

Mixed Reality and the interactive imagination: Adding the art to the science and technology of Mixed Reality for training, education and entertainment

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Abstract

Technology has advanced to the point where realism in virtual reality is very achievable. However, in our obsession to reproduce the world and human experience in virtual space, we overlook the most important aspects of what makes us who we are—our reality. Yet, it isn't enough just to trick the eye or fool the body and mind. One must capture the imagination in order to create truly compelling experiences. Mixed Reality (MR) allows for the merging of our imagination with our physical self and virtual presence. With the additional convergence of entertainment simulation, artistic convention is playing an ever-growing importance in sparking the imagination to achieve compelling and effective simulations. This paper explores the artistic and technical research challenges of mixing these realities with the imagination based on the work at the Media Convergence Laboratory (MCL) presently being conducted at the at the University of Central Florida (UCF).

Introduction: Putting the stimulation in simulation

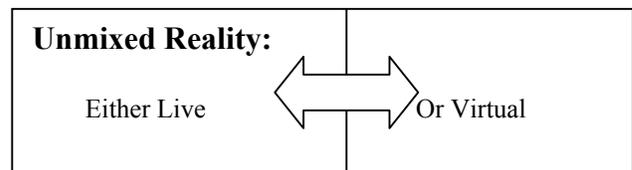
The Chief Scientist from the US Army's Simulation Training and Instrument Command (STRICOM) remarked to the creative producer of Universal Studio's Spiderman, The (simulation) Ride, "You know, we are in the same business really. We are in the business of making memories that people will never forget." During the same panel discussion at the 2000 ACM/SIGGRAPH conference, leaders and visionaries of the future of military and entertainment simulation found more in common than they found in their differences. It is not the intent to confuse the importance of training the next generation soldier for life and death scenarios with extravagant amusement park attractions, but to reflect on the importance that simulations need to be more than realistic. They need to be compelling and engaging to make a difference in one's life and maybe save one's life. It is the impact on the imagination that can seal a simulated experience into one's memory for use in preparing for war, learning or just for thrills.

In the study of Mixed Reality at the Media Convergence Laboratory, the creative techniques and technology of both experience-based entertainment (theme parks, video games, virtual sports, etc.) and simulation training, are ever

more dependent upon each other to extend the art and science of simulation to reach the next generation of simulation experience and obtain its purpose in entertainment, education and training.

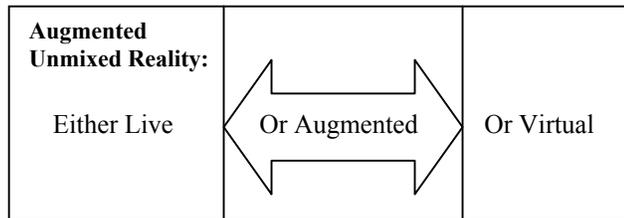
Background: Evolution of Mixed Reality

Not until the late in the last century, have computer-generated virtual simulation been able to engage successfully with live simulation. Both have had their own advantages, but the choice of the user was to use either Virtual or Live simulation. Virtual Reality (VR) was extremely pliable to one's purpose, but consisted of a disembodied experience. Live Simulation was significant in providing to a soldier the "ground truth" of Combat Reality (CR) in order to properly test the skills under fire.



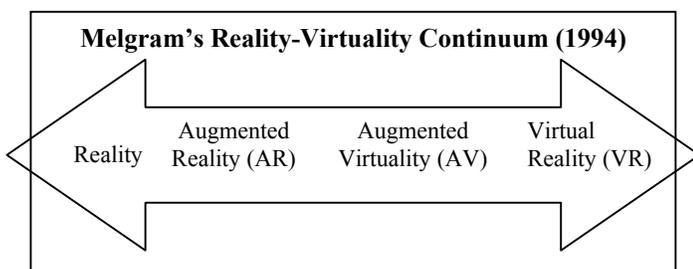
With the introduction of Augmented Reality (AR) as Boeing coined the term in the early nineties, we were able

to apply virtual objects within physical reality. Combining techniques of Sutherland/Sproull's first optical see-through Head Mounted Display (HMD) from the early 1960's with complex, real-time, computer-generated wiring diagrams and manuals. Both were registered with each other and manuals were embedded within the actual aircraft for intensely detailed procedures.



Yet the challenges in merging the realities in a seamless immersion were truly limited. Optical see-through HMDs produced transparent virtual entities that would be ghosting through reality. Spatial orientation of the user and virtual objects within reality were in conflict due to the lack of occlusion of virtual objects with real foreground objects. Items that were seen accurately with 3D perception through stereoscopic HMD would lose their effect when a real object tried to pass in front of the virtual image. In most cases, it was with the user's own hand or device that would quickly destroy the illusion and flatten the 3D effect without the parallax of foreground object produced by proper occlusion.

We depend upon the parallax of the background with foreground objects in order to negotiate spatial environments and to maintain the illusion of the visual hybrid perception.



In 1995, Mixed Reality Laboratories (headed by Hideyuki Tamura, PhD) took on an ambitious research initiative to effectively blend the entire spectrum of these realities, which was coined as Mixed Reality (MR) (Milgram 1994). With research in several aspects of technology from optics, graphics generation, video imagery, computer vision, a video see-through Head Mounted Display (HMD) was developed to more accurately represent the mixing of these realities. This was dramatically demonstrated with AquaGauntlet mixed reality game presented at the 2000 ACM/SIGGRAPH conference in New Orleans.

This was a significant development in order to consider MR for incorporation into the media research at the Media Convergence Laboratory. The application of augmented reality went beyond the typical 'text in space' to creating a more seamless interactive MR environment for art and entertainment. There was still significant work to be done in applied research.



Mixed Reality Lab, (2000 Canon Inc.)

Experiential media research: All media is Mixed Reality

Many can easily see how any type of Media can be considered virtual reality, because it takes you somewhere far away from reality into your mind's eye. Even though the technology is over one hundred years old, feature films are still one of the most immersive media forms of today. That is because over that time, artistic convention has matured the function of the motion picture to transcend the original limitations of merely capturing motion. It is now a powerful expressive art form. So compelling is the media that in the United States, feature films are only a nine million dollar industry, but it impacts a hundred billion dollar market with subsequent product markets.

With a hundred years of passive media captivating the imagination and pacifying audiences, it is more difficult to understand how even traditional media is a form of Mixed Reality. Where does the reality meet the virtual story world?

All experiences are physical and interact with the real world in some way. Whether you curl up with a romance novel in front of the rustic fireplace or escape into an exhilarating adventure at a theme park. It is usually through the venue that mediates the desires of the physical world with intension of the storyteller through the media reality. Both play a critical role in the audience's imagination and suspension of disbelief. The major difference is that one venue is designed to pacify the audience physical presence and the other is designed to engage and interact with the audience.

It is in the limitation of the technology of traditional media not being able to change that does not allow it to interact with the audience as does live theater. Cinema heightens the fidelity of the limited modalities it can control in order to transport the person within their own imagination. For

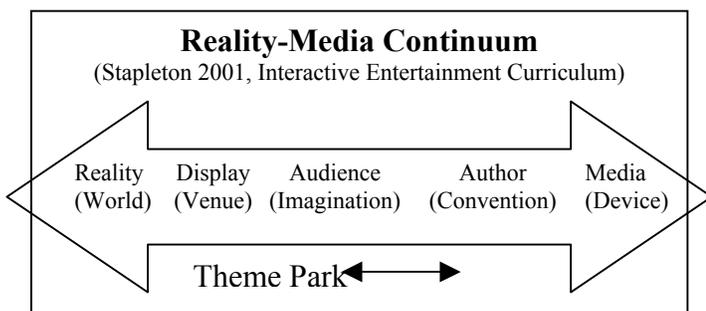
the modalities it can't control, it is essential that it disengage them so that the media technology can have full effect.

The movie theater is the epitome of the passive media venue. Every element of a movie theater is designed to disengage the body from the experience of movie watching. From the comfortable stadium seating in a dark, climate controlled room, to the acoustically treated walls and surround sound, the experience is to overwhelm you with a one way communication that leaves little to the imagination or need for interactivity. Even the saturated fats in the coconut butter of popcorn and the sugar water in the soda is all designed to pacify the body because the media does not have the capability to mediate its needs. All of these elements tell your body, "to sit down, shut up, and let your eyes and ears do all the work and be a direct path to the heart." That is the prime reason that interactive films do not work. Interactivity is inherently physical and wakes the pacified body into action and thus disrupting the purity of the media experience.

On the other hand, Experiential Media such as theme parks and videogames are simulations that are designed to interact and engage the body with the physical world. In any case, all media has a continuum of its own. This charts reality to one side of the spectrum and the virtual world of the story on the other. The audience is in the center mediating the two with its imagination, which brings all of the pieces together in a compelling false memory.

Reality-Media Continuum: The magic is behind the eyeballs

Similar to Melgram's Reality-Virtuality Continuum, media has its own Reality-Media Continuum that transforms the ordinary world into a virtual world of fiction and fantasy. However, media is more than just technology.



The technology (virtual reality, print media or optical prints) is merely a device to spark the imagination. "The

magic," as they say in the entertainment industry, "is behind the eyeballs." The critical element is the use of the imagination of the audience that merges reality and technological media device.

The creative research that is done in new media is to explore the old and new models of artistic convention that manipulate the media technology and the optimum uses of the venue to mediate and heighten the reality of the fantasy in order to produce a seamless mixed reality of its own. Seeing the commonality of these media forms, allows for the convergence of artistic convention.

Reality-Media Continuum comparison matrix

	Book	Film	Theme park	Video game
Reality (World)	Home	Mall	Roadside	Store Front
Display (Venue)	Cozy chair	Theater	Theme Park	Arcade
Audience (Imagination)	Read	Watch	Respond	Interact
Author (convention)	Novel	Feature film	Ride and show	Game
Media (Device)	Print Media	Optical Print	Actors and scenery	Virtual Reality

All media have the same components, but passive and interactive emphasis different ends of the spectrum or continuum. In the case of experience-based entertainment such as theme parks, much of the story experience lies within the physical world venue. With passive media such as a book or film it de-emphasizes the physical world. Whether the venue is designed to engage or pacify the physical reality, the artistic convention can transcend technical limitations.

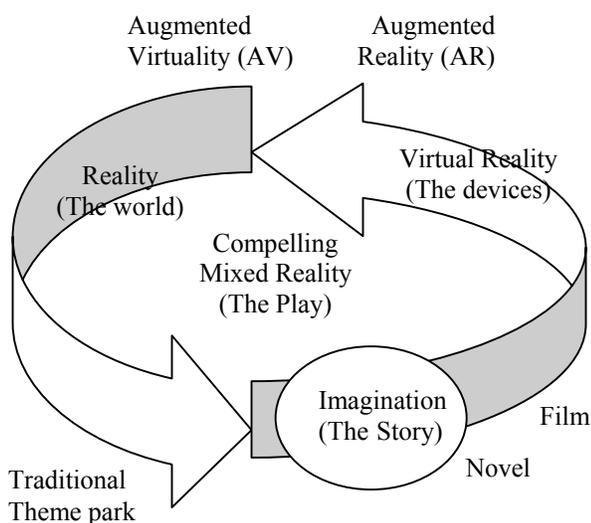
Mixed Reality continuum: Transforming Mixed Reality into compelling media

For Mixed Reality to become a compelling media form, the application of MR needs to address not only the convergence of technology as in Melgram's Reality-Virtuality Continuum, but also the convergence of media convention as in the Reality-Media Continuum.

As in most interactive and experience-based media, this is not a linear continuum. The application of Mixed Reality will need to embrace all of these concepts. By looking at the Mixed Reality Continuum as circular spectrum not unlike a color wheel. Three primary components of Mixed Reality are used by the artist and storyteller to mediate Mixed Realities-- the real, the virtual and the imagined.

With this circular spectrum, you can map traditional as well as new forms of mixed reality. The oldest type of Mixed Reality is that of the traditional theme park or social ritual event such as telling a story around a fire. Without the use of technology, the physical world and the imagination were enough.

Take for instance the child who merely needs a blanket tied around the neck to become a super hero or an empty cardboard box on a grassy knoll to fly through the galaxy at the speed of light. With a strong imagination, you don't need technology to produce a compelling virtual reality. Any new technology that comes around needs to not only match the power of that imagination, but it also needs to interactively engage with it. This is the critical omission in Melgram's Continuum.



In this circular spectrum, traditional passive media reside mostly between the virtual device of a good book or an engaging film with the use of artistic convention to spark the imagination and transform the real world into a compelling memory. This is done by pacifying the body and subduing the physical reality. This positions the passive media forms as far away as possible on the spectrum from reality. What differentiates a good book from a film is that it is pure story and depends more on the audience imagination. This places it closer to the imagination on this circular spectrum. With film or television, it relies less on the audience imaginations and more on the media devices to obtain its effect on the audience.

If you take the technology of simulation alone, it is no longer a media form. It is merely technology simulating a form reality with various degrees of virtuality. This type of application is at the opposite end of the imagination and represents Melgram's Reality-Virtuality Continuum.

The art of Mixed Reality as a form of expressive and compelling media will lie within its ability to take advantage of the entire spectrum of realities and thus be centered within the diagram. This will be accomplished by leverage all the forms of art and technology of media. In other words it will be evolved through convergence.

The Interactive Continuum: Engaging the interactive imagination

There is a quandary with the convergence of passive and highly interactive, multi-modal media forms such as Mixed Reality. How can you use conventions that are so powerful in passive media in the interactive realm? Hollywood is in the business of capturing the imagination, not interacting with it.

The comparison between the motion picture industry and the computer game industry goes beyond competing markets. If the marketplace was any true gauge of convergence, you can either make a good interactive game or a good passive story. Good movies don't necessarily make good games and good games don't necessarily make good movies.

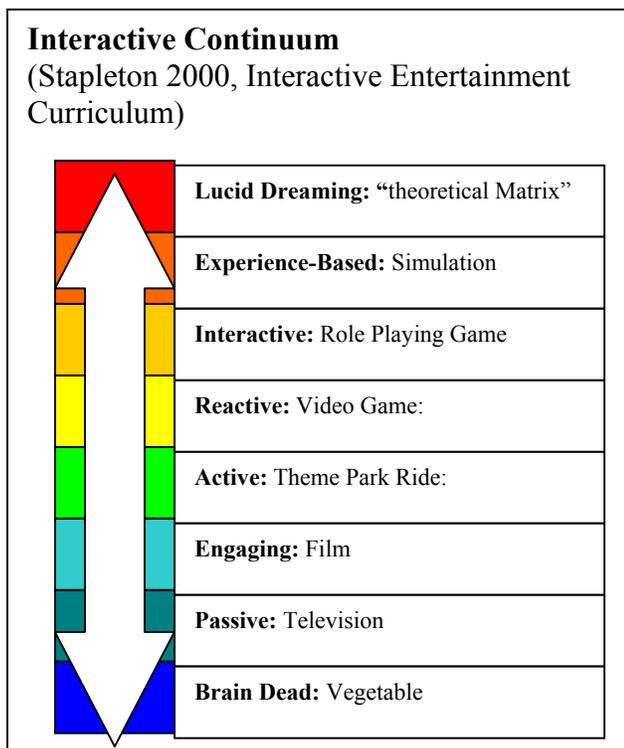
However, as Jesse Schell from Disney Imagineering suggests, this is not much difference in this argument than when physicists speculated whether things were made up of either particles or waves. We think every media is either story or game. Just as in the Mixed Reality continuum, it is not a choice of either passive or interactive, but in fact is a rich spectrum between passive and interactive. Mixed Reality cannot only help merge the virtual realms with the physical reality; it also can help transform interactivity to an expressive spectrum.

In reality, every media piece is part game and part story with different proportions of each. Star Wars is mostly story with little left to the imagination and or the choice of the audience. However, when seen for the first time, there is a natural game between the author and audience of "what's next." This is more evident within a murder mystery. Tetris is mostly game, yet there is a bit of dramatics within the tension and emotion of competing with the clock. If nothing else, the story is produced between players recapping their experiences. The game Zelda, which outsold every major film during the 1996 Christmas season, is more story than Tetris, but it is still a game.

It has been the limitation of technology that has segregated different levels of interactivity within different media. However, with the advancement of science and technology, there will be a convergence of levels of interactivity within each story either controlled by the artistic convention, storytellers or audience members. We will be able to easily transition between the levels of interactivity. The ultimate challenge is to create media that author and audience can choose the level of interactivity at

any point within the story. This would be dependent upon the convergence of artistic convention with all the interactive modalities of Mixed Reality.

This is where the creative research will reveal the most innovation. There are excellent existing media examples within each level of interactivity. What would it take to be able to effortlessly transition between them all?



Currently, the practice of simulation and training offers the most challenging venue to explore this area. With the wide range of possibilities of emergency response or the theater of war, combined with the complex variables of interservice training scenarios, it is hard to determine whether you are playing the game or the game is playing you. The entertainment industry has been hesitant to explore more sophisticated models of interactivity. The real concern was whether the story form could evolve to be more interactive.

The Story Continuum: Mediating the imagination with interactive story

It is human nature for somebody to more likely believe an outlandish lie if told as a well-told story than the boring truth. We look for the story in all we do. It is how we mediate life and explain the world. From mythology to making excuses, it is the good story that helps get through life’s challenges.

We are hard-wired for story and the good author takes complete advantage of this fact. Story is the prime tool the author uses to manipulate the audience’s imagination. Whether the storyteller uses it to spark the audience’s participation or the subconscious uses it sort our day in lucid dreaming. The imagination is so powerful; we cannot distinguish it from reality when in a dream state. It is the goal is for the scientist to bring the technology as close to the level of the imagination and the role of the media artist to transcend the limitation of that technology with artistic convention in order to immerse the interactive imagination.

The linear story as told in traditional media is powerful, but seems to be inadequate when applied to the interactive and non-linear nature of simulation and mixed reality. The holy grail of interactive storytelling is still elusive and unproven outside the venue of live theater. As with every technological advancement media, MR will drastically change the creative models of artistic convention, we need to look at story with a fresh perspective to achieve the undiscovered, but surprisingly obvious solution that eludes the greatest of Hollywood’s passive media writers.

We can look at media convergence and examine the continuum of story. Any content is composed of three parts—Content, Experience and Mediator. With theater, the playwright is responsible for the content (the story), the audience consumes the content through experience (passive or interactive) and the actor, director and designers are the mediators of that story. Content on the World Wide Web, mediation is accomplished via the computer where all new forms of mediation are being explored technically, creatively as well as economically.

The significance of the mass media market over the last hundred years is that studio executives and network presidents mediated content for us and the content creation was kept far away from the direct influence of the audience. The demand for passive, one-size-fits all stories became dominant and thus conditioning the audience not to be an interactive participant of storytelling as in live theater.

With the rise of interactivity technology, we can start employing new tools of media integrated with interactive performance to evolve the computer mediated interactive story. It is in the convergence of techniques we can start finding the continuum of the interactive story.

The Interactive Story Matrix below has been created to map out storytelling conventions and technology that will be involved with making stories interactive. It is broken down into a simple, but dynamic cross-reference of the three main components of story telling (Content, Mediation and Experience). The rows represent the people who have the critical role in each story telling component and the columns represent their goal within the interactive story. In corpora ting the Interactive Continuum these

roles and goals do not stay consistent. Each participant can take advantage of each paradigm. Each cell of this matrix points to a particular convention where the unique combination is embraced by that form of media.

Interactive Story Matrix

(Stapleton 2001, Joe's Garage, interactive storytelling workshop)

	Authoring	Acting	Absorbing
Author (Content)	Passive Media	Video Games	Artificial Intelligence
Actor (Mediator)	Improvisation	Passive Media	Interactive Theater
Audience (Experience)	Role Playing Games	Participatory Theater	Passive Media

In the case of traditional passive media, the roles and goals are rigid. The author authors; the actor acts; and the audience absorbs. It is when we step out of this convention that interactive story can flourish. The creative research in story is to examine these diverse conventions and to melt the boundaries between them for the Author of the content, the actor of mediation and the audience's experiences can interactively collaborate for the purpose of story evolution.

It is important to keep in mind that each role is necessary and is not given up for sake of interactive, which is commonly assumed. The author should always be in control of the story's intent. The actor should be in control of the mediation and the audience is in control of it own experience, no matter how much they give up to the author and actor.

Actor Authoring

In Improvisation, for example, the author is not absent. It is the actor who performs the role of the author. The trained improviser knows full well the repertoire of skits they can pull from for their performance. The content is there. It is their role of actor and mediator that is responsible for artistically stitching these content components together into a seamlessly performance for the pleasure of the audience.

Audience Authoring

In the case of the Role Playing Games, the audience has the unique opportunity to play the role of the author. This is one of the more challenging forms of interactive storytelling from the audience point of view. However, the content is consistent with the theme and democratic story tell body and stays in control of the story intent, as would an author. It is with the "Dungeon Masters" that the mediation of these two are resolved to the satisfaction of the general audience.

Author Acting

In the form of the typical computer game, the programmer as one of the story/games authors plays the role of the actor. Behaviors are written into the virtual characters for the audience to interact with. The avatar or agent of the author is embedded with the author's intent. The actor in this case is virtual, but still must take on the role and behavior of a trained actor.

Author Absorbing

For true interactivity to be realized, there needs to be a true intercourse between author and audience in order for the result to be able to be unexpected (but not unpredictable) result. This provides the story with the true non-linearity that interactivity demands. What is needed is the intelligence of both the author and actor to listen and observe the audience member in order to maximize that unique and customized exchange. This requires the author to listen in order for the story to be played out faithful to the author's intent. With digital media, the author writes in forms of Artificial Intelligence to interrupt the audience actions and reactions. With out this, the experience becomes merely as reactive as a video game and not to the emotional depth of a compelling story.

Audience Acting

In the case of participatory theater, the audience is invited on to the stage to participate in the acting out or mediation of the story. Whether it is in a Renaissance fair of theme park, the actor uses the audience participant to bond with the entire audience in a more personal way. Even though the whole audience is not on stage, the participant is the surrogate for the audience's imagination, which projects them into closer proximity of the action. The difference between traditional improvisational theater and participatory theater is the fact the audience member is on stage acting out.

Actor Absorbing

Interactive Acting represents the actor playing the role of audience and absorbing information, as does the author with Artificial Intelligence. The focus is not as much in authoring the story, because that may very well be predetermined. The focus is to mediate the audience's contribution to the story without diluting the author's intent. Unlike improvisation or participatory theater, interactive acting allows for the audience to contribute in unpredictable ways and it is the role of the mediator/actor to negotiate positive resolve in real-time. This involves a more sophisticated form of participatory theater and improvisation.

In our creative story research, we are looking into all of these venues and media forms to better understand the relationships between author, audience and actor/mediator

to guide us to a satisfactory process. The goal is not to reinvent time proven story convention, but to melt the boundaries between techniques so that a creative convergence can happen.

As with all story through out the ages, it is still the Author's intent that drives the story but now invites the actor/mediator into the process with the audience imagination. The resistance and difficulty to evolving the interactive story convention is enormous complexities involved and the lack of refinement in the tools for creation and evolution.

Conclusion

Mixed Reality is not new and computers are a relatively recent phenomenon within the art and science of simulation. Artists, educators and military strategists have been simulating in other medias for hundreds and thousands of years. They did not have the advantage of virtual reality to dynamically change scenarios in real-time computer generated imagery. They had an even more powerful tool much overlooked in today's simulations. The interactive imagination has been the driving force in simulations prior to computers.

In finding solutions in mastering the art of Mixed Reality, half of the challenge will be to reinvent age-old conventions and traditions. The other half will be embracing age-old conventions and traditions. The technology challenges all of our preconceived notions and our results are limited only by our imagination. Task at hand is to play and discover and find those obvious surprises that make up most of the revelations in art and science.

Acknowledgments

Ideas in this paper are not possible without decades of dialogue with extremely creative and intelligent people to sort out the wild perspectives of creative reality. Let's keep up the discussion.

My thanks goes to: Clark Dodsworth, Paul Dumanior, Timothy Eck, Linda Ellis, Pat Garrity, David Gillette, Andrew Glassner, Ron Hofer, Peter Kincaid, Michael Macedonia, Dale Mason, Erik Dyke, Jeffery Mayer, Barry Mauer, Jacqueline Morie, Joseph Osmani, Randy Pausch, Jesse Schell, Constance Stapleton, Siggy Tiekdtte, Scott Trowbridge, Hideyuku Tamura, Sterling VanWagenen, Marc Watson, Ron Weaver, Eric White, and Jeff Wirth.

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