Synopsis: This document presents a high-level overview of the Immersive Education faculty-student ecosystem and its potential impact on the future of education and the immediate and long-term impact on faculty, students, and digital media development communities.

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Relevant background items (visit http://gridinstitute.com/people/aew/ for details):

- International best-selling technology author. Published over a dozen books (ranging from entry-level "For Dummies…" titles to professional software engineering titles), numerous journal articles and technical papers on the subject of digital media and software development.
- Boston College faculty responsible for courses in Computer Graphics, Virtual Reality, Internet and Web development.
- Since 2004 has led the development "Immersive Education" and the related student/faculty/industry ecosystem around which Immersive Education revolves. Immersive Education combines interactive 3D graphics, commercial gaming technology, virtual reality, and digital media with collaborative online course environments and classrooms. Immersive Education was unveiled during a keynote presentation to approximately 30 universities at the Association of Jesuit Colleges and Universities (AJCU) Conference hosted by Boston College in October 2005. ACJU members include Boston College, Georgetown University, Loyola University, and the University of San Francisco.
- Teaching with New Media (TWIN) award winner, nominated for "Immersive Education" and the related student/faculty/industry ecosystem around which Immersive Education revolves. As a way to honor exemplary uses of technology in teaching TWIN nominees are selected by the Boston College student body who identify instructors whose use of technology in (and outside) the classroom enhanced their learning experience. A committee comprised of faculty, students and staff narrows the large group of nominees to a smaller number of finalists.
- Active in the International Standards community (digital media standards) as founding Chair of the Web3D Consortium (Web3DC) Universal Media Working Group, founding Chair of the Web3D-MPEG Working Group responsible for the convergence of Web3D and Moving Picture Experts Group (MPEG); Co-Chair of the Web3D Consortium's Intellectual Property Rights (IPR) Task Group; and Web3D Liaison to MPEG and the World Wide Web Consortium (W3C). Web3D Consortium and MPEG are official International Standards bodies recognized by ISO/IEC; W3C is the de facto standards body for the World Wide Web (Directed by Tim Berners-Lee).
- Director of international Media Grid standards group. The Media Grid is a public utility for digital media. Based on new and emerging technologies, the Media Grid is an open network optimized for digital media delivery, storage, and processing. Applications enabled by the Media Grid include: on-demand digital cinema and interactive movies; film and movie rendering; truly immersive multiplayer games and virtual reality; real-time visualization of complex data (weather, medical, engineering, and so forth); telepresence and telemedicine (remote surgery, medical imaging, drug design, etc.); vehicle and aircraft design and simulation; other applications that produce or consume digital media.
- Nominated in 2007 for Computerworld's "40 under 40" (top 40 innovative technology people to watch under the age of 40).

Abstract

Immersive Education is a game-based learning platform that combines interactive 3D graphics, commercial game technology, virtual reality, voice over IP (VoIP), and digital media with collaborative online course environments and classrooms. Unlike traditional online courses, which typically involve the delivery of standard Web pages or streaming video, Immersive Education is designed to *immerse and engage* students in the same way that today's best video games grab and keep the attention of players.

Immersive Education enables both self-directed learning as well as collaborative group-based learning. By using full-screen interactive 3D game technology Immersive Education gives students a sense of "being there" even when attending class in person isn't possible, practical, or desirable, which in turn provides faculty and remote students with the ability to connect and communicate in a way that greatly enhances the learning experience.

Imagine, for instance, a history class that brings far-flung students and faculty together online in a shared interactive space to explore the tombs and pyramids of ancient Egypt as a group. Or consider the power of being able to participate in a lecture on nanotechnology that includes a hands-on lab session to examine and manipulate molecular structures at your own pace, and in great detail, yet never attending the class in person. Students can participate in Immersive Education from anywhere in the world, no matter where they are, as long as they have a computer and access to the Internet. Shorter mini-games can be injected into a larger body of course material to further enhance the learning experience and entice students to learn as they play.

Although relatively new in terms of availability (Boston College now conducts several classes using the technology and is making the system available free of charge) the concept of Immersive Education is not new. The notion of "serious games" has recently become a hot topic for the video game industry, the business sector, and academia alike. After years of speculation we're finally starting to see state-of-the-art game technology flow into the classroom, enabling the classroom itself to morph into completely virtual environments. Many of our students are more than enthusiastic about the combination of games and learning and often exclaim that they "love" taking the Immersive Education courses that we now offer at Boston College, and they often continue to explore course materials on their own long after class has ended.

Yet despite the obvious appeal and potential for game-based learning systems and environments several major barriers stand in our way, especially:

- **Cost** – The best commercial game engines are, at heart, multi-million dollar simulators that often cost in excess of $500,000 to license for the development of a single game. Likewise, the cost of hiring experienced game developers to build specific content around game engines (such as an online classroom) is extremely expensive and can easily cost more than the engine license fees. We now live in a world where it routinely costs more than $10,000,000 (ten million) to develop a commercial video game; spending the same amount to build just one high-quality learning game or environment is inconceivable.

- **Complexity** – The development of learning games and environments is inherently interdisciplinary and requires the coordinated interaction of a wide range of skilled technologists such as digital artists, modelers, animators, software developers, and testers. Factor in the faculty members whose domain expertise is captured in the resulting product and the combined complexity shoots through the roof.

- **Continuity** – Creating engaging learning games and environments that are infused with educational value is not only challenging for the traditional video game industry, it's almost impossible owing to a mismatch in expertise. Game developers excel at creating video games, not learning experiences. Game development skills alone don't create high-caliber learning games and are merely the technical bones upon which educators must heap digital flesh and blood that comes to life in a fully realized learning experience. Faculty and students *must* be integral to the entire production process in order to maintain continuity between gameplay and educational value.

These "Three Cs" aren't the only barriers to developing quality game-based learning environments, yet they are among the most significant: Cost, complexity and continuity issues have the potential to bring the development of learning games to a screeching halt. Immersive Education at Boston College would have stopped dead in its tracks in the absence of an ecosystem that not only overcomes each of these issues but also creates numerous benefits for the game industry, faculty and students.

Game-based Learning Ecosystems

In late 2003 the following text was written to describe the game-based Immersive Education effort about to begin at Boston College in collaboration with the Grid Institute and Media Grid:

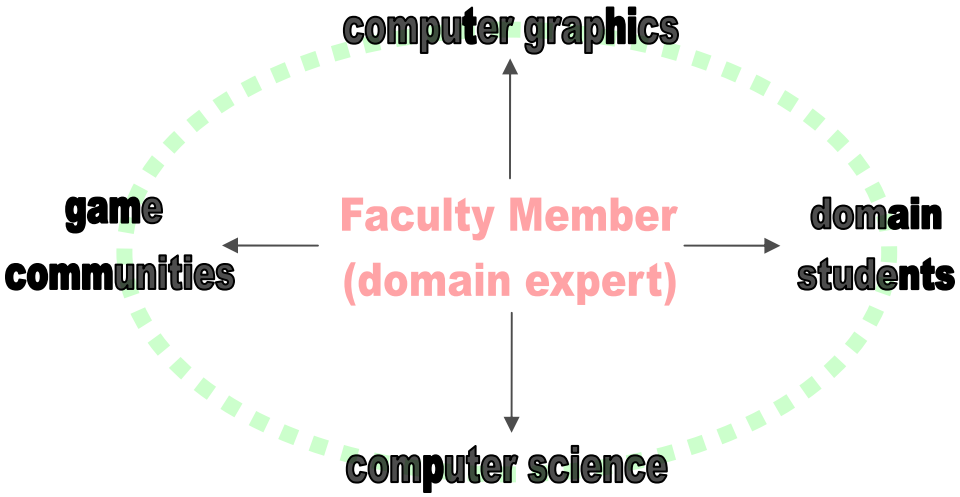
> *"Beginning in 2004 a select group of Boston College students will begin to develop a new form of distance learning that combines interactive virtual reality with collaborative online course environments and classrooms. Using commercial graphics applications and state-of-the-art 3D simulation and game technology the Advanced Computer Graphics students will create the first generation of immersive distance learning content by crafting the 'end user experience' for immersive education courses. Immersive education is inherently interdisciplinary; because of the range of technology skills required to develop immersive education content students are organized into teams, with each team consisting of artists, modelers, animators, actors, and software developers. Following industry standard team-based development practices students collaborate in person and electronically as they develop highly interactive three-dimensional (3D) multimedia courseware designed to be experienced by end users through a computer attached to the Internet."*

From the onset, even before this work began, it was clear that a complete ecosystem was necessary to contain the cost, manage the complexity, and ensure the continuity of the learning games and environments that we planned to develop. The resulting ecosystem involves three key participants:

1. Faculty with domain expertise
2. Students with computer graphics and computer science experience
3. Game development support and modification ("mod") communities

At the center of the ecosystem are faculty members with domain expertise who are interested in creating a specific learning game or learning environment. For example, a professor might like to have an educational game or learning environment about ancient Egypt to augment her traditional history course materials.

Naturally, domain expertise faculty members aren't expected to posses the technical skills necessary to build any aspect of the game or environment and usually have only a very small amount of time to participate in the process. They therefore assume a role similar to that of a Hollywood film director; they know what they want in terms of content, and are responsible for giving creative direction to the computer graphics and computer science faculty and students who actually develop the learning experience with assistance from the larger game development community. Students of the domain expertise faculty (such as history students in this example) provide quality assurance and testing.



Aside from enabling the creation of high-quality learning games and environments this form of ecosystem generates a surprising number of benefits and positive side effects, including:

- Real-world projects and resume material for computer graphics and computer science students
- Connecting faculty and students with the larger game development community
- Preparing students to be first-class citizens in the world of gaming and digital media
- Providing the impetus and direction for new courses in computer graphics and computer science
- Giving faculty and students alike a deeper understanding of topic matter by way of building it
- Unfolding of shy and reclusive personalities through a shared experience ("virtual barn raising")
- Capturing, recording, and preserving human knowledge in a modern, interactive form

Immersive Education Keynote Presentations

The following outline is derived from the keynote presentation "Enabling the Age of Immersive Education" that was delivered to approximately 30 universities at the Association of Jesuit Colleges and Universities (AJCU) Conference hosted by Boston College on October 13-14 2005. This material was also the basis of the keynote presentation given at the Sixth International Conference on Humans and Computers (Aizu, Japan) August 28-30, 2003:

I. Distance Learning Yesterday, Today, and Tomorrow
II. Introducing Game-based Learning Ecosystems
III. Immersive Education at Boston College: An Ecosystem in Motion
    a. A New Dimension in Distance Learning
    b. Infusing High Tech with High Touch
    c. Levels of Immersion
    d. Scheduled vs. Time-shifted Learning
    e. Course Scalability
    f. Building the Immersive "Boston Tea Party" atop Unreal Tournament 2004
IV. Developing, Delivering and Maintaining Learning Games and Environments
    a. Building From Scratch vs. From Existing Course Material
    b. Pressure Points: Freeing Faculty to Teach and Shape Courses
    c. Roles: Who Does What, When, and How?
    d. Team-based Course Development: What it Takes, When it Fails
    e. Core Infrastructure: Selecting a Game Engine and Content Formats
    f. Bridging the Gap: Working with Commercial Game Communities
    g. Course Structure and Instruction: Traditional vs. Modular
    h. Delivering to End Users: Assumptions, Challenges, Roadblocks
    i. The Hand-Off: Maintaining Momentum Across Students, Semesters and Years
    j. Supporting End Users Remotely: Tiers of Peers, Assistants, and Faculty
V. Planning and Coordinating Across Students, Departments, and Industries
VI. Return On Investment (ROI): Exactly How Much Money Did We Save?
VII. Job Hunt: Factoring Student Graduation Into the Ecosystem Equation
VIII. Health Concerns: VR Addiction, VR Sickness and VR Schizophrenia
IX. Timelines To Tomorrow: Where We've Been, Where We Are, Where We're Going

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