

Imagination: The Third Reality to the Virtuality Continuum

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ABSTRACT

Both the art and science of the imagination have integral roles in defining compelling Mixed Reality (MR) experiences. In this paper we posit that the audience member's own imagination is an essential third kind of input in defining the full virtuality continuum for MR. It is traditionally accepted that there are two experiential inputs in MR incorporating a combination of stimuli of the real world as well as from virtual artifacts (typically from computers). Using a case study of a MemoryScape Prototype for the Maitland Holocaust Museum, we explore how, in addition to reality and augmented/virtual reality, imagination artistically and scientifically serves as an important third reality to the virtuality continuum to achieve the experience designer's intent for the audience's perception of MR experiences.

KEYWORDS: Theory, design methodology, augmented reality, mixed reality, virtual reality, imagination, cognitive science, interplay (story, play & game) conventions.

INDEX TERMS:

1 INTRODUCTION

In creating an immersive Mixed Reality experience, as with any entertainment, education, or training scenario, the experience designer is looking to leverage the audience's imagination to provide the most compelling, personal, and transformative experience.

As Mixed Reality is maturing from a technological capability into an expressive medium, fully engaging the imagination can achieve a new level of impact for audiences [18]. As a result, the definition, theory, and heuristics of Mixed Reality are advancing from merely the function of registering virtual objects into physical spaces (Milgram et. al.) into creating all new ways to capture and transport the imagination into narrative worlds for art, entertainment, and education. With MR as a form of media, the importance of the imagination begins to take a primary position in the convergence of these realities beyond helping create the perceptual illusion (figure 7). The role of the imagination a) stands on its own as its own reality separate from the real and virtual worlds; b) is critical to the perception of both real and virtual individually; and c) helps melt the boundaries between the real and virtual worlds.

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Mixed Reality: Melting The Boundaries

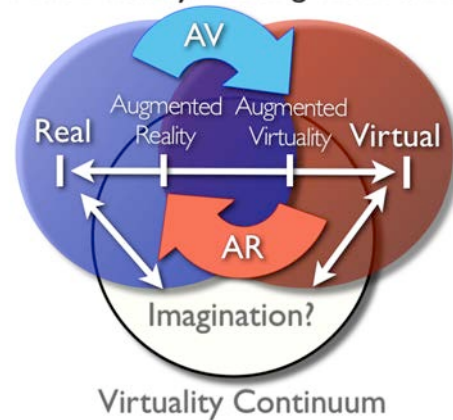


Figure 1: The traditional Virtuality Continuum of Mixed Reality includes Augmented Reality (AR), the registering of virtual assets within the real world; and Augmented Virtuality (AV), the capturing of real assets and registering them in the virtual world -. What is the role of the imagination?

Imagination: *The faculty or action of forming new ideas, or images, or concepts of external objects not present to the senses: "a vivid imagination."*

As the storyteller considers applying the conventions of a medium, it is less about perceiving the medium than it is about stimulating the audience's imagination. When you read a novel, the author selects words and composes sentences to provoke memories and feelings that you don't see or hear from the book; the images and sounds are triggered within your mind's eye. A graphic novelist considers what is in between the frames of the comic book. A filmmaker considers what is in between the scenes such as the subtext or the time and relationship that has elapsed. We complete what is left out, but what is intended by the author.

"If a writer of prose knows enough of what he is writing about he may omit things that he knows and the reader, if the writer is writing truly enough, will have a feeling of those things as strongly as though the writer had stated them. The dignity of movement of an ice-berg is due to only one-eighth of it being above water. A writer who omits things because he does not know them only makes hollow places in his writing."

—Ernest Hemingway, [Death in the Afternoon](#)

The power of suggestion, or the artistry of the literary medium in Hemmingway's case, is figuratively painting with the audience's imagination. The text is merely the tip of the iceberg. The reader imagines what is beyond the page to gain the full

intent of the author. This is not about mind control, but the collaborative nature of any narrative. The story experience is the result of two and not one imaginations. You have the author's expressive imagination within the mastery of the medium that then suggests to the audience's empathetic imagination the intention of the author. The audience imagine their own relevant contributions to capture the fully intended story experience. This contribution to the media experience is remembered differently with each audience member. This is why reading the book will never be exactly like seeing the film. Each type of medium engages and triggers the imagination differently as does each storyteller and audience member.

In the design of experiential entertainment such as theme parks, when reality is the canvas of the story's author, the designer can set up the audience's expectation just before throwing them into total darkness so that they imagine the worst, best, or most compelling personal experience with no additional media.

Carson [1] states it eloquently. "Much of this (environmental storytelling) is done by manipulating an audience's expectations, which they have based on their own experiences of the physical world. Armed only with their own knowledge of the world, and those visions collected from movies and books, the audience is ripe to be dropped into your adventure. The trick is to play on those memories and expectations to heighten the thrill of venturing into your created universe."



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Figure 2: Universal Studios Florida replica of Alfred Hitchcock's "The Rear Window" scene utilizing early versions of Mixed Reality (view of set was skewed for the benefit of the publicity photo)

In addition, the designer can influence the audience's perception to paint in the gaps between real and virtual, imply a world beyond perception, ignore elements with optical illusion, or redirect one's attention to provide a more seamless blend of the different perceived realities within the mind. For instance, haunted houses create «monsters» in the imagination that are not

there. Magic shows redirect your imagination to ignore what is there.

In an early 1990 example of Spatial Augmented Reality in Universal Studios' Alfred Hitchcock Pavilion's Rear Window Exhibit, visitors were hooked into becoming the voyeur as was Jimmy Stewart's character in the movie. A scenic replica of the courtyard scene was recreated in a vignette across the interactive atrium to spark their curiosity. Through binoculars, visitors were compelled to go against their nature to peer into their neighbor's windows. The portal of the scenic windows registered the perspective of the cinematic reenactment of the movie to the forced perspective of the real theatrical façade. The viewer was transported to living the scenario of the movie to recreate the situational murder mystery of the movie's plot. As in most murder mysteries, the audience observes the real evidence to imagine the life beyond their perception to guess, «who done it?»

Given the power of the imagination, the design of Mixed Reality needs to consider guiding the imagination as much as designing the real and virtual assets. However, what are the scientific foundations of the neuro-cognitive functions of the imagination that can be drawn upon more effectively by the designer that will enhance an immersive experience and lasting memory? In this paper we will discuss how the audience's imagination, in addition to reality and virtual elements, plays a critical third influence on constructed experiences.

1.1 Background

Since first proposing the concept of adding the imagination to the Mixed Reality virtuality continuum in a 2001 International Symposium of Mixed Reality keynote, the author has conducted ten years of applied research in exploring the importance of the imagination in the application of Mixed Reality. This research has also integrated over twenty years of creating entertainment, education, and training experiences that the authors leverage to support this hypothesis from a transdisciplinary approach. This paper will be interweaving how lessons learned from a portfolio of projects support the importance of imagination in its role as the third reality of Mixed Reality. This approach is applied to the challenge of an experiential learning experience about telling the story of the Holocaust through children's diaries.

This paper is not about the exhibit, but how the "lessons learned" from applied research of MR media support leveraging the imagination as a critical component of the Mixed Reality. The case study provides unique challenges that directly require the heightened engagement of the imagination. This paper is from the media practitioner perspective, but it explains how the neuro-cognitive science and learning theories support the function of the imagination. The goal is to better understand how the role of the audience's imagination can be better applied to prototyping the next generation of experiential media using Mixed Reality.

2 CASE STUDY: GOALS AND PURPOSE

The Vision Committee of the Maitland Holocaust Museum was seeking out new opportunities to reinvent their small, local 20-year-old museum into an experience that would make the subject of the Holocaust relevant in the lives of a diverse community. As well, it needed to satisfy its largest percentage of visitors, which were middle school students that were satisfying Florida state education standards. The purpose of the standards was in teaching the Holocaust and American Slavery to convey a civics lessons in how to be a better citizen of democracy. Traditional museum exhibit design practices of the current museum would not

attract nor meet the expectations of their 21st Century tech-savvy consumer. Neither did current modern media of video games and graphic movies do justice to the subject matter or the learning objectives of the museum.

After experiencing our interactive storytelling research demonstration of MemoryScape utilizing Spatial Augmented Reality (SAR) techniques to tell ghost stories [3], the committee saw potential in using MemoryScape to tell the story of the Holocaust. MR could tell the story differently, having potentially more impact with fewer negative implications of traditional media or exhibit design. We would transport the young visitors to a 1930s domestic environment where most of the diaries of children of the Holocaust started. This was to relate the normal life of the young author with that of the young visitor. This created an ordinary world of the child in a family setting that is similar in many ways. In this ordinary world of our protagonist [22], the early events and emotions of the family would play out with the virtual embedded media projections. It was to create the memories from the journal testimonies to bring to life the children’s own words, feelings, and perspectives.

With several Holocaust survivors on the museum’s Board of Directors, this approach first needed to be prototyped to explore its appropriateness as a media form. As a result, there were critical insights on the importance of the imagination and how Mixed Reality provides unique opportunities to engage the audience’s compassion. This also supports the reverse discussion of how critical the imagination is to effective design of Mixed Reality experiences as a third reality.

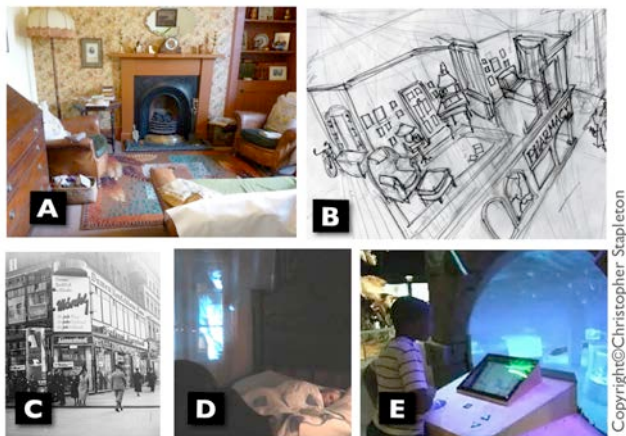


Figure 3: MemoryScape was to recreate a vignette of a 1930s a) middle-class home, b) in an European urban area, c) over the family store utilizing SAR techniques of previous projects such as mixed reality ghost stories, and e) Sea Creatures exhibit at Orlando Science Center [18].

2.1 Challenge

Any medium has the challenge of doing justice to the story of the Holocaust. The story is so large, diverse, complex, and personal, the more the media tries to examine the diverse details, the less it will achieve in telling the larger story. The story is difficult to approach without over-simplification or becoming too distressing for young perspectives. It is a depressing subject for the public to digest, and many may find it easier to ignore. So there is a desire to try to find new ways to tell this story as compelling as possible with emerging media. This becomes more urgent as fewer survivors are able to tell their stories themselves. As powerful as

traditional media can be to ignite emotions, a Hollywood story technique can do more harm by demanding a tight resolution and uplifting ending [19]. From the perspective of the museum, the Holocaust is an “open wound” of unresolved issues, emotions, and endings. The MemoryScape of the Holocaust needs to spark the beginning of inquiry, conversations, compassion, and action, not resolution and closure. This is where traditional media conventions tend to pacify one’s own post-experience motivation for action, not stimulate one’s personal conviction and action towards seeing and preventing future injustices in others’ lives. [20].

The museum staff expressed to us, the power of a medium to tell the story (and reach the learning objectives) of the Holocaust installation lies in two key functions of the imagination: first, - its ability to transport the viewer into the heart and mind of the witness; and second, its ability to transfer the lessons of the event back into the audience’s everyday life. This, by no means suggests that one should simulate or replicate the experience—quite the opposite. The most effective way they have achieved this objective is through oral storytelling with the safe, yet chilling testimony from first-hand witnesses. That story is enhanced by telling those stories in context. The deep personal connection with the subject and physical proximity and immersion of “being there” can swell up emotions and personal impact that is hard to explain both artistically or scientifically [2] (figure 5). This is the role of the museum: to bring together collections of *real* artifacts - with a *relational* connection to content that is *relevant* to the visitor.



Figure 4: The MemoryScape Prototype entailed A) audio portals such as a phone, radio, neighbors, streetmosphere, and voices with HyperSonic Sound® B) set in a middle-class home with C) Visual portals such as the photo album, vanity mirror, and front door keyhole D) the audio visual SAR media projection painted early memories and events of Nazi oppression.

3 MEMORYSCAPE

A MemoryScape installation puts the audience into the shoes of a main character by merging the theatrical staging and cinematic language within a participatory and immersive experiential exhibit (figure 2) [3]. It is presented as an interpreted art installation utilizing theme park techniques presenting historical artifacts and context. As an implicit work of art, the intention was to trigger a dialogue of questions more than answers to spark the active empathy of the viewer into discussion. The target audience of young teenagers -was to gain a first person perspective of some of

the systemic events of the Holocaust from the point of view of a witness of their age. The virtual reality media would be changed out with stories of other various diaries. Over time, this same installation infrastructure would be able to tap into the hundreds of diaries written by children witnessing the rise of Nazism and escalation of the Holocaust across Europe. The exhibit would bring to life these diaries that were difficult and obscure artifacts and testimonials not easily or effectively presented.

3.1 Experiential Media Factor

A MemoryScape installation combines the use of traditional media (literature, audio, video and simulation) embedded within a physical theatrical environment. The passive media take on a new experiential presence similar to a theme park. The participant's feeling of proximity to the event in a live environment increases the intensity of the experience [2]. The difference with an experiential MR environment is that the audience engages the physical and social environment and doesn't block it out as it would in a movie theatre. The cinematic language registered in context to experiencing the real world provides additional immediacy similar to a hallucination. Hearing a spoken memory, a reflection in a mirror, a view through a keyhole, or a voice on the radio or telephone (figure 4), the event gains an urgency and intimacy that commands the viewer's attention [3]. The cinematic experience in a movie theatre becomes a disembodied experience about another time. The exhibit venue, unlike the theatre, encourages the social interaction.

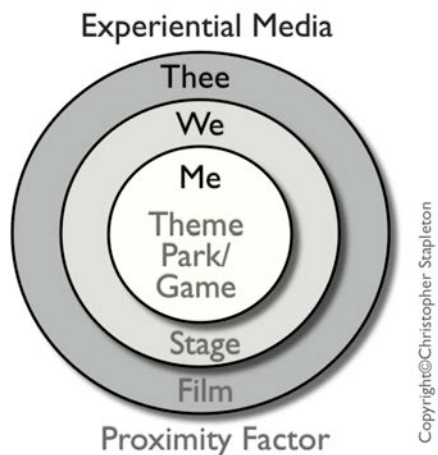


Figure 5: The Proximity Factor of experiential media puts the participant physically in the center of the action to increase the intensity of the experience [2]. The theater experience decreases the proximity to the audience by placing the action behind the “forth wall” and out of the control of the audience. The proximity of captured performance on film decreases the proximity another degree by representing action from another time and place.

With the use of Augmented Reality (AR) markers, the turning of a photo album would trigger projections to animate or change pictures in the album and voices would speak from a photo or from the photographer's perspective. With the use of HyperSonic Sound® [23], the speakers would be inaudible until they bounced

off a surface such as a picture on a wall. When directed at a very low volume towards one's ear, the sound would only be perceived within the head. A half-written journal would be left on a bed with the voice of the child writer completing the entry verbally by an audio track playing inside our head, while sounds of the street played outside the adjacent window. Sitting in Grandfather's chair next to the smell of his pipe, his newspaper, and slippers, the could hear his voice. The intent is to paint with the audience's imagination using sensory cues that project an event before them, one that they -can question, visualize, or complete-.

As in Hemingway's example earlier, the expressive imagination of the survivor's memories and the empathetic audience's imagination, based on personal knowledge, experience, and compassion, became one storytelling experience. The emotions and thoughts were shared and became one in the consciousness of the audience, feeling the emotion without the pain of the experience itself. Audiences that were moved to tears, were compelled to question how the holocaust - happened. This - audience inquiry is the combined result - of the feeling of being in the real world of the site, the sense of presences in the survivors' memories through the virtual world of the recording, and the enhancement of the imagination to relate one's own experience. This was the basis of the MemoryScape design for the museum experience.

4 IMAGINATION AS A FUNCTIONING REALITY

There is commonly thought to be a spectrum ranging from the experience of reality to the experience of virtual reality. What both ends of this spectrum have in common (at least using current technology) is that the experiences are taken as input through the sensory organs. For example, whether one experiences a sunset by seeing a real one or looking at a virtual one generated by a computer and presented with a heads-up display, the visual stimuli enters the agent through the eyes (future technology might allow virtual reality to come directly into the brain, activating the sensory brain regions directly).

The act of imagination operates similarly—although it does not stimulate the sensory organs, it directly triggers the sensory areas of the brain. As such it should be considered a form of virtual and augmented reality. In practice, imagination works simultaneously with all experiences on the spectrum.

We argue that imagination constitutes a third channel of input (in addition to reality and artificial stimuli) to be reckoned with during any given experience.

We will describe a framework to situate these various notions. Ultimately, visual sensory experience requires activation of the visual cortex (or the corresponding area for other modalities). The difference between VR, imagination, and the experience of reality lies in the nature of the source of input.

4.1 How Visual Sensory Imagination Works in the Mind

Although sensory stimulation can occur with any of our senses, for simplicity we will focus on the visual system, as it is the most important and best understood (figure 6). However, our arguments are intended to apply to all sensory modalities (figure 7).

It is wellknown that light entering the eyes plays upon the retina, which has photosensitive neurons that send signals to the visual areas of the brain. What is less well-known is that in the visual cortex there is an area that shows a pattern of activation that has a spatial organization similar to the pattern found on the retina during normal perception. This is called a retino-topic mapping. This has been found for monkeys [8] and humans [9].

It turns out that this area is activated during mental imagery [10][11], i.e., when a person visualizes something in the "mind's eye." It is thought that mental imagery brings a depictive, bitmap-like representation to activation in the visual cortex in much the same way stimulation from the eyes does. Although this interpretation remains controversial [12], it appears that the mind's eye is the visual cortex.

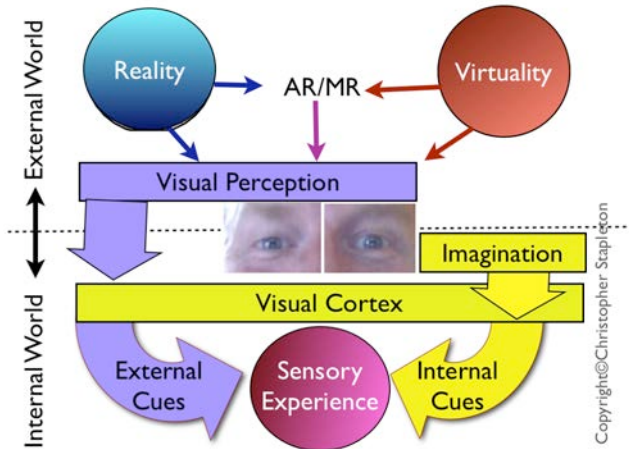


Figure 6: Reality and computer-generated virtual reality enter the sensory organs (e.g., the eyes), which are interpreted in the visual cortex. Imagination stimulates the visual cortex directly.

One of the reasons this view is contentious is -that it seems to suppose that some further process is needed to interpret this pattern of activation. Indeed, the idea is that during mental imagery, images are generated precisely so that they can be re-interpreted. An anecdotal example is how one responds to the question "how many windows are in your house?" Most people have never calculated this number, so it cannot be simply retrieved from memory. People tend to report imagining walking through their house, counting the windows. Viewing the rooms in the mind's eye and counting the windows is a convincing example of re-interpretation, or re-perception, of something stored in visual memory. However, it must be said that evidence for re-perception has proven difficult to find under controlled laboratory conditions. (see [13,14] for some failed attempts, and [15] for a response).

The deliberate act of simulating a walk through your house resembles, in many ways, a virtual reality experience. Dreaming resembles a form of internal virtuality, or let's call it "imaginability," because it is distinct and separate from the computer-generated Virtual Reality. In fact, it would be reasonable to consider dreaming to be the most immersive, persuasive simulated reality that exists--and it is generated completely internally, bypassing the sensory organs altogether.

Imagination can also function as a form of Augmented Reality (AR), as when one imagines a different color of paint on a wall You might have heard that a good strategy for overcoming stage-fright when giving a talk is to imagine your audience naked. The ability to simultaneously observe people and to imagine them naked indicates that imagination can occur along with actual vision, just as computer-based AR systems do. Hallucination and optical illusions constitute other striking examples of imagination-generated AR.

Normally we are able to distinguish the things we imagine from the things we actually see. Hallucination, caused by certain drugs and mental illnesses, is when we are unable to recognize our imaginings for what they are. However distinct the imagining is, the believability can be as compelling as "seeing monsters" in the dark in a spooky house.

This is commonly called the "suspension of disbelief" where we choose or are compelled to ignore what we know of reality in favor of the artificial cues that we want to believe. In actuality, it is not a suspension of disbelief as much as it is a replacement of one belief system with another [24]. We instinctively follow the external cues through our body, but we can override those cues with internal cues from the imagination. In either case, it relies on a tremendous amount of experience and belief. We are in essence suspending our sense of reality in favor of our virtual and/or imaginary reality. However, it is all ultimately mediated by our imagination making it the primary reality, or "imaginability."

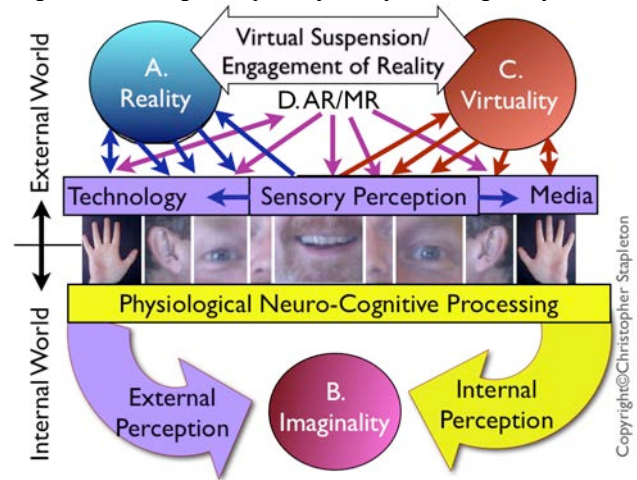


Figure 7: A) the Physical Reality and C) the Virtual Reality are perceived by each sense separately through different neuro-cognitive pathways before they come together as external perception in B) the imagination. The imagination can produce its own internal perception to influence the external perception.

The above diagram represents the role of the imagination within the Mixed Reality Continuum. The Physical Reality (A) is perceived by by each of the senses differently through different physiological, neuro-cognitive processing. The Virtual Reality medium (C) is perceived much the same way; however, the subject is able to either suspend or engage the physical reality cues to emphasize the virtual. Both the Physical Reality and the Virtual Reality perception from external sensory cues are combined with the imagination. In addition the imagination has generated its own internal perception to integrate with the external perception to create the Imaginary Reality or Imaginability (B) that creates the memories.

4.2 The Use of Suppositional Imagination

The audience's imagination is an integral part of the narrative experience integrated within the physical and virtual worlds. When an audience member hears a story told to them, he/she must actively comprehend it. Although it might feel as though the stories we hear are simple and require no interpretation, we take a great deal of our unconscious processing for granted. In fact, the

comprehension of any story requires building a model of the world of the story in our minds - [4].

When people learn about something in the world of the story, they "imagine" that it is true. It is akin to hypothetical reasoning. In MemoryScape, the audience member might hear the voice of a fictitious character named Eva say that she lived in Romania. This "fact" is entertained in the context of the story. Goldman [5] refers to this as "supposition imagination." The audience can reason about this fact much like he or she would with an actually believed fact, suggesting that these facts are stored in memory with the same "code" [6]. However, in most fictional contexts, we do not use these supposed facts to infer things about the real world. Somehow the mind keeps these facts in some kind of quarantine so that they don't contaminate our actual beliefs [7]. For example, if one imagines that one can fly, one does not then step off of a building expecting to be able to.

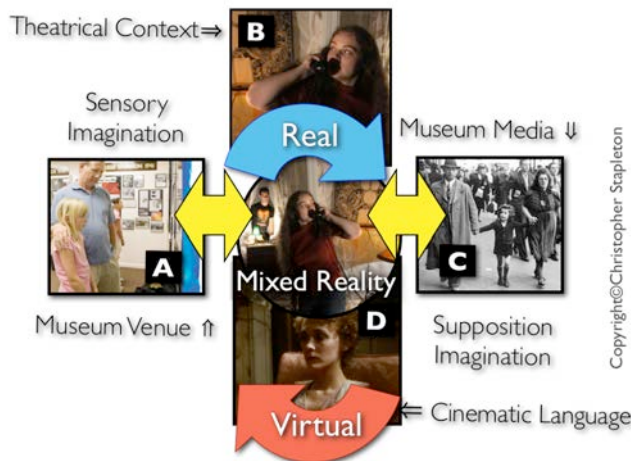


Figure 8: MemoryScapes transform A) the traditional museum venue with full-bodied sensory immersion using B) theatrical context of being in a real place. C) Audio/visual media is created based on museum collections and research to bring the theatrical setting alive and to D) trigger suppositional imagination utilizing cinematic techniques seen through Mixed Reality portals.

When Eva tells our audience member that Nazi troops invaded Romania, the audience member can reason that Eva would be in danger. To do this, our audience member must infer that because of the supposed facts that Eva lives in Romania, and that troops invaded her neighborhood in Romania, and that anybody living in Romania during an invasion would be in trouble, that Eva would be in trouble. This is an example of the importance of the suppositional imagination in the MemoryScape experience.

Note that all of the above reasoning can happen without any specific *sensory* imagination (also called "enactment imagination" [5]), which is imagining sensory experience (e.g., hearing a song in your head). However, "sensory" imagination merges with "suppositional" imagination to intensify the believability. Not only might the audience imagine the fact that Eva's neighborhood is in Romania, but they might literally picture it in their mind's eye. For example, they might picture buildings, and troops marching in the street. Similarly, when hearing the grandfather's voice, they might picture the grandfather speaking. The images that come to mind when reading or hearing a narrative are a part of the sensory imagination, be they visual, auditory, or involved with any of the other senses. They too are an important part of many artistic experiences.

5 IMAGINALITY: THE 3RD REALITY

How will the Mixed Reality imagination affect practitioners who design experiences? One problem is that the experience designer has relatively little direct control over the imagination of the audience member. However, the expressive power of the medium to spark an audience member's imagination can provide predictable responses with matured artistic conventions. As with all new forms of media heuristics, artistic conventions emerge from trial and error, which is the reason for our prototype. However, eventually the emerging conventions will become a part of our cultural lexicon and we can predict more reliably about how to trigger the audience's internal perception, such as with the cinematic or literary language [18]. MR will also adopt its own techniques and traditions to predictably spark inferences within the suppositional imagination; create magical moments with sensory imagination; and evoke emotions by tapping memories and previous knowledge. For instance, the child excitedly responding to the sound of marching Nazi soldiers, not realizing it is not a parade, but the beginning of a tragic life. Our knowledge is projected within this scenario with great sadness in our imagination, even though the scene is painted with joy and happiness.

5.1 Painting the MemoryScape Imaginality

The MemoryScape exhibit takes journal reproductions of a child of the Holocaust and places them within three "domestic" scenes that represent the transition of the Holocaust's victim's family condition. The family home is the contextual premise that the modern day young teenager can relate to with the journal's author. The first room is a modest, middle-class, urban European family of the 1930s. The second vignette represents a corner of a home in the Ghetto. The third area was between the bunks in a section of the concentration camp barracks. As drastically different as the room vignettes were, they all represent a domestic setting surrounded by whatever family they had left or could redefine. This illustrated the continuous strangulation by the oppressive forces and the decline of the human condition.

A common artifact in each of the spaces was a child's doll. In the first room was a rather new doll. In the second space was a desheveled doll. In the third room was a doll made from found objects from the residents of the concentration camp for a young victim to play with (a replication of an actual museum artifact). This last doll represented the most heart-breaking form of holding on to one's humanity in the face of brutal Nazi oppression. The child's play was a defiant act of resistance, that was not tolerated. This symbolises that even the smallest of us has a role to play - in preserving human dignity.

The power of this one real artifact (Physical Reality) and an innocent voice of a child playing (Virtual Reality) in context to what we imagined as to the horror that was surrounding that moment (Imaginality) can be more powerful than any of the graphic archival footage. It is not only more moving, but also motivating to bring that the lesson of tolerance and compassion to one's own life. The power of Mixed Reality lies in bringing together realistic artifacts in context to relational stories with relevant issues that define the audience's experience and memories. This can't happen without orchestrating that moment with the audience's imagination in mind.

Within the design, each room is made up of real artifacts that become portals into the virtual world of memories that are meant to trigger specific imaginary perceptions of the times from within

the hearts and mind of the people represented in the journals. In the table below, we map out the rooms with the physical props that become the portals where the virtual characters are intended to paint a larger picture with the audience's imagination.

For instance, the physical hallway mirror reflects a virtual image, not of the participant, but of the author of the journal that introduces us to their ordinary world that is about to be turned upside down. The telephone is the portal of outside, distant threats. Meanwhile the door is rigged to activate mechanical banging with threatening muffled voices. As we look through the peephole, we see a virtual display of the neighbors being forcefully evacuated, while we hear the voice of the child wondering about the dog that is left behind, calling for its owners. The desk has a photo album with a lamp overhead that not only projects light, but also projects images that bring the photos alive with voice memories attached to each page as they are turned.

Table 1: Real, Virtual and Imagined worlds to be created to tell the story.

Room	Real: Home	Virtual: Memories	Imagined: World
Hallway	Hallway set	Wall pictures	Family stature
	Hall props	Tags & tape	Nazi oppression
	Hall mirror	Rear projection	Child's life
	Living	Gramp's chair	Gramp's voice
	Radio	Audio program	City & world
	Telephone	Show audio	Confrontation
	Front door	Knocking	Confrontation
	Peephole	Hall view	Neighbor's fate
	Dining table	Family voices	Family worries
	Floor toys	Child's voice	Child's confusion
	Photo album	Photo project	Extended family
Bedroom	Bedroom set	Lighting cue	Grandparents life
	Window	Sounds & lights	Nazi occupation
	Bed set	Child's voice	Family heritage
	Night stand	Parent's voice	Child's past

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5.2 Technical Set-up

It was important that the technology did not call attention to itself. In fact, for the period nature of the scene, it is important that the media and technology are completely transparent. That is why the MemoryScape installation used Spatial Augmented Reality by combining the use of traditional media (literature, audio, video, and simulation) in context within a physical, theatrical environment, where the virtual media world would be registered within the real world as a spoken memory, a reflection in a mirror, a view through a keyhole, or a voice on the radio or telephone [3]. Physical or virtual triggers would cue the media system. Augmented Reality (AR) feature markers tracking the turning of a photo album would trigger projections to animate or change pictures in the album, and voices would speak from photo or from the photographer's perspective.

With the use of hypersonic sound, the speakers would be inaudible until they bounced off a surface such as a picture on a wall. When directed at a very low volume towards one's ear, the sound would only be perceived within your head. A half-written journal would be left on a bed with the voice of the child writer completing the entry playing inside our head, while sounds of the street played outside the adjacent window.. The intent - is to paint with the audience's imagination using sensory cues that project an event before them, one that they would question, propose, or complete. For instance, police would bang on the door to attract

the participant's attention -to the keyhole, though which we would witness them entering the apartment -to evict the neighbours (off-screen). Afterwards, the doors would be sealed but with a dog still inside the apartment left to suffer. With only sound, we imagine the fate of the people and their pet, and we are faced with - the author's dilemma of defying orders to save the life of an animal.

6 CONCLUSION

The Imaginality of Mixed Reality provides significant added value to learning experiences. It provides a broader bandwidth of experience utilizing all the senses, in all directions, dimensions, AND realities. The imagination is able to expand the perception of the physical and virtual space to tell a big story in a small space. In inviting the user's imaginative contributions, it creates a more personal and relevant connections. Leveraging the audience's imagination allows the content to be perceived in different ways by different people to accommodate their needs and limitations, such as having an age-appropriate level of detail. Allowing the audience's imagination to take a more significant and active role provides an opening for interpretation to help exercise the visitor's ethics and principles. Expressing one's imagination also provides a channel to express our emotions and thoughts to bring more relevance to the subject matter.

7 FUTURE WORK

The MemoryScape Holocaust prototype proved to be an intriguing and compelling experience that offered new positive possibilities that addressed many of the museum's concerns -that this was a legitimate format in which to present the Holocaust Story. The future work will entail working with living survivors that were children of the holocaust -and translating their stories into the venue to give them life beyond their owners' ability to tell their own stories.

User studies and formative evaluations will be conducted to examine the power of Mixed Reality in comparison to traditional media and exhibit presentations. Scientific and pedagogical evaluations -will be conducted to examine the unique impact that utilizing all the realities have in experiential learning. As new experiential learning theories emerge that engage the imagination, emotions, and creativity of the participants, Mixed Reality will be studied to better understand the effective learning strategies.

8 DISCUSSION

With the growing real-world use of Mixed Reality (MR) within transformational applications such as training, education, and marketing, there needs to be a consensus about how the science of the brain engages with the art of the media to explore the true impact of MR on the human experience and its performance. As a result, we need to consider imagination as a key reality within the MR Framework. In defining the application of Mixed Reality to the field of media and entertainment at the Yokohama International Symposium on Mixed Reality (ISMR 2001) we proposed that imagination be added to the Mixed Reality taxonomy spawning two more continua that was referred to the Mixed Fantasy Framework [16].

In the ten years since that proposal was presented, there has been little published on the subject that represented both a scientific *and* the artistic merits of expanding this taxonomy to a third reality of the imagination. As the research and application of Mixed Reality expands rapidly into the arts, media, and humanities disciplines, this paper attempts to begin to examine a transdisciplinary explanation for this framework to provide a

foundation to stimulate further basic and applied research. With this broader framework, we can build upon and expand the future impact of Mixed Reality to enhance human experience and performance.

Mixed Reality is being considered within more serious applications with life and death consequences from training and enhancing work performance of surgeons, soldiers, educators, and vehicular manufacturers. By inserting MR within a higher-consequence, performance workflow, the user demands more than the merging, registration, or tracking of realities. They not only need to *perceive* but *believe* the realities are one [17]. The failure to consider the role of the imagination or cognition within this MR framework hinders the ability to examine the power MR has as a compelling media form, and thus diminishes its relevance to the application of the arts, media, and humanities, much less to the area of all human performance.. The success of each reality can be explicitly addressed and assessed within each field of study: human factors, technology, and media performance.

The power of the imagination is at work with the understanding of every media revolution. The revolutionary moment happens when one can transform the obvious technological *function* into the magical artistic *purpose* of transporting audiences into a compelling illusion through their imagination. The maturation of artistic convention integrated with better understanding of neuro-cognitive science is what will transform the impact and adoption of MR technology [18].

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