Proposal for Computer Game Production Curriculum

Henry Jenkins III, Philip Tan and Brett Camper, MIT Comparative Media Studies 2004

1. Problem Statement

The instruction of digital game production presents a significant challenge to most computer science programs. Many aspects of the design and implementation of a computer game seem amenable to best practices that are already well established in computer science methodology. Unlike most computer science projects, however, the success of game production hinges on the ability of programmers to quickly prototype, test, and iterate to discover and refine effective game mechanics specific to the project at hand. Similarly, it is both acceptable and vital to remove major features from a game production project during its implementation. Furthermore, real-world game production requires an organic application of different skill sets not typically expected of a programmer.

To assess the quality of a student's decisions in a strong game production curriculum, both students and instructors must clearly understand and effectively communicate in the vocabulary and the concepts of game design with as much confidence as they address the terminology and logic of game programming. A growing number of MIT's Computer Science students double-major or minor in the Comparative Media Studies Program, based in the School of Humanities, Arts and Social Sciences. The CMS subjects directly address many of the specific features of games as a medium. Other computer science students use these courses to fulfill compulsory humanities requirements. These courses are seen as highly desirable for students wishing to enter the games industry. Designing an effective and portable game production curriculum for computer science would necessarily involve the integration of essential elements from all the CMS courses as well as leverage other options available to students in their college careers. In particular, any game production syllabus of value to the game industry must recognize and emphasize opportunities that students have to experiment with less conventional game ideas, which allow them to better understand the unreleased potentials and basic building blocks of the medium.

2. Expected Outcomes

The curriculum will include the development and execution of four components: 1) a summer game development workshop program; 2) a small, repeatable graphics research seminar on emerging technologies relevant to games; 3) a fall colloquia series of lectures on game culture, technology, and business; 4) on-going support for student thesis projects related to game development. The summer workshop is designed as the centerpiece of the curriculum, providing a foundation in game development and design and taking advantage of the greater time and

attention available to students during a three-month summer course. The components are intended to be complementary. However, students may take each component independent of the others. Development of the workshop and seminar will include the free, public dissemination of the syllabi, as well as the release of any executable software and source code developed, including tools created by the instructors and projects written by the student participants. Each component is described in depth below.

A) Game Development Workshop

The game development workshop is an intensive summer-long course designed to teach students not just the technologies of game development, but also the vocabulary of game design. Taught by current CMS game design instructors experienced in professional software development and game design research, the course will be conducted as an all-day, 10-week workshop divided into several 1- or 2-week units. Each unit pairs an area of game development technology with a theoretical topic in game design. Technical functional areas will be learned through hands-on use of the DirectX API and textbooks such as *Real-Time Rendering* by Eric Haines and Tomas Akenine-Moller (2nd edition, AK Peters, 200), while design topics will be illustrated from a series of books and articles by practicing game designers and developers drawn from works such as Eric Zimmerman and Katie Salen's *Rules of Play: Game Design Fundamentals* (MIT Press, 2003). This course is intended to serve MIT Computer Science majors and Comparative Media Studies double-majors who are already familiar with C++.

The workshop is intended to encourage a wide range of experimentation in game design. Towards this end, during each unit students will work in pairs to develop standalone "minigames" emphasizing the technology and design concepts for that unit. Our intention in focusing development on minigames rather than on a single, term-long project is to allow students to try out a series of ideas, iteratively applying the design knowledge they gain from each unit to the next. From a game design perspective, the minigame format is based on similar incarnations found in commercially successful games (e.g. Nintendo's "Made in Wario" series and other "party game" titles) and activities organized by current game designers and programmers to promote design innovation, e.g. the successful Indie Game Jam (http://www.indiegamejam.com/) annually presented at the Game Developers Conference.

By focusing on the DirectX API rather than on an existing game engine, students will become more familiar with the low-level tools of game development. While the use of middleware is rapidly growing in the games industry, we feel that a solid understanding of the underlying technologies of development takes priority over learning vendor-specific frameworks. Students who go on to work in the industry will carry with them the

knowledge necessary to evaluate and extend middleware instead of merely working within its confines. For ease of teaching and timely development, the Direct3D Sample Framework will provide the basis for the development of the minigames. The use of pair programming will further foster teamwork and experience with a method of development increasingly common in software and games companies.

The workshop will be run in a physically open space that promotes the active exchange of programming and design ideas. Students will read technical documentation and design theory outside of class. Structured activities inside the workshop will include reviews of game design theory as a group through the examination of specific commercial digital and non-digital games, frequent critique sessions blending the traditions of the architectural/art studio with that of the code review, and collaborative play-tests of minigames as they are produced. All student-made minigames will be released to the public as executables and source code. Currently proposed units include:

1. The Game Loop: An introduction to the Direct3D Sample Framework; the use of rules to formally define games; the unique aspects of digital games in comparison to their precursors such as board and card games.
2. Game Vision: Direct3D for use in both 2D and simple 3D real-time graphics environments; fundamentals of the rendering pipeline; the importance of spatial layout in games, including realistic and non-realistic mappings of space as seen through the history of games, from the Atari 2600 to today's consoles.
3. Feedback: The use of positive and negative feedback loops to control gameplay mechanics; the user-game interface through DirectInput; design challenge: using unusual input devices to create new gameplay – webcams, microphones, touch pads, knobs, etc.
4. Making Noise: DirectMusic and DirectSound; the neglected role of sound in games; creating dynamically reactive sound environments and soundtracks; comparing the historical use of music in film and in games.
5. Conflict and Cooperation: Multiplayer games and networking via DirectPlay; elements of competition in gameplay; the often overlooked potential for multiplayer collaboration.

To develop effective strategies for implementing DirectX solutions for teaching, in-kind donations of Microsoft XNA development kits, graphics-accelerated PCs and Microsoft Visual Studio .NET from Microsoft Research would allow students to work with technologies closer to what they can expect in the game industry instead of struggling with out-of-date tools.

B) Graphics Research Seminar

MIT's Computer Graphics class, 6.837 (and its Advanced Topics counterpart 6.838), teaches students the state-of-the-art in graphics algorithms and 2D and 3D rendering techniques. These algorithms, including raytracing, shadow volumes and non-photorealistic rendering, are often poorly suited for current game hardware and the real-time demands of games. This seminar is intended to serve students who have taken or are concurrently taking 6.837 and 6.838 by allowing them to assess possible current and future applications of these rendering techniques within the context of real-time games. Similar courses at another university may substitute for 6.837 and 6.838.

While the curriculum as a whole addresses the wide range of expertise required for game production, this seminar recognizes the particular technical and design prominence of visuals in games, supplementing traditional computer graphics courses with an explicit focus on feasible real-time performance. The seminar specifically looks at approaches that improve on game technologies both technologically and stylistically. Each student would select a particular algorithm or technique and research its potential for real-time use along multiple avenues, including:

1 The technical requirements for future generations of console hardware necessary to support the technique in real-time, estimating when such use may be feasible.

2 Optimizations or approximations of the model to make the algorithm suitable for current hardware, including prototypes built using the High-Level Shader Language (HLSL) in Direct3D.

3 Aesthetic possibilities for expanding the graphical style of games, e.g. through a non-photorealistic pen and ink algorithm. Within the game industry, such efforts have yielded the recent popularity of "cel-shading."

The graphics seminar is repeatable and will include a large amount of independent student research. The course would be offered at a frequency that matches student demand during either fall or spring terms. Possible textbook references include *Non-Photorealistic Rendering* by Gooch and Gooch (AK Peters, 2001) and *Non-Photorealistic Computer Graphics*, Strothotte and Schlechtweg (Morgan Kaufman, 2002). Student prototypes, including source code, will be made publicly available.

C) Games Colloquia: Culture, Technology, Business

To complement the hands-on development and research components above, a lecture series embracing the interdisciplinary nature of games will expose students to the cultural and business contexts in which game development occurs in our society. Planned for the fall of 2005, the colloquia will include talks by Comparative

Media Studies faculty on the cultural study of games, with topics such as: trends in online gaming communities, games and storytelling, new possibilities for educational and "serious games" and debates over violence in games. Seeking to put computer science in context, we will include talks from the many successful game development studios in the Boston area. Professional programmers, producers, and business managers will help students to understand the everyday experience of game development, from team logistics to marketing demands. From a technical perspective, such real-world exposure will address differences between computer science concepts in theory and in practice. For benefit beyond the MIT community, these lectures will be digitally archived and made available for public download via the web.

D) Independent Thesis Projects

The intention of this game curriculum is to sustain student interest in game development over the long-term. Towards that end, the components above can serve as springboards for computer game related senior thesis projects, which will allow students to engage in deeper and more comprehensive explorations into game production. MIT departments allow students to pursue a senior thesis project to fulfill graduation requirements, and computer science students can complete their theses with CMS faculty as their principal advisors. There is already substantial crossover in student interest and class attendance between the departments — over half of the students taking CMS.600: Game Design and Theory are majors in computer science, and double-majors between the two programs are common. Funding of this curriculum will help support the software and hardware demands of such projects.

3. Schedule

Feb – Mar 2005	Software installation. Syllabus review. Instructor tests of Direct3D Sample Framework.
Apr – May 2005	Equipment installation. Publishing of complete syllabus. Student enrollment for summer.
Jun –Aug 2005	First summer workshop (size of class dependent on funding). Public demonstrations of projects.
Sep – Oct 2005	Games Colloquia begins (compulsory for workshop participants). Graphics seminar begins.
Nov –Dec 2005	Games Colloquia continues. Advising of students interested in pursuing senior game theses.
Jan 2006	Publish whitepaper on Game Production Curriculum. Students begin work on senior theses.

4. Use of Funds

The following budget would permit MIT Comparative Media Studies to maintain a project manager and a graduate student within the program who have game production and teaching experience. Note that the budget below does not cover the manager and student for the entirety of the funding period — see "Other Support" below.

Salaries and benefits	
Salary and wages	
Project Manager (Apr-May 05)	$8,333
Project Manager (Sep 05-Jan 06)	$20,833
Student Research Assistant Stipend (Spring 05)	$8,100
Student Research Assistant (Summer 05)	$4,800
Total salaries and wages	**$42,066**
Employee benefits	
Vacation accrual (9.5%)	$2,771
Employee benefits @ 27%	$7,875
Total Employee benefits	**$10,646**
Total salaries and benefits	**$52,712**
Expenses not subject to F&A	
Student Research Assistant Tuition (Spring 05)	**$8,415**
TOTAL DIRECT EXPENSES	**$61,127**
INDIRECT EXPENSES -Facilities and Admin. @ 62%	**$32,681**
TOTAL BUDGET REQUEST	**$93,808**

5. Dissemination and Evaluation

Feedback from the students will be just as valuable in the development of the curriculum as the results of their work and the planning of the instructors. To this end, students in the summer workshop will have to maintain design diaries and collaboratively update documentation on their work using weblogs and wikis. These web archives would be available online for interested observers to keep track of the class progress throughout the summer, and will be used after the summer to improve the syllabus. Completed minigames and source code from the summer workshop would be available for download from a CMS-hosted website during the fall under the standard MIT X Window System License (http://www.opensource.org/licenses/mit-license.php). The success of the first year of the syllabus can be assessed by the quality of the completed minigames as well as the level of interest among students in pursuing further game projects at the completion of the workshop and the colloquium. The syllabus itself will be presented in January as a whitepaper and the structure of the syllabus will be published on the same website under the MIT License.

6. Other Support

Because MIT Comparative Media Studies already runs game design and production courses, the staff and graduate students designing and testing the proposed game design curriculum are already partially funded through alumni donations and other projects. Thus, the budget proposed above only describes the funding required to justify the additional workload and commit the staff and graduate students towards this project.

7. Qualifications of Principal Investigator

Henry Jenkins III, the DeFlorez Professor of Humanities and Director of MIT Comparative Media Studies, has spent his career studying media and the way people incorporate it into their lives. He was the principle investigator for the MIT-Microsoft Games-to-Teach project, and one of the coordinators of The Education Arcade which is examining the educational potential of computer and video games. He writes a regular column, The Digital Renaissance, for Technology Review magazine and is currently writing a book designed to explain "why media change matters." He testified in 1999 before the U.S. Senate during the hearings on media violence that followed the Littleton, Colorado shootings, testified before the Federal Communications Commission about media literacy, and spoke to the governor's board of the World Economic Forum about intellectual property law. His books include Hop on Pop: The Politics and Pleasures of Popular Culture (co-edited with Tara McPherson and Jane Shattuc, 2003), From Barbie to Mortal Kombat: Gender and Computer Games (co-editor with Justine Cassell, 1998), The Children's Cultural Reader (editor, 1998), Science Fiction Audiences: Doctor Who, Star Trek and Their Followers (with John Tullock, 1995), Classical Hollywood Comedy (co-editor with Kristine Brunovska Karnick, 1994), Textual Poachers: Television Fans and Participatory Culture (1992), What Made Pistachio Nuts?: Early Sound Comedy and the Vaudeville Aesthetic (1992), and the forthcoming The Politics and Pleasures of Popular Culture. Jenkins earned his doctorate in communication arts from the University of Wisconsin, Madison and a master's degree in communication studies from the University of Iowa.