Immersive Media projects [33]. Although a coherent narrative is not presented per se in the projection-based corporeal interactions, which are mostly museum installations, the authors do report of an overarching usage of *remediation* from cinema and HCI as guidelines for authors of similar experiences. The different Narrative Models, as Sinbbe and Raffle define them, only rarely present autonomous characters other than user, however they do situate the interaction in a story-world that allows ontological control. Snibbe and Raffle also used *cinematic* conventions such as ease-ins and outs, overlapping action, and *theatrical* actor staging and lighting, which was also utilized to some degree in Mateas, Moreno, McIntyre and Dow's work [16, 25, 17, 7].

3.2.2 Location-Based Narratives

The M-views system created at the MIT Media Lab allows readers to experience a cinematic narrative embedded in the MIT campus. Users are encouraged to walk around the campus and view video clips that are triggered by their physical location. This is an exploratory interactive narrative, it lets readers go about the story-world freely and serendipitously discover the story, it has a non-linear progression of the plot as the clips may be viewed in every kind of order depending on the places the readers visit [5]. This project resembles another location-based narrative, "Murder on Beacon Hill", which takes users on a murder-mystery tour of

Table 1: List of AR narrative projects. Narrative Model is categorized by Linear, Spatial (linear "Spine" with branches) and Non-Linear. See Section 3.1 for a discussion of Augmented Worlds. The Type of Interaction follows the definition of interactive narratives in [31], and our discussion in Section 2.1.

Project Name	Year	Narrative Model	Augmented World	AR Type	Type of Interaction
Mad Tea Party [25]	2001	Spatial	Situated	HMD	Exploratory (POV), Ontological (Gestures, Audio)
[inbox] [2]	2001	Non-linear	Situated	Handheld	Exploratory (Space)
M-Views [5]	2003	Non-linear	Location	Handheld	Exploratory (Location)
The Beast [22]	2003	Linear	World	Live, Online	Exploratory, Ontological
Three Angry Men [17]	2003	Linear++	Situated	HMD	Exploratory (POV)
GEIST [18]	2004	Non-linear	Location	HMD	Exploratory (Location)
Hopstory [26]	2004	Non-linear	Location	Projection	Exploratory (Space)
Oakland Cemetery [6]	2005	Spatial	Location	Audio	Exploratory (Location)
AR/Façade [7]	2006	Linear+	Situated	HMD	Exploratory (POV), Ontological (Speech)
Gustafsson et al. [8]	2006	Spatial	Location	Audio	Exploratory (Location)
Social Immersive Media [33]	2009	Non-linear	Situated	Projection	Exploratory, Ontological (Gestures)
Murder on Beacon Hill [23]	2009	Linear	Location	Handheld	Exploratory (Location)
The Westwood Experience [37]	2010	Linear	Situated & Location	Handheld, Live	Exploratory (Location)
Conspiracy For Good [36]	2011	Spatial	World	Handheld, Live	Exploratory, Ontological

+ The narrative is generative and therefore (to an extent,) non-repeatable, but still has a linear course of progression
++ The events in the story are static and linear, however the character behavior is changing

downtown Boston, though the clips are not automatically triggered by the system but the user [23]. The GEIST system is another similar project, which allows users to explore the history of 17th century Heidelberg, Germany, via mini-stories spread throughout the modern city with a wearable AR system and a hybrid GPS and vision-based tracker [18]. To form the mini-stories GEIST uses *a familiar plot-line* such as fairy tale stories (which Abbott calls "masterplots" [1]), or *a familiar story arc* such as Freytag's triangle [11].

Nisi et al., who created Hopstory, a location-based narrative, added a higher level of progression to that of the aforementioned projects by allowing the characters in the story to act in their own timeline and move to different locations throughout the building during the user's exploration of it [26]. This adds the layer of Time and Evolution, on top of the base layer of a story-world, which Ryan requires in her definition of narrative.

The Westwood Experience, created at the Nokia Research Center, tried to find novel ways for integrating physical with virtual in a location-based narrative AR, even though the narrative itself was linear and not interactive. The creators used real live actors and physical setups to increase the immersion, alongside computer vision methods for registration of landmark buildings and locations in the town of Westwood in order to augment them with visuals. At certain moments a metalepsis occurred, where live actors broke from their 1950s characters to explain technical details of the Nokia system the users were using [37].

The Oakland Cemetery experience is an audio only location-based narrative that takes readers on a tour through the cemetery. The system is based on a type of spatial narrative, which is mostly linear with pockets of non-linearity where the user is offered a branch off the main story to explore a local mini-story around a single grave before coming back the "spine" of the story [6].

A different approach on location-based augmented storytelling was taken in [8], where a system was built to engage people driving the backseat of a car with a story that unfolds in the landscape they are driving through. The researchers combined a position tracking system with a handheld directional "microphone" (essentially a pointing device), to trigger parts of a spatial narrative. The narrative progression is linear, however at any decision point there are more than one linear branches ready to trigger, but the branches can only trigger in an appropriate sequence in order to maintain coherence of the story. In this experience the reader does not control the movement throughout the space, rather the driver of the car does, so the narrative must match the changing environment, and not rely on exploration like other location-based narratives.

3.2.3 World-level Augmented Narratives

One especially interesting form of AR narratives is Alternate Reality Games (ARGs), which are mass-participatory interactive narratives that take place in "a fictional world superimposed on the reality of everyday life". In essence, these games invite players to roam the streets as well as online forums and chat rooms while solving puzzles put forth by the game moderators, themed by a predominant narrative. In "Conspiracy For Good" (CFG), an ARG set in 2010 London, the production involved both online and offline presence, with live actors. CFG did not allow changes in the master narrative, however the players had the ability to change the order or the advent of the next story "beat" (a pervasive method in interactive narratives, essentially a linear mini-narrative that is part of a larger non-linear narrative), which led them to believe it were their actions that were driving the progression of the plot [36]. In the case of "The Beast" game of 2001, the production had a hard time keeping up with the puzzle-solving capacity of the players, when a batch of puzzles planned to last three months was solved within the first day of the game, essentially giving the players high control of the pace of the game [22].

The blending of real and virtual in the case of ARGs is brought forth by the transparency of the medium, effectively – the real world, as it is immersive and viscerally real. While the players are aware they are playing a game and not real life, the action is not a simulation but happens to them corporally [22]. At the same time the game producers go to great measures to erase the boundaries between game and reality, avoid metalepsis and maintain the illusion of an alternate, but complete, reality.

3.3 Challenges and Solutions in AR Interactive Narratives

Researchers overcome the challenges in AR narratives in many creative ways, some of which were presented in Section 2.5. A recurring theme that rises from the implementations reviewed in the previous section is that narratives often use a narrative model (see the 2nd column of Table 1) of a non-linear exploratory nature. This is a result of the inherent connection AR creates between the story-world and real life, which is arguably non-linear and exploratory. In projects that strive for a concrete interactive storyline, higher-order computational story generators are used, however in some cases we find a certain level of operator intervention (Wizard of Oz, man-in-the-machine) intertwined in the system to alleviate some of its shortcomings.

Traditional interactive narratives pose their own problems, which are inherently replicated in augmented interactive narratives. Controlling story progression according to an overarching narrative, and the level of agency the user has over the story world is a key element in a compelling interactive narrative, to support immersion and belief. To resolve these issues McIntyre et al. used cul-de-sacs and procedural nodes that evolved into story "beats" and goal-oriented behavior programming [16, 25, 21]. Malaka et el. are using a Propp model of fairytale stories to structure the story-arc in GEIST [18], however the authors handcraft the entire narrative rather than the system deciding the progression on-the-fly.

On top of exploring the plot, AR narratives add the layer of exploration of the space by letting the users roam the augmented area freely. Unable to script the free-roaming user, many AR narrative implementations resort to non-interactive linear narratives that demand constant user attention, with the occasional cul-de-sac (to create a spatial narrative,) or simply non-linear fragmented narratives, where the fragments are randomly accessed without narratorial control of the camera. The problem of POV control manifests itself when the action is happening where the user is not looking. Therefore, researchers looked into *scripting the user*. Moreno used physical objects as cues for where the virtual action is going to occur, as well as having the virtual characters gaze in the proper direction of action and a smart usage of lighting, borrowed from theatrical staging [16, 25, 17]. Using visible AR markers is a good solution for letting the user know where the augmentation is going to appear, but goes against the wish to keep the medium hidden and immerse in the content (the story). Indeed most AR narrative researchers used various technologies to support non-marker based augmentation, e.g. user-external tracking systems such as a GPS [5, 8] or an indoor IR-based tracker [7], natural images as markers [2], architecture as a marker [18, 37] or tangible objects [26].

The high level of interactivity that truly immersive narratives demand requires sophisticated input methods to the system. McIntyre et al. made it a quest to see how much an autonomous computational system can support unscripted user behavior, thus they used natural language processing and intelligent computational agents. However other projects opted for either limiting the user's input or system's output to selected dimensions [25], Wizard of Oz type of interaction [7], and the usage of live actors for the users to interact with [37].

Problems in AR are inherent in augmented narratives as well. AR takes users out in public spaces donning head-worn gear or waving mobile devices in different directions, lacking conformal social cues this behavior can be awkward. Wither et al. confronted a problem with audio-based augmentation where users wore headphones that acted as a "do not disturb" sign, and alienated them [37]. Dow et al. faced the challenge of augmenting a functional cemetery, which demands respect to the place and the families or visitors that are using it, and opted for an audio-only augmentation lacking the ability to put up markers or signage [6].

Eliciting the feeling of immersion in a story during an AR experience requires a delicate balance of realism and fiction, perhaps even more so than in utilitarian AR or interactive narratives. On one hand the system must upkeep the suspension of disbelief in order to invite users to the world of the story, on the other hand it is the real world the system is using, which is not typically part of stories but reality. Barba et al. and Dow et al. both expressed concerns in regards to augmentation graphics that are "too real" and may actually harm the fictionality of the experience [7], or mistakenly invite the users to try and physically manipulate a virtual object. Barba et al. and Dow et al. opted to keep augmentations in 2D to circumvent the problem of over-realism [7, 2].

3.4 Future projection for AR narratives

Perhaps the strongest ideograph of the future of AR is a totally augmented world, where augmentations can appear at any time and any place to support us through daily life, extend our senses, enhance our cognitive abilities to make us as efficient and effective as we can be and beyond. Being a compelling ideograph, most of research in AR is trending in this direction, and we are sure to see concrete projects advancing this front [19, 15, 4]. However it is not perfectly clear that narratives wish for this kind of total augmentation, in fact narrative is sometimes defined as a discourse whose whole purpose is to elicit emotion in the reader, not necessarily knowledge or efficiency [11]. That is where utilitarian AR technology and narratives diverge, only to reconcile at the interesting point of immersive narratives.

The quest for immersion is ubiquitous throughout out the different media of narration and its importance is unchallenged. augmented reality, as an idea and a set of technologies, offers a promising solution for blending virtual aspects into reality, with the goal of making an augmented world as immersive as reality itself, and immersive narratives can clearly benefit from it. In the idealistic world of AR, as can be seen in popular media [28], all spaces can be augmented and all objects are part of the blended reality. While some researchers contest ultimate realism in narrative augmentation [7, 2], they mostly agree that when technology, not only for augmentation but for an entire full-body interface, will catch up with the dream of a perfectly real augmentation it will be a very welcomed embodiment of interactive narratives [30, 7].

Another evident front for future incarnations of AR narratives is the matter of agency and control over the narrative. Research on interactive narratives shows promising progress towards a truly generative, coherent and believable narrative, albeit short, with the use of smart agents [20, 21, 3]. However, as our discussion has shown, the challenge of narration in AR is greater than in other mediums and poses fresh problems to tackle. We believe that truly emergent situated narratives, those that arise from an *unseen physical environment*, not only characters and a predetermined set of events, will be the next breakthrough in augmented narratives. Some researchers already proposed solutions for certain environments, e.g. [8] for a car-ride narrative based on GPS positioning, but the matter remains at large for other categories. The task of creating environment-generative narrative is especially obvious in smaller scale, where physical spaces can be mapped or scanned, however then, a special method is required to dynamically align the physical space with the story-world, i.e. staging of actors to support the drama. Recent work shows great potential in automatic scanning and augmentation of spaces in the goal of an immersive gaming experience [13], which is directly related to interactive storytelling.

4 Conclusion

This work presented numerous points of contact between augmented reality and immersive narratives, and surveyed recent implementations of AR-based narratives. The theme emerging from the work is a postulation that AR, by the use of metalepsis and other

forms of reality-fiction blending, creates a unique medium for narration with its own capabilities and shortcomings.

We believe authors of AR narratives can benefit greatly from remediation of elements from theatrical staging, film and computer games to acquaint users with the new medium. Something quite non-intuitive must be done: Rather than making the medium disappear and creating complete immersion, it is necessary to refer to specific conventions and known situations, much in the way that the mockumentary refers to documentary conventions, because only then can the boundary (fiction/documentary or reality/augmentation) be transgressed in a recognizable way. This seems to be the *opposite* of what most AR developers suppose. Only by use of *remediation* and in some ways emphasizing the "staging" can we effectively harness AR's power to blur the boundary between reality and fiction/augmentation.

In conclusion of the discussion in the last section, we believe the future of AR narratives will be greatly influenced by technological advancement in three domains: AR technology (wearable, handheld, projected or other), interactive narratives (believable agents and narrative generators) and lastly physical-space dramatic analyzers that marry physical-space with story-space. All of these areas are under active and prominent research.

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