"To Live And Learn in 3D"

Exploring The Use of Immersion Environments For Education

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Abstract

This paper explores the use of computer-generated "immersion' environments (aka virtual reality, artificial reality, telepresence) as an optimal component to a learning mix combining the best assets of entertainment and educational design. Couched within the description of a learning model that progresses from information retrieval through collaborative learning (teacher-led social interaction) to individualized reflection, I review the five principal components to the evolution of believable, plausable immersion environments for education: 3D CGI projection systems, narrative-based expert systems, DSP-based projection system, 3D audio systems and interface clothing. I conclude with the outline of an exemplary model of an imagined virtual reality learning experience, and close with caveats as to the likelihood of virtual reality actually finding its way into institutional learning environments, and with a brief sketch of the potential psychodynamic dangers of photorealistically compelling virtual reality. While these technologies are not quite evolved to the point of enabling complex, real time and dynamic interactions with realistic, simulated characters, the converging computer and AI technologies supporting virtual reality are pointing in this direction.

Key Words: immersion environments, educational design, learning model, CGI projection systems, narrative based expert-systems, DSP, 3D audio, interface clothing, psychodynamic dangers.

Category: Real-time computer simulation, artifical reality, implementation of virtual space

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The Drive

The educational philosopher Piaget once said that *"the ultimate path to learning is through life itself."* This quote becomes significant given a continued decline of our existing educational infrastructure due to misplaced fiscal logic; given the continued trend to employ teachers as truancy administrators rather than as educators, collaborators, and as cheerleaders; and particularly, given the continued irresponsible attempts by our current administration to redistribute educational accountability to the home, community, and private industry.

The quote becomes significant because it suggests the roots of a new formula that would enable us to optimize learning against current restrictions of time, resources, space, and the availability of appropriately-trained and well-orchestrated educational manpower. It suggests that the ability to embed lessons within life-like contexts may solicit some of the same kinds and efficiencies of learning that a student subconsciously realizes on a daily basis in real life. Moreover, if such a solution can be easily constrained in terms of space and expense, it may also lead to a number of scenarios for decentralized and distant learning.

So inspired, I have looked over the past ten years at a variety of machine-assisted learning scenarios that could theoretically allow educators to create knowledge-rich synthetic realities that could capture, engage and compel an audience while optimizing their their potential for learning. In the early 80's as an undergraduate student I looked to harness the popular cinema's power to engage an audience's identification with compelling characters and drama. More recently my focus as a graduate student was upon exploring the power of computer-based interactive technologies such as CD-ROM to replicate life's

native stimulous-response mechanism. Today I ponder the issue of personal impact as a development executive for an entertainment company committed to producing "inspirational content" for multiple medias.

The Vision

In this emerging vision I have come to see that "immersion-oriented" simulations incorporating strong entertainment values represents a significant part of the solution. This is a technology-based experiential environment that minimizes interface -- or the distance between user and interactive content, while maximizing both the user's engagement and her ability to control discovery within the context of an external pedagogical intention. I have come to realize that one of the key tools for the future educational mix will be "virtual environments" increasingly tooled to respond as a real-life "Holodeck."[1]
Of late there is an evolving convergence of several key technologies that will lead to this "Holodeck" as these technologies reach maturity:

• A variety of first- and second-generation computer-generated 3D projection systems are coming to market which are able to offer the user a basic experience of "immersion." Some provide access to this experience by having the user don a sensor-laden head-mounted display system (VPL, Sense 8, Autodesk, Telepresence Research, Division, W Industries and others). Other engage their audience with comprehensive widescreen projection scenarios (Simgraphics, Omnimax Theaters). A third scenario places a user or users within self-contained or networked simulation cabs (Battletech, Bullet Proof Software [pending]).

• Expert Systems have been evolving over the last 25 years which enable increasingly sophisticated: (1) robust, rule-based story-telling programs which are programmed to maintain narrative continuities (and thus audience engagement) while allowing for audience-input (AI-based story-telling); and (2) the development of (movement, and eventually-behavioral) script-based synthetic actors (smart character generation).

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[1] The "Holodeck" is a term for a fictional technology borrowed from the television show "Star Trek: The Next Generation" that describes the capacity to simulate virtual worlds that users can explore in the first person as if they were real.

• Digital signal processing (DSP)-based video projection systems such as Vivid Effects "Mandala" system are rapidly evolving which allow the likeness of a user to be integrated into a computer-generated synthetic reality whereby the user witnesses himself as an integral component to that synthetic reality -- optimizing the experience of identification.

• 3D audio systems by companies such as Audio Cybernetics and Crystal River which can render wholly believable multi-dimensional audio realities by processing and rendering multiple channels of audio along discrete x, y, z axes.

• Modern interface clothing such as datagloves offering tactile feedback, eyetrackers, mini-LCD devices, bio-feedback MIDI-triggers such as the Biomuse system, and I/O devices such as Simgraphics flying mouse which serve to further decrease the distance between user, data and synthetic environment.

Once combined, these and other immersion-oriented technologies suggest two distinct and fairly recent media concepts: "interactive cinema," and the exponentially popular "virtual reality."[1]

The term "interactive cinema" describes a computer-based cinematic model whereby either an expert system or sophisticated branching structures are employed to enable an audience to influence the unfolding outcome of a story while the microprocessor maintains some general continuity for that story. The basis of this control are rule-based control systems which are able to continuously reconfigure the continuity of a story drawn from a database of parsed cinematic components (shots, sequences), according to user input and pre-programmed cinematic logic.

The term "Virtual Reality" (VR) suggests a comprehensive, immersion-oriented" first person[2] experience (you as direct participant) within a simulated reality. The basis for virtual reality experiences are the above described 3D projection systems and interface clothing.

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[1] Also known as virtual environments, cyberspace, telepresence, artificial reality, etc.

Combined, virtual reality and interactive cinema suggest computer-generated environments peopled with expert-system-driven synthetic actors that are optimized for the construction of learning experiences tailored by the specific dictates of a particular learning intention. They suggest an optimal milieu for "experiential learning" that should only continue to increase in popularity with the evolution of appropriate hardware and software technologies -- and with the continued decline of existing educational structures and strategies.

Taken together, these technologies theoretically provide the second or first-person experiences I am imagine as part of home,- corporate,- or community theater-based complex wherein prepackaged educational simulations might be experienced as supplement to a greater, human-directed educational experience.

A Theatric Model For Learning

At a recent "Intertainment" Conference, novelist Isaac Azimov said that our brains, "by far the most complex matter in the universe, are built for amusement, and that learning is the optimal path to amusement."[1] Amusement is most definitely one of the key components to the simulated learning experiences I envision for our naturally experience-hungry future learners.

I envision environments that will enable the user to "design" simulated dynamic microsystems[2] that will highlight for this user a particular knowledge base or critical thinking within the context of a real-life stimulous-response scenario. This experience would allow users to "observe" these simulated occurrences "first-hand" within the context of various internally and externally-generated stimulus. It could even enable users to "participate" in the development of these knowledge bases in the first person. In so doing the user will principally or vicariously gains access to the positive and negative dynamics of this complex interaction -- as they would in real life.

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[1] Intertainment 89, New York. Keynote speaker.

[2] Bronfenbrenner, Urie. "Toward an Experimental Ecology of Human Development." American Psychologist, July 177, page 514. Bronfenbrenner defines a "microsystem" as "the complex of relations between the developing person and environment in an immediate setting containing that person (e.g., home, school, workplace, etc)." While I am positing the use of this environment for the development of simulated historic constructs, I could easily see it applied to other dynamic microsystems, for example those that might take place within other educational constructs such as the understanding of mathematical or scientific concepts.

So, finally, a brief view of my scenario. Assuming the choice of head-mounted display -- and a lesson slanted to history, a view of my model might unfolds as follows. The user engages the simulation by:

(1) Placing oneself within an unobstructed cube, the user proceeds to a touchscreen interface on a wall and begins to define his or her experience by choosing among several recent periods and a character he or she would like to identify with (in this case the student has chosen a specific epoch and has chosen against a less discrete pathway whereby the student must create his or her own pathway by triangulating among factors of period, class, significance, occupation, historic dynamics).

(2) Next, the user donnes the headmounted display, moving to the center of the room.

(3) Noting a "virtual" menu that allows for the launch of further character-external action options (such as the behaviors of other key characters), the user clicks on an imaginary "start" button.

(4) The games begin as the historic events evolve within the user's midst, assiduously integrating those internal or external events the user has chosen to trigger via the menu.

(5) Options would exist, of course, for various testing, analytical, replay, remediation, or modification scenarios.

Instructional Problem

There are several arguments against the treatment of simulated conflicts within the context of machine-facilitated interventions. For one, the challenge of enabling a simulation that the user will readily accept and participate within, despite current limitations in resolution and the awkward dramatic continuities put forth by today's mediating computers. An ultimate hope for such a system is to enable the user sufficient first person identification so as to explore a reality as it it were real, thereby optimizing the potential for long-term learning.

Another problem is the notion of facilitating a technological intervention in the realm of education that might challenge the designers ability to a maintain a pedagogical intention within the context of a users ability to fashion his or her own experience. Most certainly this later consideration poses ethical and applications-oriented issues that must be confronted and resolved to the satisfaction of some greater societal moral telos (indeed there are a slew of potential moral and psychological problems inherent to the development of "compelling" virtual realities [see *Addendum]*).

The third problem, of course, will be the tendency to dwell upon these technological versus humanistic tools and techniques as a innovative and timely solution to a crisis in part based on a lack of appropriate trained and motivated teachers. This is particularly a problem given recent consensus through the educational community that, in fact, people learn primarily through social interaction and collaborative processes that are external to any technology-assisted solution -- unless technology is combined to facilitate collaborative learning (researchers in collaborative computing and computer-supported collaborative work (CSCW) are working in this direction).

Nonetheless, one human's bane is another human's boon. A long as immersion-oriented dramatic simulations are viewed within the context of a greater, more comprehensive educational design, any technological tool, whether it be a virtual environment or a TV, can be viewed as a powerful learning tool with indigenous assets that are valuable additions to the educational mix.

Conclusion

While these technologies are not quite evolved to the point of enabling complex, real time and dynamic interactions with realistic, simulated characters, the converging computer and AI technologies supporting virtual reality are pointing in this direction.

For now, it is mostly still fantasy to imagine the hypothetical "interactive virtual environment" I have described above. Yet each of the component technologies required to make the vision possible are now thriving beyond prototype and moving to market. It seems only a matter of time before they will be integrated

within single solutions that are readily available and poised for integration. I toast this future with the firm knowledge that there *will be* positive benefits, in conjunction with, and in support of human interactions, to be derived of these systems -- beyond the military posturing, industrial manufacture and the corporate communications which typically precede the application of new technologies to education. I toast the efforts of anyone who might use and develop immersion-oriented simulation technologies with the intent to deliver educational benefit to a rapidly evolving world culture that is busily speeding to a severely-threatened 21st century.

Addendum:

The following are a consideration of some of the social and moral dilemmas that must be considered in the construction of virtual reality environments. Some of the possible psychological dangers of the virtual reality experience might be as follows: the ability to theoretically replicate a user's likeness could be a very dangerous proposition, depending on the modeling that's enacted. And regardless of likeness, any simulated negative judgement of a behavior of an observer is undoubtedly going to leave the observed feeling condemned -- and maybe even looking to this machine for their next move. In many ways this proposed system might serve to actually *dehumanize* the very users it's purported to be humanizing (via the provision of empathic insight). Simulating complex behaviors, including emotions, might certainly be taken as a trivialization of these activities -- or of ones inability to experience them, or of their past experience of them, or even of one's inability to seek and share such experiences, except under the example of such a machine. What of the respect for the human motive, or emotions, or ones right to unpredictable behavior, now somehow boiled down to algorithmic predictability. One of the biggest issues is that people might get hooked, either on manipulation, or by the vicarious thrill of television taken to greater 3D heights. The other is one of ethics. Who decides the outcomes of these interactions, or even of the compositions of the characters that inhabit them? Who determines the standards of conduct and moral behavior that comprise the norms of healthy versus pathological behavior that would undoubtedly be the reward if such a family simulation were couched as a game? Perhaps the biggest question of all is the most important question: "will people actually want to use such a system?" All the above would be academic if the answer is no, and some question that this would be a strong

possibility. However, I feel that if it were well done, interesting, complex, moderately random (at conceiving interesting dramatic twists), and of course technologically feasible, there would be an audience from many stations.

As for solutions...it is not enough to say, let the audience decide. We must to the best of our ability: (1) recognize as many possible dangers as possible; (2) anticipate them in the design of the questions (for example, ponder as much democracy as possible in providing comprehensive options for the development of characters; create as few truly pathological -- and destructive -- outcomes and behaviors as possible; (3) build an interpersonal theme as many options for social and collaborative use as possible, facilitating a shared experience which might actually encourage greater intimacy and human communication among users; (4) build in a system for monitoring usage and users, perhaps even to the point of limiting usage (if only for reasons of liability); (5) finance significant formative and behavioral research into the possible averse effects well before the doors are open; and (6), in general, remain sensitive to the potential for negative outcomes, always looking for the opportunity to undermine this phenomenon in support of the positive.