Crafting Memorable VR Experiences using Experiential Fidelity

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Abstract

Much of Virtual Reality (VR) is about creating virtual worlds that are believable. But though the visual and audio experiences we provide today technically approach the limits of human sensory systems, there is still something lacking; something beyond sensory fidelity hinders us from fully buying into the worlds we experience through VR technology.

We introduce the notion of *Experiential Fidelity*, which is an attempt to create a deeper sense of presence by carefully designing the user experience. We suggest to guide the user's frame of mind in a way that their expectations, attitude, and attention are aligned with the actual VR experience, and that the user's own imagination is stimulated to complete the experience. We propose to do this by structuring the time prior to exposure to increase anticipation, expectation, and the like.

CR Categories: H.1.2 [Models and Principles]: User/Machine Systems; Human factors. H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems; Artificial, augmented, and virtual realities.

Keywords: Experience Design, User Experience, Presence, Virtual Reality

1 Introduction

The virtual environments we create today have the potential to achieve a level of realism that is arguably indistinguishable from real life. In film, digital artists create character models with a combination of geometry, textures, and articulation. They act on screen with real actors to give audiences the feeling that the virtual and real actors are occupying the same space and time. Illumination and camera-movement matching have received considerable attention from the research community, further improving the meshing of the real and the virtual. Simulations of crowds show emergent behavior and are readily available in 3D modeling packages. Interface devices allow us to turn natural user gestures into control of the experiences. Finally, content-creation tools have achieved a level of maturity that provides access to a large pool of people to generate compelling experiences.

Many different types of systems exist to present a virtual environment at a suitable frame rate, featuring the stimulation of multiple senses, and the presentation of interactive content; each has its advantages and limitations for fostering the user experience. Virtual Reality (VR) systems, using Immersive Projection technology (IPT) on large screens or Head-Mounted Displays (HMDs), are well known in the community and offer diverse technical means to deliver high speed, multi sensory stimuli to users. One of their main deficiencies is the large number of technical devices surrounding, limiting, and potentially distracting the user. The current generation of video consoles and games continues to push the level of realism, though frame-rate requirements, typically greater than 30 frames per second (fps), still limit scalability. There are also still limitations on the number of simultaneous on-screen virtual characters, creatures, and objects that react to dynamically changing scenes. On-line multi-player systems further complicate things by adding network latency, slowing the amount and depth of data that can be exchanged while maintaining interactivity. Finally, the current explosion in popularity of mobile interactive systems, with their reduced display device power, and network connections with lower bandwidth, higher variability, and error rates, further reduces the baseline properties of systems that will be used to present strong feelings of realism in users.

All of these systems provide varying levels of sensory experiences to users, ranging from fully-immersive, multi-sensory 3D, including features for surround audio, haptic, and olfactory cues, to hand-held 2D devices with limited or even no audio capabilities. It is, however, not the case that immersive multi-sensory technology automatically makes for a better experience; it may arguably be the other way around, which is sometimes a frustrating realization for VR practitioners. Even though the visual and audio experiences we provide today with VR approach the limits of our human sensory system, there is still something lacking; something beyond sensory fidelity hinders us from crossing the uncanny valley [Mori 1970], keeping us from fully buying into the worlds we experience through VR technology.

In this paper, we look at the type of experience a user might have with a virtual environment. We explore techniques and guidelines for tapping into the user's mind to increase the effectiveness of VR experiences, offering a possible "new" thrust of effort for VR researchers. We propose the notion of *Experiential Fidelity*, and present a first pass at ways we as VR researchers may work on improving the VR experience.

2 Experiential Fidelity

Improving realism has been a driving force behind much of VR research. The breadth of work the VR community has used to attack the problem includes improving **visual characteristics**, such as resolution, field of view, field of regard, model fidelity, and rendering speed, **audio attributes**, such as bit rate, number of simultaneous audio sources, faithfulness, and spatialization [Wenzel 1992], **haptic cues**, such as direction and magnitude of forces, coverage of the human body, and delay, **olfactory displays**, dealing with scent generation, scene delivery, and scent variety [Yanagida et al. 2004; Yamada et al. 2006; Haselhoff and Beckhaus 2006], and even **gustatory output**, such as food consistency and sample delivery [Iwata et al. 2004]. Apart from these sensory-motor attributes, others have worked on more *content-driven* factors, such as realism of virtual characters

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[Magnenat-Thalmann et al. 2004; Kontraza et al. 2008] and environments [Mania et al. 2006], naturalness of user interaction [Bowman et al. 2005], evaluation of performance [Ruddle and Lessels 2006], presence [Slater et al. 1994], and perception [Interrante et al. 2006]. As stated before, however, these alone have not proved to be sufficient for creating "good" experiences.

One claim may be that our expectations for sensory experiences are still not fully met. These expectations are based on what we have learned from living in our everyday "real" world, which shows some impressive features. The real world has a perfect update rate, supports a massive number of users, provides integrated multi-modal rendering, has more than convincing physics, and gives us nearly infinite fidelity, all with minimal lag; this is just the type of system we have all been chasing for decades in VR research.

As we have not yet achieved this level of realism in virtual worlds, one might claim they are not real enough, yet. A first solution would be to abandon the goal of providing a fully virtual experience (which we arguably have never been able to achieve anyway, because of the physical nature of our interaction devices and displays) and include only as many elements of the real world as necessary to support the target experience. Researchers in the field of Augmented Reality (AR) study the *technical* approaches for the mixing of real-world and computer-generated stimuli. Even though solutions exist, AR applications fail to consistently show a higher quality experience simply by using real artifacts.

Therefore, we propose that it is necessary to look beyond sensory experiences and perfect content generation, to address the user experience itself. For this we have to go beyond traditional AR and VR approaches and address *perceptual* aspects, *i.e.*, draw upon more-cognitive resources such as *anticipation*, *expectation*, and *attitude*. We can tap into the real-world experiences already assembled in the mind of the user, and leverage those to improve fidelity. Further, instead of relying on experiences the user may (or may not) have had, we can *prime users* prior to entering the virtual world, thereby structuring their anticipation in a way that will increase the impact of what we present. Along the same lines, we can avoid exposing users to things that break the sense of realism, such as bumping into (or even seeing) lots of cables. The reminder of the paper addresses these topics with a focus on what VR designers should bear in mind when staging a VR experience.

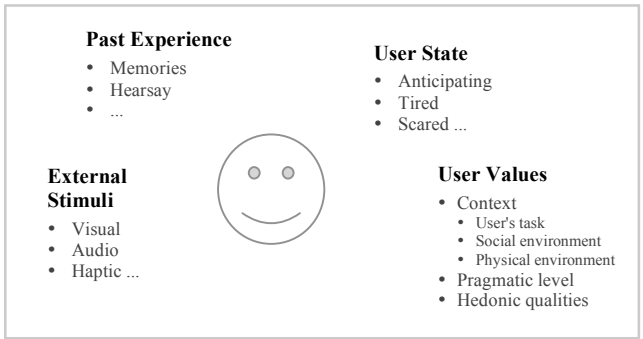

Figure 1: Factors that influence the user experience.

To be able to discuss what makes up the user experience of a game, a show, a product, etc., Figure 1 gives a simplified overview of possible factors influencing the experience. This overview is influenced by [Hassenzahl 2003] and [Jetter and Ecken 2006] who include the pragmatic qualities (functionality and usability), but moreover the hedonic qualities of stimulation, identification, and evocation, into their discussion of users experiencing various products. The product here is the VR system, plus the application, plus the staged experience for the user which together function as a medium between the *intention* of VR authors or task to be fulfilled, and the actual *experience* a user might have. At the perceptual level, the various human sensory systems (*e.g.*, vision, audition) are fed stimuli that reach the brain, where they are interpreted through a "lens" of previous experience, and tempered by the current state of the user. The experience is simultaneously stored for later retrieval and further interpretation. In addition, the new experience could alter the user state, moving her from one of relaxation to anticipation, for example.

While this is a fairly simplistic model, it allows us to think about ways of designing for the user experience beyond altering the sensory stimuli. While some work has been done on trying to *interpret* the state of the user, another approach would be to *coerce* the user into a state of mind that is receptive for her to more-easily believe what the VR experience is designed for.

This is what we mean by the term **Experiential Fidelity**: *improving the user experience by increasing the alignment of what the VR experience provides with that which the user is likely to believe.*

3 Aligning the Experience with Expectation

Disney and Universal Studios have understood the power of the "pre-experience" for a long time, and masterfully implement it in their parks (see also [Trowbridge and Stapleton 2009]). While waiting in line for a Disney experience, for example, visitors receive "back story" content, which puts them in a certain frame of mind, mood, and attitude. At Universal Orlando's *The Amazing Adventures of Spider-Man®*, the visitor waiting line snakes past video screens and a mockup of the *Daily Bugle* newspaper, providing the back story. Once the visitor reaches the actual ride, he has been literally immersed in the world of Spider-Man in the very recent-past, and, it is hoped, has achieved a level of suspension of disbelief that will allow him to better internalize the ride experience.

To apply this to VR experiences, we propose that, prior to the experience, users should not watch someone else using the system, as this might be a form of *negative priming*. We can think of this approach as, in addition to the classical first-person experience, *designing a third-person experience*, either in the waiting area of the VR system or even as a spectator of somebody else's VR experience; this attention to design is seldom done in current VR applications outside of entertainment. The third-person experience can then be used to set the stage for the later first-person experience.

One common problem with VR experiences is that the appearance of the system components (*e.g.*, cables, heavy HMDs) can quickly destroy any feelings of engagement, as they are not part of the planned experience. Disney in particular pays careful attention to this. Therefore, another idea would be to create a perfect sense of non-mediation in VR system design by avoiding distracting components (or including them actively into the experience, as discussed later).

The experience actually starts long before entering an IPT or donning an HMD. Even the way in which the invitation is phrased

will influence the experience itself. For example, people might anticipate something very different from a VR experience they have to pay five Euros for, compared to one that is free, based on the assumption that "if it costs something, it must be good."

Prefacing a lab visit with "I'm working on what I call the 'PlayStation 6' in my lab. Do you want to try it?" plants a seed in fertile ground in the mind of many visitors. Because the PlayStation is usually thought of as a high-end video-game platform that provides a (known) level of realism, and is used for gaming, the variability from user to user about what to expect is small. Simply asking "Would you like to visit my virtual reality lab?" evokes a different set of expectations, probably with higher variation. This technique leverages known common terms to better structure the upcoming experience.

This method extends to low-tech experiences as well. Consider sitting on a couch in your house reading a scary ghost story. If a cold breeze from an open window suddenly comes from behind you, it may evoke the feeling that the physical place is haunted and raise your fright level. If the same breeze instead blew on you while you were reading a newspaper, maybe it would just trigger you to get up and close the window, rather than evoking fright.

Indeed, it is clear that high fidelity is not required to induce a sense of deep realism and believability. Books, music, and film regularly transport us to fantastic situations, and engross us to the point of willing suspension of disbelief that we are not actually in the worlds they conjure. Many filmmakers understand the power of the human mind for rounding out the experience. For example, Ridley Scott taps into this in his movie *Alien* [Carroll et al. 1979], whereby instead of explicitly *showing* the audience the creature, we only get to see quick flashes of it, its shadow, evidence that it had been there (residual slime), and what it does (dead victims).

This points at another aspect of **Experiential Fidelity**: *the extent to which a person is able to fill in gaps in perception is related to the amount and richness of previous material from which to draw*.

4 Elements of Magic

In the quest to design the user experience in VR, one of the questions to ask is what the actual magic moments are that we then might be able to support. In June 2008, a Dagstuhl Seminar on Virtual Realities[1] was held. Approximately 50 leading VR researchers from around the world met to discuss the state of VR, Grand Challenges in VR, and other related topics. During a session called *Designing the Experience*, we explored the notions outlined above by way of describing *Personal Magic Moments*, and identified several diverse attributes that characterize great experiences. Each participant volunteered stories that he felt fit the notion of a magic moment. Many stories were very personal, which is very much in line with the open nature of Dagstuhl.

After reviewing all the stories relayed by participants, several common themes were apparent, summarized next.

Strong Emotion
Several statements focused on the level of emotion and the notion of anticipation prior to exposure to an event:

- "For me, it usually has some element of surprise or novelty."
- "For me, it's about emotions, experiencing a range of them, and feeling the extremes."
- "For me, memorable moments are those with high anticipation, followed by achievement of a goal (performance)."
- "Visiting the Oklahoma City bombing site was unforgettable, because of the weight of the event that happened there."
- "I had the good fortune of fulfilling a childhood dream of playing hockey in a famous stadium."

Deep Engagement
Many of the comments focused on the depth of engagement or focus the person was experiencing at the time:

- "Achievement of flow [Csikszentmihalyi 1991] constitutes magic moments for me."
- "For me, it is when I am so engaged in an activity that I lose track of time and space; my focus is drawn in to what I am doing."
- "Sometimes, though rarely, I experience a focus of consciousness and self-sense of the scale of things, extreme hypersensitivity, a heightened awareness and lack of distraction."

Massive Stimulation
Another key component cited often by participants was the notion of all the senses receiving large amounts of stimulation in concert:

- "I most remember full-body experiences, and living in the moment, such as sitting in a hot tub while really stressed, or standing in the rain and getting that full experience."
- "I was a spectator at a unique theatre that had a huge outdoor stage (1 km wide) with planes, fire, video walls and such set up by a river. This was true full-sensory stimulation."
- "Doing 'The Wave' at a stadium is an example of a large group engaged in a shared experience."

Escape from Reality
The notion of becoming removed from reality was cited by several participants:

- "Magic often happens for me when I can get time alone, for quiet relaxation, a lack of demands, and solitude."
- "Some of these [moments] are an escape from reality, and are in stark contrast to the real world; maybe the key is being in the moment and knowing you are doing so."
- "The book *Blink* by Malcolm Gladwell describes situations where things slow down and sometimes you don't pay attention to other senses. This gets at one aspect of it for me."

While not a scientific approach, these descriptions are by people who have been working in VR research for a significant number of years with great investment into thinking about this issue. The main theme to come out of all of the discussions is that a maximum effect of experience is best achieved by providing support for the user to use her mind to create a platform for the

[1] http://tinyurl.com/5ubu9n

experience. Prior to exposure, give the user a back-story about the experience. Also, instead of providing maximum realism, give just enough clues about the situation for the user to fill in the rest with her imagination.

Taken together, we posit that combining the build up of user expectation through pre-experiences with a rich and engaging, multi-sensory primary experience can trigger memorable VR moments. It is only really possible to design *for* an experience, and not the experience itself [Hassenzahl and Tractinsky 2006], as the lens of the mind refracts any stimuli we present.

5 Crafting the Experience

We as VR researchers are both (a) technology providers, and (b) content creators. For too long, we have been focusing on (a) and (greatly) ignoring (b). Arguably, we can do (a) pretty effectively. What we need to learn to do is to embrace (b) by working with visionary experience designers. This is analogous to successful game design teams, which marry technologists, artists, and designers to craft seamless, believable, and compelling experiences. While this might seem like striving for the unachievable, we as VR designers can contribute significantly by paying attention to the user's experience.

Supporting the story in the user's mind also means having as few distractions as possible. One option is to include potential distractions into the story (giving the motion-platform a name and story, making it a buddy instead of a piece of VR technology). The experience itself is in the head, and that can be guided; as Disney does so well, we need to do a better job of creating and guiding the mindset of our users.

6 Finally, in for the Experience

With the advancement of VR technology and applications, we feel that now is the time to pay attention to improved experience. We postulate that the ultimate experience is best achieved by providing support for the user to use her mind to create a platform for the experience. By carefully structuring the entire experience, however, we can provide a scaffold for the platform, and then align the sensory stimuli to fit with this scaffold. A fertile mind is able to effortlessly provide far greater fidelity than any technology we can conjure. The creativity and processing power of the mind must be tapped to bring virtual worlds to a level that allows us to improve user effectiveness through *Experiential Fidelity*, rather than striving to match the actual fidelity of the real world.

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