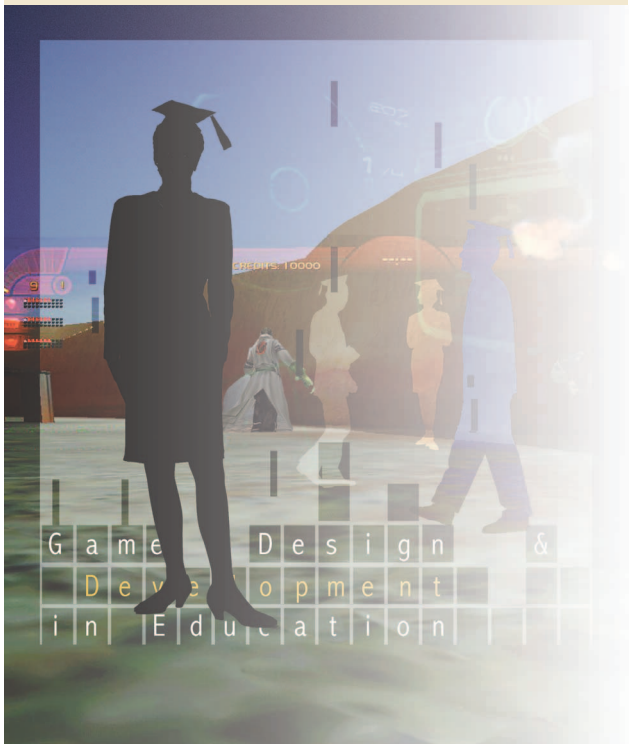

Educating the Next Generation of Game Developers

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To advance the state of the art of game technology, many universities have begun new degree programs focused on game design and development. This special issue profiles four programs that are exploring this emerging and important discipline and have proposed similar—or even novel—solutions to the challenges it presents.

The current revolution in videogaming used for both entertainment and serious purposes engenders a strong requirement that we advance the state of the art of game technology and design through our university research and education programs. To make this happen, many universities have begun new degree programs focused on game design and development.

This special issue discusses the programs we are creating, decisions we've made, challenges encountered in establishing these programs, and actual results. Two articles in this issue come from the game design side of the educational equation, two others from the computer science side. If we feel so strongly that the creation of game programs is what we absolutely must do, we imagine that perhaps other people and organizations will find our experiences interesting. Since there are no guidebooks on this, we attempt with this special issue to detail our designs and the lessons learned.

THE GAME INDUSTRY

The worldwide game industry reached $33.5 billion in size in 2005, with expected growth to $58.4 billion by 2007, a near doubling in size in a two-year period (www.gamasutra.com/php-bin/news_index.php?story=6942.). In addition to the game industry's demand, there is additional demand from government and nongame industry corporations for the new area of serious games.

As the industrial and governmental demand grows, the requirement for intellectual property generated by universities and university graduates increases. An industry that doubles in size in two years creates a huge new demand for employees, and building game development degrees to support that demand is quite important. The hiring requirements at Electronic Arts, a game-publishing industry leader, are something on the order of 65 percent computer scientists, 30 percent artists, and 5 percent designers. So we imagine that game development degree programs that satisfy each of these demand areas are in order.

With computer science being the largest requirement, university computer science departments must begin developing programs to meet that demand. Internationally, computer science has experienced a 70 percent decrease in undergraduate enrollments since 2000. Without some refocusing of our educational programs, computer scientists may become a scarce commodity just at the time the game industry has a substantial requirement. Several university computer science departments have begun to build game development degree programs, some creating wholly

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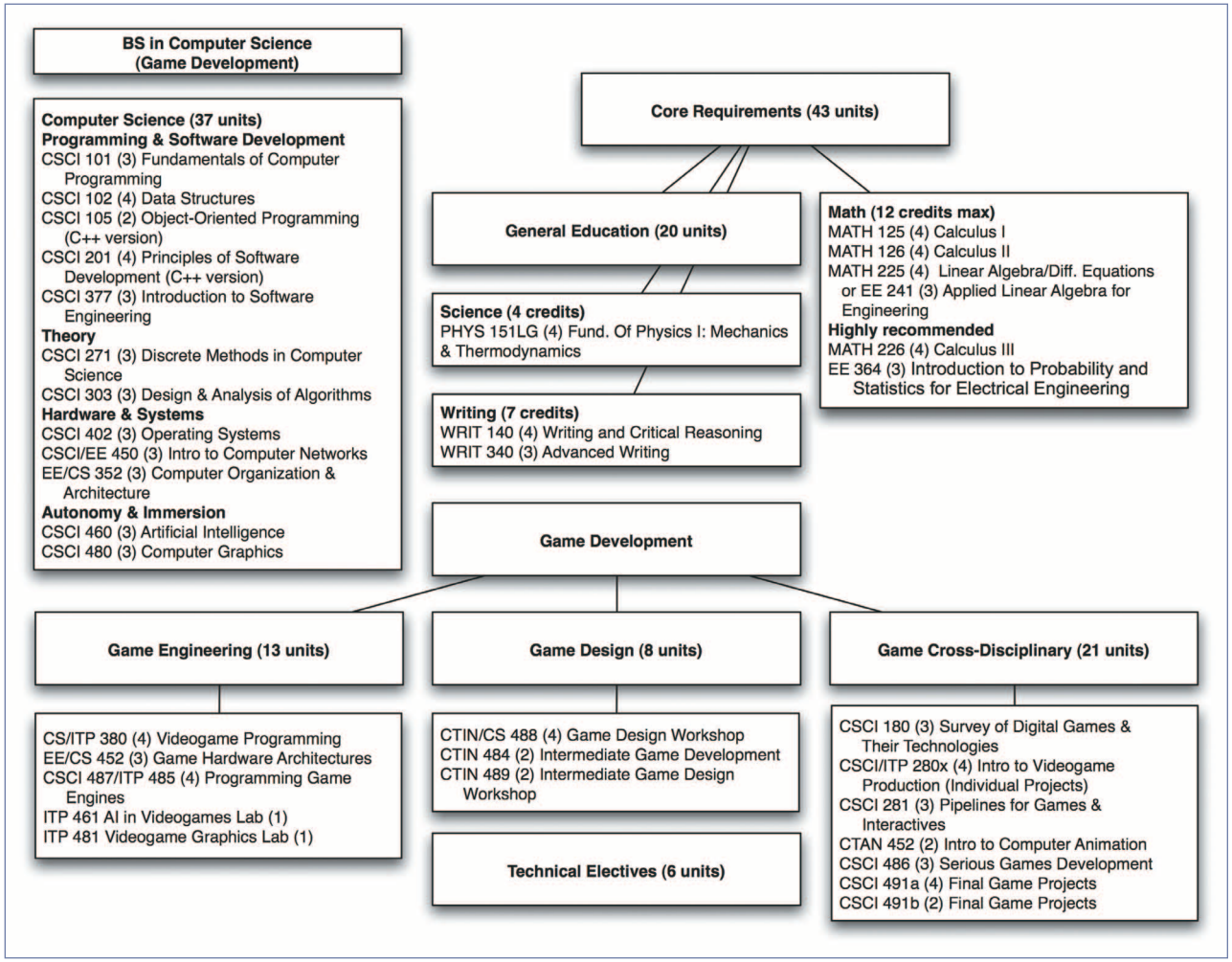

Figure 1. USC Game Development degree program. The program includes the traditional computer science blocks of material.

contained computer-science-only efforts, with others building more advanced cross-disciplinary efforts. We examine some of these programs in this special issue.

Game development has the potential to revitalize and increase interest in computer science. Defense and NASA used to provide some of the larger driving problems for this field. With basic research budget lines diminishing for defense and space, this focus on videogame research, development, and education becomes quite important. Putting this into financial perspective, DARPA's budget is approximately equal to the available on-hand cash for Electronic Arts, and most of DARPA's funding is for applied, defense-focused applications, not for research.

A CROSS-DISCIPLINARY DEGREE

Is a BS in computer science specializing in game development a weaker degree than a traditional BS in computer science? No. The degree, in fact, should look like a cross-disciplinary double major in computer science and game development and be definitely harder.

Here, we use the USC Computer Science Department's Game Development degree program as an example. As Figure 1 shows, the program includes the traditional computer science blocks of material—programming and software development, theory, hardware and systems, and autonomy and immersion.

The only deviation from a traditional computer science program is that we condense the electrical engineering transistors and VLSI focus to a how-do-we-program-it, computer organization, and architecture focus. So instead of learning how to build integrated circuits, the students learn how to program novel architectures. This prepares them for the parallel programming of game consoles and graphics processor units covered in the game hardware architectures course.

An additional change was that we moved the compilers class from being a requirement to make it a highly recommended elective. We had no problem with making that change as the compiler course was removed as a requirement in the ACM computer science BS core in 1979. We moved the design and construction of large software systems into the highly recommended electives list as well, figuring that the yearlong final game projects courses covered that material. So this degree defi-

Figure 2. Final game projects. (a) Fish Quest, a serious game built for the UCSD Scripps Institute of Oceanography Digital Fish Library. The game's premise is that the player acts as a scientist in search of the habitat of a mysterious fish that holds the clue to the cure for a disease. The player catches fish around the world and compares the anatomy of the different fish to decide where the mysterious fish came from. (b) Tame Tom, a networked training game in which multiple players work together to train Tom, a rowdy artificially intelligent dog.

nitely has computer science as its core.

The BS degree ends with a yearlong final game projects course in which the students propose, select, and build out a game for their graduation portfolio. This course gives our students a year's experience in integrating the sum of their coursework in a team-based development effort. Building a significant piece of a game provides a ready portfolio for use in industry interviews. Figure 2 shows two games built in the last semester in this course.

Students demonstrate all games built during the course at a Demo Day event, where game-industry executives evaluate the student-developed work. Representatives from companies including Electronic Arts, THQ, Activision, Disney, Sony Computer Entertainment, Emsense, Motorola, Midway Games, Microsoft, and New Media BC attended the spring 2006 event.

GRADUATE DEGREE

In addition to the BS degree, we designed an MS in Computer Science (Game Development). The goal of this degree program is to graduate professionally educated students capable of engineering next-generation games and their required technologies. With the game industry soon to become the size of the US Navy, we believe that it requires an R&D capability of some size. Since our expectation is that game industry internal investment is small R and big D, we believe the university can become a venue for the creation of next-generation game technologies.

The MS degree has a computer science core and a game development core. The game development core matches the BS degree so that students coming from the BS program have already taken 11 credits. The game development core consists of the School of Cinema-Television's game design workshop course, a course on programming game engines, and a course on game hardware architectures. Students then choose a concentration area and complete two classes in that area.

Concentration areas correspond to the research directions for the GamePipe Laboratory and include infrastructure, cognition and games, immersion, and serious games.

One of the oddest issues we had to deal with involved establishing the game hardware architectures course. In the traditional engineering faculty, we could not find ready expertise in the new parallel architectures found in game consoles. When we then sought an adjunct in the game industry, several candidates indicated that they had signed so many NDAs from game console companies that they no longer knew what they could or could not discuss with students working on degrees of direct benefit to the game industry. We are still working on resolving that issue.

THE GAME DEVELOPMENT PART OF THE DEGREE

The game development part of the degree is divided into three major components: game engineering, game design, and game cross-disciplinary. In game engineering, students learn the fundamentals of videogame programming, game engine programming, game hardware architectures, and the special requirements that videogame artificial intelligence and graphics have as distinct from the traditional computer science courses, which all students take.

At USC, game design comes out of the successful School of Cinema-Television's Interactive Media program. We place our undergraduate computer science students into the game design workshop, intermediate game development, and intermediate game design workshop courses of that program. These students learn the player-centric design principles of the game design workshop series alongside the Cinema School's game design students. So, the engineering program, in effect, cross-pollinates its students with the game design program students to produce graduates capable of designing and engineering games. This cross-pollination strengthens both programs.

The game cross-disciplinary component of the degree program contains courses that are not just computer science but rather are fundamental to game production, courses that engineers, artists, and game designers all can take.

We begin with a survey of digital games and their technologies to provide students an introduction to the language and a basic understanding of games and game play. In the Introduction to Videogame Production course, we begin to detail the game production process. Pipelines for Games and Interactives teaches the students about the processes and procedures required for the integration of design, art, and software. The Introduction to Computer Animation course from the Division of Animation and Digital Arts gives students a background in animation for games. Serious Games Development is the course in which we teach the students how to design and build games for serious purposes.

The game cross-disciplinary component of the degree program offers courses that engineers, artists, and game designers all can take.

WHY A CROSS-DISCIPLINARY PROGRAM IS HARD

Game development is inherently cross-disciplinary, but most universities are not set up to handle cross-disciplinary programs well. Games are story (design), art, and software, but our new degree programs are only cross-disciplinary in the design and software domains. When we began the design of these degree programs, USC did not have a core effort in game art. We also thought the following: We can easily put engineers into design courses as they are comfortable with the fundamentals of design, but they are not necessarily comfortable with art.

During the process of establishing these degree programs, we have begun discussions with the USC School of Fine Arts. They are looking for guidance on how they can create a BFA/MFA in Fine Arts (Game Art & Design). Our initial suggestion is to join with the engineering students in the game cross-disciplinary courses. Discussions about how to do this are under way between the Viterbi School of Engineering, the Roski School of Fine Arts, and the School of Cinema-Television.

The main issue we dealt with in building this program was the concern about which division received the tuition money from the courses. Our guiding principle was that, for lab-intensive courses, the tuition money should go to the department that provides the lab and the instructor.

ABET accreditation presented an additional issue. Because it preserves traditional disciplines, mastering this accreditation process is a difficult endeavor for new, cross-disciplinary programs that look like double majors. Fortunately, we had a strong and supportive dean who provided valuable guidance.

Other institutions exploring this emerging and important discipline have encountered similar challenges and proposed similar—or even novel—solutions. We profile four such programs in this special issue, all of which seek to establish game design and development as an academic field of research.

IN THIS ISSUE

Major universities around the world now offer degree programs in game design in response to student demand; more than 80 such programs exist in North America alone. The International Game Developers Association has established a committee to help educators craft a cur-

riculum that reflects the real-world creative process of professional game designers. Unfortunately, many such programs address only the technical aspects of game design, preparing students for entry-level positions in the industry but depriving them of the liberal-arts-based critical thinking necessary to transcend existing boundaries of content and expression.

In "Play-Centric Games Education," Tracy Fullerton describes USC's program in interactive entertainment established in the School of Cinema-Television with support from Electronic Arts. The new program aims to impart an understanding of the essential properties of an effective and entertaining interactive experience as well as to teach the necessary technical skills to envision, design, and produce such experiences. The program's emphasis on play-centric design puts player experience at the heart of the design process to create richer characters, more complex stories, and more meaningful interactions.

The industry demands an increasing supply of graduates trained as specialists in the technologies and techniques that drive the latest best sellers.

The industry demands an increasing supply of graduates trained not as generic programmers, artists, or producers, but as specialists in the particular technologies and techniques that drive the latest best sellers. Universities have responded to this demand with programs that fall into two categories: game production and game studies. Game production programs focus on feeding the industry and necessarily reinforce its current practices. Game studies programs, on the other hand, fall into the domain of academic researchers with PhDs in the humanities and social sciences. Oriented away from commercial values, these offerings emphasize fundamental questions of human experience and methodologies that provide a critical and historical perspective on current cultural trends.

In "Game Design Education: Integrating Computation and Culture," Ian Bogost and colleagues describe Georgia Tech's School of Literature, Communication and Culture's attempt to combine the strengths of both approaches. Georgia Tech's program offers a range of perspectives, emphasizing connections with poetry, art installations, human-computer interaction, interactive television, film studies, science studies, information design, and computer science.

In 2004, the University of Denver began offering majors in game development, with research and scholarship directed toward "humane gaming," a term that includes medical and socially conscious gaming. In "Building a Game Development Program," Scott Leutenegger and colleagues describe their efforts to build a program that espouses game development as an interdisciplinary field requiring some appreciation for both the technical and creative, with a deep passion in at least one area. This game development major has the goal of providing a humane emphasis and fostering "whole brain education" as well as increasing enrollments in computer science as part of a technically strong major.

"Evolving the Artist-Technologist" by Ian Horswill and Marlena Novak describes the Animate Arts program at Northwestern University. Begun in 2005, the program aims to provide students with an integrated, team-taught curriculum emphasizing basic literacy in a range of disciplines—visual art, narrative and sound design, cultural theory, and programming. To shape this hybrid major, program faculty combine their expertise in art theory and practice, electrical engineering and computer science, music technology and composition, and radio, television, and film.

PREDICTIONS FOR THE FUTURE

There is clearly strong interest in these new degree programs from incoming students. Some 80 percent of those admitted to the Viterbi School of Engineering with undeclared majors have indicated to the school that they plan on choosing the BS in computer science (game development). At USC, we anticipate a 45 percent increase in the number of applicants to the Computer Science BS program for fall 2006 as well, and that is with a Web page that says, "We plan on running the BS in Computer Science (Game Development) in the Fall, apply for the BS in CS." Similarly, Denver University, a relatively small school that enrolls about 4,000 undergraduate students and 5,000 graduate students, expects 30 new game development majors in fall 2006, representing a significant increase compared to its 10 incoming game development majors in fall 2005.

The mission of motivating potential CS students and getting CS grads to be more capable of building real things looks readily achievable with our new programs, using our experience with the prototype courses currently being offered. It is highly motivating for us all as we look forward to participating in a brave new world.

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