Graphically Speaking

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Believing is Seeing: Cultivating Radical Media Innovations

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A major challenge to making creative leaps in media innovations is demonstrating the magnitude of human impact that each new media technology will bring.

> If an American foundation had been commissioned to research the prospects of Gutenberg's process called printing they would probably have said, "Interesting, but of limited value because most people cannot read."
>
> —*Anonymous, TerraMedia.co.uk quotations*

The leading media companies today tend to base their future decisions on repeating financial successes, a practice that discourages radical innovation. Luckily Gutenberg had the Bible to drive sales, because the novel and the newspaper took hundreds of years to evolve. Even when we celebrate new technical capabilities, we follow the celebration with hype and expectations that scientific or technical solutions can't meet alone. All technology is inherently limited. For media to have human impact it must affect the imagination—that is, it must have an associated magic "behind the eyeballs" that the artist cultivates—to push new technological capabilities to their limits and invent new media conventions. This bridges technological limitations with the human imagination, leading to true innovation that, as a result, forces us to change the way we do business commercially, academically and even personally, a prospect that frightens most traditional and funded operations. Now that we are in a state of constant innovation, new media is a dangerous business.

> It is the business of the future to be dangerous.
>
> —*Alfred North Whitehead, philosopher*

Inventors bring new capabilities into our hands in the form of inventions; innovators bring new possibilities to inventions by adapting them in unintended ways that expand their application. History has shown that we are inventors and innovators, but we are rarely the innovators of our own inventions. It's the generation following the invention that can examine its possibilities, unfettered by current perceived limitations. (For example, Douglas Engelbart invented the mouse, but it was Apple and their customers that innovated his invention some 20 years later.) In lieu of waiting for the next generation, the artist who is teamed with the inventor can make these creative leaps.

The infusion of artistic expression within scientific exploration of new media can be a process that defies some traditions and embraces a dangerous naïveté of the artists that appears to be an unpredictable alchemy of the mind, machine, and magic. Like the alchemist, we don't need to see it to believe it; we see it because we believe it. Even though new science and technological capability spark every media revolution, its possibilities are proven by artistic imagination, the consequent effects inevitably changing life as we know it, and never in ways we expect.

The emerging media of mixed reality—the blending of real and synthetic environments and objects—has melted the boundaries between physical and virtual realities, letting us interweave simulated characters and scenes into real-world experiences (see, for example, Figures 1 and 2). So why do we treat mixed reality as we do more limiting media technology such as virtual reality, television, cinema, radio, or print media? A new vision might borrow from tradition, but by making creative leaps, we can find the magical power that lies within.

Making creative leaps

> All media, as extension of ourselves, serve to provide new transforming vision and awareness.
>
> —*Marshall McLuhan, Oracle of the electronic age*

We must not use new technology in the old ways, but rather use new technology to see in new ways. Our research goal is to discover the magic that transforms mixed reality from technological invention into media innovation. Because the "Ministry of Magic" isn't funding any projects this millennium, we approached agencies and companies that are most directly affected or whose constituencies are most impacted by media (in particular, entertainment, education, and training organizations). We then cross-fertilized insights from each application to formulate tools, conventions, and infrastructure that stimulate innovation.

Mixed reality differs from traditional linear media. It's real time, immersive, multisensory, and intended to engage, not capture or pacify, the audience's imagina-

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tion. Mixed reality also aims to embrace real experience, unlike traditional electronic or virtual media viewing. The impact of this future participatory experiential media requires less that we empower the creator's imagination than we spark and interact with the user's imagination.

We also quickly learned that media innovation transforms each of the applications we explored as much as each application informs the evolution of the media innovation. Our approach aims to melt the boundaries not only between physical and imagined reality, but also between applications, disciplines, and markets, increasing potential economic rewards by applying core technologies across a spectrum of diverse industries. By using the common denominator of human experience, we avoided reinventing technologies for each of these varied industries.

We changed the criteria of success from achieving technological function to measuring human impact through performance. We structured the innovation process' priority to what the technology should do, not what it could do, and then invented the technology and artistic convention to match. This concept goes beyond "form follows function" to the more applicable expression, "form follows function that serves a purpose." This is the requisite condition so that technology becomes transparent to the user.

1 Family research subjects play-testing Mixed Reality Aquarium for next-generation mainstream audiences.

2 Mixed Reality for Military Operations in Urban Terrain (MR MOUT) for close-quartered, dismounted soldier training.

Innovating innovation

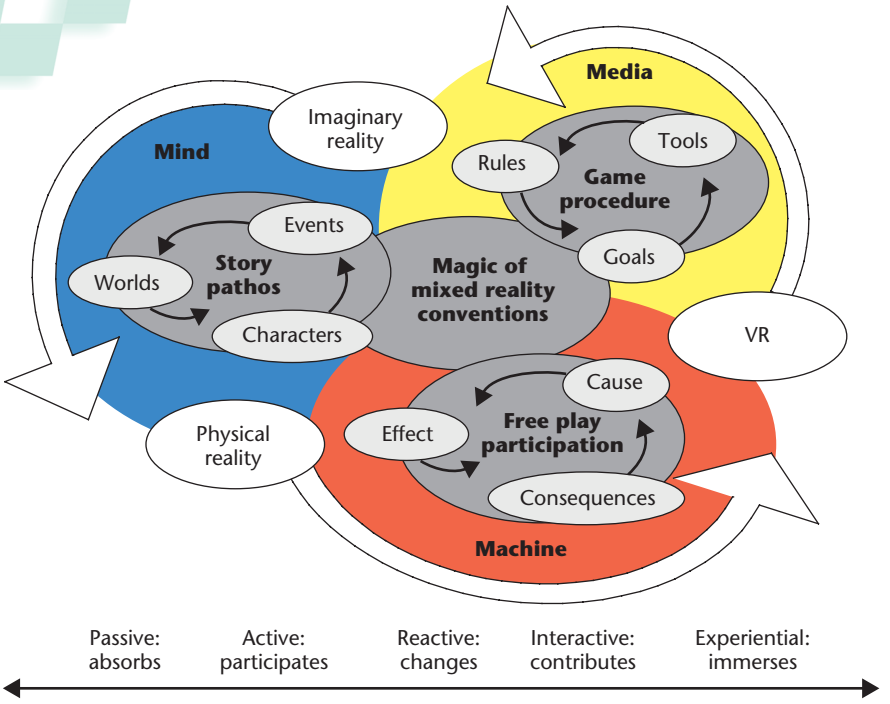
> Any sufficiently advanced technology is indistinguishable from magic.
> —*Arthur C. Clarke, science fiction writer*

How do you inspire the crazy ideas that produce radical innovations that change not only the product, but also the market, the business, and even the users? What will foster the ideas with which people can make creative leaps into the future and envision the next transformational innovation that will change how we work, play, learn, and live? What does it take to make the technology disappear so the result becomes indistinguishable from magic?

Truly radical media innovations stem from an alchemy of the mind (cognitive and imaginative), the machine (science and technology), and the magic (media and money) over a long and involved process of technological convergence, interdisciplinary creativity, and cross-industry transfer. In the past, this evolution has had as much to do with blind faith, dumb luck, and failed investments as it did with anybody's preconceived, well-organized innovation road map.

With all of the horror stories of these inventors' dilemmas, is there a better way of crossing the chasm to transform ideas into inventions and to neutralize adoption obstacles to true innovations? Do all radical innovations need to be disruptive? Without such a process, can we keep up with the ideas and inventions backlogged in academic laboratories and commercial proprietary archives? What can serve as a logistical guide for transfer? What is a measure of success? What can we do to integrate diverse genius and innovate innovation itself?

When newly invented capabilities overcome limitations in capturing, rendering, replicating, and transmitting sensory stimuli, the artists can transform the invention into a blockbuster media outlet that we can't live without. Edison invented motion pictures (projector and camera), but never made a successful film. It



3 Interplay conventions for transdisciplinary poesies of mixed reality.

took the Charlie Chaplins, Mary Pickfords, and D.W. Griffiths to create the movie media experience that transformed the novelty of moving pictures to the market phenomenon of cinema. The same is true for radio, television, cable, and now for simulation and video games. Thus, it isn't the technology's function but the content's purpose that transforms inventions into lucrative media innovations. The application creates demand and drives the economics and then the adoption of new media technology.

With science and technology's accelerated advancement comes a demand for constant media innovation. How do you integrate areas of study into disciplinary collaboration, versus sequential cross-disciplinary development, so that each exploration informs the others simultaneously? How do you measure the impact of each development on human performance to validate results across disciplines? If we could just see the innovation's impact beforehand, we could gain this insight.

MR modeling human experience

Mixed reality is the spectrum of physical reality (participating in the real world), VR (procedural media stimulation), and imaginary reality (sparking cognitive perception and creation by the user). By spanning the sensory modalities and richly layering the realities in all directions and dimensions, we can effectively capture, replicate, render, display, and distribute human experience. What we thought of as science fiction only a few decades ago is now possible with mixed reality.

Our ability to melt the boundaries between our real and familiar physical world and the simulated fantasy of the virtual world, engaging the emotions and psychology of the imaginative world, gives us a powerful capability to impact human performance. This is most evident in "life or death" professions such as law enforcement or the military. For example, the Mixed Reality in Military Operations in Urban Terrain project uses mixed reality and theme park entertainment techniques to simulate future capabilities (see Figure 2).[1] Such experimental projects let us evaluate human performance before we fully develop the technology's function and direction. Human testing is no longer an afterthought to invention; rather, it's a prerequisite, helping to define any future innovation's function and form.

Authoring MR interplay conventions

The three nodes of the mixed reality, represented in a circular continuum, are the physical, virtual, and imaginary realities, as Figure 3 illustrates. The *machine*'s participatory function mediates the interaction with physical reality. The media's procedural convention sparks the VR's *magic*. The story's emotional empathy paints with the user's imaginary reality, drawing in the *mind*.

In applying mixed reality to mainstream educational and entertainment venues, we found that authoring these diverse spectrums of reality required the full range of age-old technical and artistic conventions of story, game, and free play, each working interdependently. These techniques of the media artist needed to clarify enough to be integrated into the computer's algorhythmic process to produce the magic.

For the sea creatures exhibit (see Figure 4), we deconstructed traditional structural elements of convention into an innovative convention that addresses both artistic purpose and technical function. We transferred this model from an earlier marketing/entertainment scenario modeled in partnership with the Human Machine Perception Laboratory (formerly the MR Systems Laboratory) at Canon, for MGM marketing, where the expectation was for the model to feel like a movie, play like a game, and be immersive like a theme park.

The diagram in Figure 3 doesn't define a solution as much as it defines the challenge of mixed reality convention. Story conventions draw on the participant's empathy and deal with characters, environments, and events. Unlike a traditional linear story, this process borrows from the interactive and nonlinear techniques and theories of role-playing games. Game conventions, on the other hand, deal with procedure (or mechanics), using rules, tools, and goals to engage the media's computer rendering. Free play draws on the intuitive physical interaction's participatory aspect and generates cause, effect, and consequences. These integrated conventions engage the heart, mind, and body, respectively. Ideally, these conventions use the entire spectrum of interactivity, converging conventions instead of inventing new ones.

This approach's pitfall is that those not intimately versed in all three conventions find it difficult to mediate. Most storytellers are fearful of interactivity and game mechanics because of their ability to lead the audience's interactivity down a wrong path. Most gamers know little about interactive story versus linear full-motion video, and thus marginalize the story's power to engage. Most Hollywood game and story masters are unaccustomed to inviting the user to contribute outside of a passive or reactive role as in free-play techniques. This is where the next generation of transmedia story creators plays a critical role in defining future conventions. Transmedia pioneers such as Brenda Laurel purposely interweave the techniques of story, game, and play, or theater, cinema, and simulation to be complementary versus competitive disciplines.

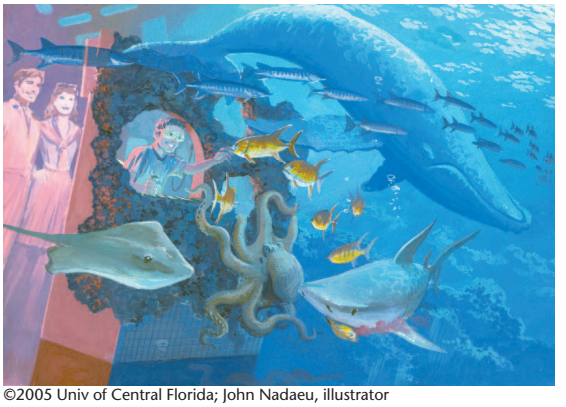
> An important scientific (and artistic) innovation rarely makes its way by gradually winning over and converting its opponents. What does happen is that its opponents gradually die out, and that the growing generation is familiarized with the ideas from the beginning.
>
> —*Max Planck 1858-1947, theoretical physicist*

This transmedia-based approach interweaves psychology (mind/cognition/imagination), computer science (machine/algorithms/story engine), and media (magic/experiential story conventions) into one process that can simulate human experience. A system is needed to mediate all of these.

Human experience modeler

The technology for creating innovations in training, education, and entertainment also applies to cognitive rehabilitation. Human experience modeling in all mixtures of realities, modalities, directions, and dimensions is a mixed reality capability that lets us capture, codify, and replicate a wide range of experiences in great detail. Experiencing activities as mundane as making breakfast, as demanding as protecting your comrades in urban combat, and as playful as interacting with prehistoric marine reptiles lets us model capabilities not yet invented to explore their impact on human performance before developing real processes and products.

Adapting mixed reality human experience modeling for use in cognitive rehabilitation (see Figure 5) clearly demonstrated the limitations of pure VR. The test subject was comfortable with the virtuality; however, both the instructor's and the subject's need for human-to-human interaction and full body and sensory perception was critical. Balancing virtuality and reality produced an adaptable system that met the application's objective. When purely virtual environments (VEs) are integrated with reality, you can utilize the real world—with its eye-to-eye contact, a therapist's gentle guiding hand, the arrangement of actual mementos from home, the interaction with real appliances, the smell of coffee brewing and a bagel toasting, the sensation of spreading the cream cheese, the refrigerator's coldness, and the toaster oven's heat—to help both user and instructor with the tasks at hand. With the VE's dynamics, users can adapt and transfer real day-to-day activities into adjustable experiences that capture, simulate, replicate, and analyze the experience in an exceptionally detailed way. We modeled, animated, tracked, and integrated real and virtual worlds, allowing for an out-of-body after-action-review of the session.



4 Sea Creatures Journey, novel concept for MR Experiential Learning Landscapes.

5 Traumatic brain injury patient working with instructor within MR during cognitive rehabilitation for daily activities.

Rehabilitation centers typically have only one generic kitchen, requiring the patient to generalize skills that transfer to the home. The adjustable modularity of our kitchen human experience model allowed for a more complete and realistic rendering of the specific home experience, with interaction enhancing the learning experience. Contextualizing the patient's real kitchen allowed the direct transfer of skills learned. Results from the pilot test show promise for effective training that could shorten a patient's stay at the rehabilitation center. Our pilot test subject reduced the time spent preparing breakfast by nearly in half after only five training sessions.[2,3]

Capturing the subject's viewpoint also let friends and family gain better insight and empathy for the challenges the patient faced. Graphical read-outs support the recognition of patterns for automating behavioral analysis into detailed quantitative and qualitative aspects. The continuity of diverse environments in the same facility lets us compare aggregate data across subjects.

Mapping vision into reality

> Every innovation occasions more harm and derangement of order by its novelty, than benefit by its abstract utility.
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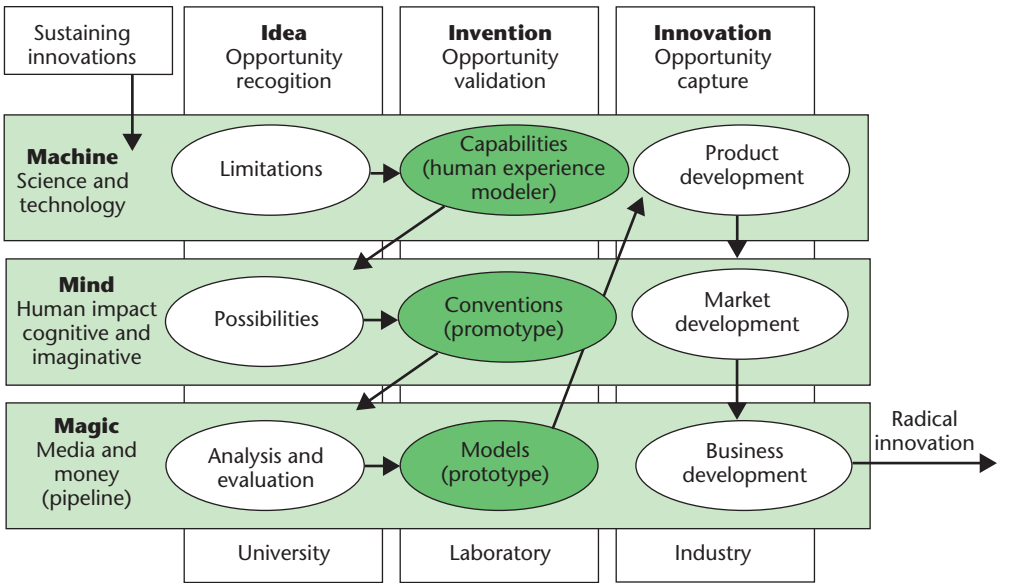
> —*Legal maxim, Thinkexist.com quotations*



6 Transferring innovation models.

Managing a culture of disruptive change to stimulate and nurture media innovation from idea to utility pushed us to create a repeatable innovation infrastructure, or interdisciplinary roadmap, involving academia, government, and business. The goal was to track, nurture, and anticipate change before discarding good ideas because of practices that resist radical change. By exploring and developing the technology, media, and human modeling in parallel, we could gather critical feedback to inform each discipline and evolve a solution that can overcome typical obstacles to adoption. Human experience models created in the lab produced adaptable and demonstrable prototypes that incorporate critical field requirements and expertise to better match purpose and function.

The belief that a killer app might appear and change the world just by the fact of its invention lost all credibility during the Internet's dot bomb phase. Venture capitalists seized the opportunity to get rich quick, thinking that they could throw an idea into the marketplace and it would innovate by itself. They assumed that if they made it, consumers would buy it, starting not only a media revolution, but a new business model as well. The other misconception is that media technology can develop without experimentation and validation of new ideas and conventions. Historically, new technology enters the marketplaces via the new content that drives adoption and validates new business models, delivering new products that are cheaper, faster, and better than the old.

Strategic media innovation infrastructure

Each of our research projects adapt a repeatable pattern of media innovation abstracted from hundreds of years of media revolutions.

Our model (see Figure 6) follows a pattern found in most media innovation that is obvious in hindsight, yet continually ignored. A new science or technology idea sparked almost every disruptive media innovation, transforming old limitations into new capabilities. Within the human experience model, we push these new capabilities to the limit with content creators who formulate ideas to transform technological capabilities into creative possibilities. We realize these possibilities through new media conventions that tap the marketplace's imagination in the form of promotypes (proof-of-concept for the marketplace), creating both a demand for the product and the human impact. Even after completing these steps, we define a new product's life cycle by how we can effectively get the product to market less expensively and more quickly than ever before. Thus, the process continues with

- the development of new production and business methods that emanate from an analysis and evaluation of current standards and practices as well as problems and challenges;
- the invention and refinement of new prototypes that serve as models (cost, operation, production pipelines, and so on) within the laboratory environment to discover failure points and invent refinements; and
- the creation of a process to transfer ownership after demonstrating successful models.

Even though the transfer is the last step, the transfer process must start from stage one, with industry contributing to the recognition of limitations that inform the entire process.

Industry then transforms laboratory models into products, and markets and businesses incorporate the integration of mind, machine, and magic. To do so, engineers apply the science and technology for product development; market development strategically prepares new markets to create demand; and operations and production change the business development to accommodate the new products and processes.

We map each phase of research collaboration from basic research on university campuses, to applied research in commercial and academic laboratories, to technology transfer for industry adoption. Key princi-

pal investigators and sponsors guide and monitor this process. Each cell presents a unique potential failure point, tradeoff, and opportunity. Radical innovation not only creates new products, but whole new industries that need not only product models, but also new business and market models.

Conclusion

With their unique and vast intellectual capital and facilities, universities are in the ideal position to lead this venture, but are unfortunately the least prepared because of the bureaucratic inertia commonly associated with academia. They must lead and not follow industry and invest, nurture, and be accountable for wild ideas and nurture new successful models that can decipher hype from measurable outcomes. As a knowledge network and honest broker, academia needs to reinvent itself, taking some of the professors and administrators out of the ivory towers and some of the industrial and political professionals out of the trenches, bringing these diverse people together to play venture catalysts to the future. The creative individuals need a technological playground of ideas and dreams to discover the alchemy of the mind, machine, and magic without the pressure of making or losing funding. This way, academia can more rapidly capture the radical ideas that can change society's future for the better. ■

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