Game Design Education: Integrating Computation and Culture

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Although many universities focus their digital media curricula on game production and game studies, Georgia Tech defines a third approach that integrates technical and cultural knowledge by emphasizing research into the expressive potential of games.

Electronic games are growing rapidly as a cultural form, a set of media technologies, and a global industry. Humanists look at these games as a new expressive genre like drama, opera, or movies; social scientists view them as a new form of collective behavior; computer scientists, engineers, and industrial designers find them a new focus of invention.

New academic journals such as *Game Studies* and *Games and Culture*, conferences such as Serious Games and Living Game Worlds, organizations such as the Digital Games Research Association, and an active blog culture that includes GrandTextAuto.org and ludology.org have arisen to absorb and facilitate this energized discourse.

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. At Georgia Tech, we are defining a third category, one that integrates technical and cultural knowledge by emphasizing research into the expressive potential of games.[1]

PRODUCTION VERSUS STUDIES

Game production programs focus on feeding the industry and necessarily reinforce its current practices. Indeed, the success of a game production program lies in how well it understands and responds to the industry's needs.

Largely taught by artists with MFAs and computer programmers with industry experience, Game production programs often include internships within the major game studios, sometimes even substituting multisemester work experience for class time. These close ties with industry provide students with valuable opportunities for postgraduation employment and game companies with a source of new employees who are immediately productive. But if the fit is too narrow and the program too short-sighted in serving the immediate hiring needs, its graduates might find their skills losing value when the needs of the industry shift in response to new technologies.

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 critical and historical perspective on current cultural trends. Like American studies, film studies, women's studies, and Afro-American studies, the name game studies provides an interdisciplinary umbrella for an emerging field that emphasizes study over the disciplinary approach.

Game studies provides a productive direction for research, but it can be a risky choice for students because graduates might lack both the skills that make them employable by industry and the disciplinary legitimacy that would prepare them for academic careers in more traditional departments. However, the increasing

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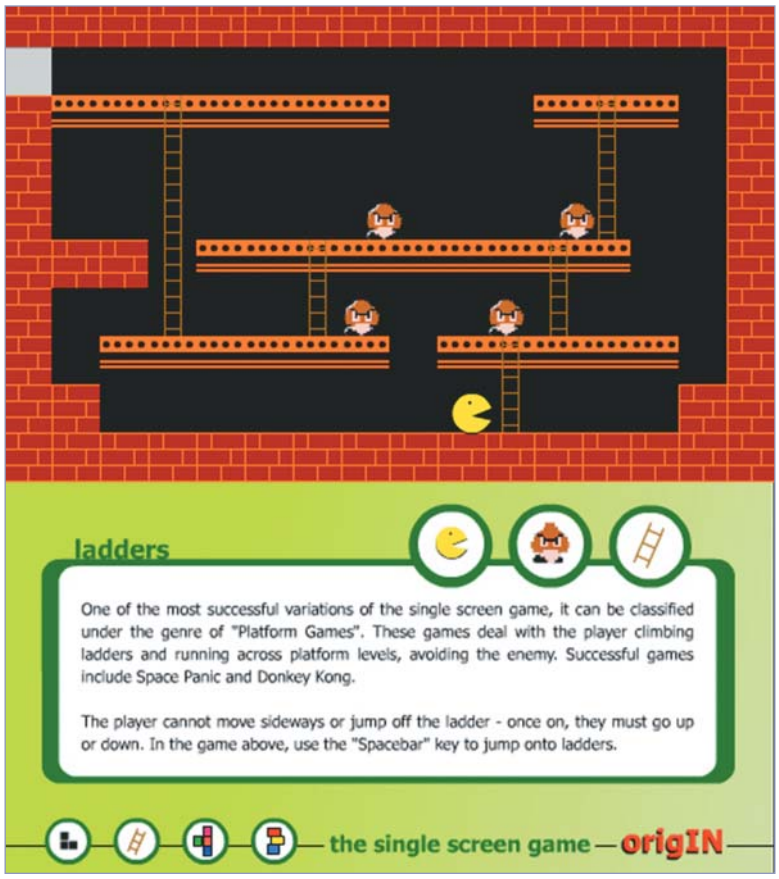

Figure 1.* OrigIN.** ***Roshan Menon's prototype game aimed at helping users understand and appreciate some of the all-time classic arcade, video, and computer games.

demand for these courses will produce more university slots in the long run.

GEORGIA TECH'S APPROACH

At Georgia Tech, we seek to combine the strengths of both approaches. We teach digital game development from the perspective of older cultural practices, critical humanistic discourse, and an understanding of computation as expressive practice.

We have a growing academic unit that emphasizes the integration of theory and practice—housed within the School of Literature, Communication, and Culture—and offers graduate degrees in digital media. We also participate in two interdisciplinary degrees, an MS in human-computer interaction jointly with computing and psychology, and a BS in computational media jointly with computing.

Students from all these degree programs can specialize in game design, but they do so in the context of a wider range of digital expression. They have the opportunity to do internships at places ranging from Electronic Arts to CNN to the Museum of Modern Art. With boundaries always in flux between games, online communities, art installations, and other digital genres, the range of experience offers a wider palette to our game design students and causes games to permeate other research areas.

Blazing trails

Georgia Tech was among the first universities to offer academic rather than preprofessional degrees in digital media. The university began offering the MS in information design and technology in 1993 and the PhD in digital media in 2004.

The graduate curriculum rests on four required core courses that give students a grounding in the history and theory of digital media and in a core skill set that includes object-oriented programming, visual culture and design, moving images and 3D environments, and interaction design and information architecture. Students do not rely on a single skill set, such as programming or graphic design, for their project work. Everyone learns to express themselves both procedurally and visually.

Our aim is not to create narrowly specialized team members—although most of our students have specialty-level strengths in one or more areas—but broadly skilled professionals capable of prototyping their own ideas, initiating projects, and leading design teams. We weave the critical and historical approach to media through all these courses, with the *New Media Reader* serving as an important core text.

A key theme of the courses is the noninevitability of technological change, including the social forces and cultural values that drive invention in one direction or another. Other themes include the formal conventions that link media and the specific affordances of digital media that lead to new conventions and expressive possibilities.

Courses are project-based, with students given ample leeway to shape their own responses to an assignment. As Figures 1 and 2 show, many students respond to all their core assignments by developing games, whether the problem is a Java-based screen saver or a database-driven mashup of Google maps.

We also offer multiple game-specific courses at the undergraduate and graduate level, including Games Design as a Cultural Practice, Game Programming, Game AI, and related courses in Expressive Spaces, Experimental Media, and Interactive Narrative.

Focusing on research

The program's research focus is expressed in the required graduate course Project Studio, which provides master's degree students with the opportunity to work on well-shaped problems in small, faculty-directed

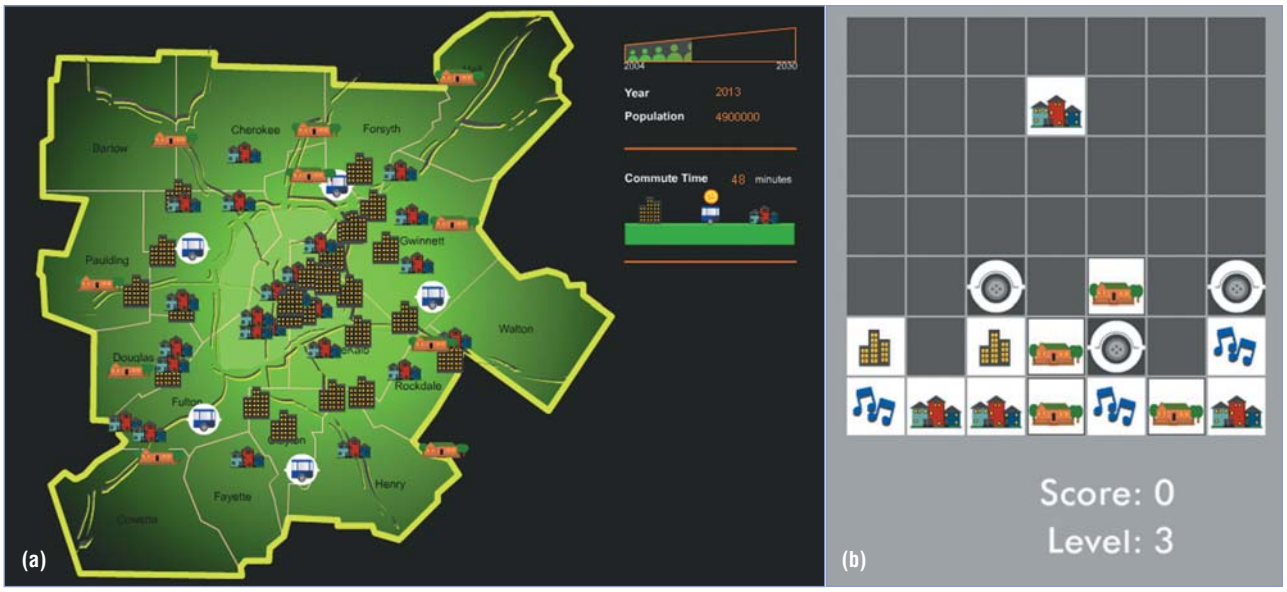

Figure 2. Game prototypes. Prototypes such as (a) **SimGame Atlanta** *and (b)* **Live-Work-Play** *explore the possibilities of using games to influence ideas and opinions on issues such as land-use planning, traffic, and water.*

groups. Project Studios, hosted within the Experimental Game Lab (EGL), include work on machinima, procedurally generated game spaces, and game ontologies. The Mobile Technology Group hosts a project studio that focuses on mobile games such as the one shown in Figure 3, and the Experimental Television Group frequently works on games as well. Graduate students' exposure to long-term, faculty-led research questions results in more productive master's projects.

The graduate program's centerpiece, the master's project, draws on the engineering and humanistic traditions: Students work within established research areas but are encouraged to initiate projects that express their own creativity and self-directed goals.

The master's project makes up about half of the second year's work, including one or more courses in the fall semester that support writing the proposal and two three-credit courses in the spring semester devoted to creating and documenting the project. Students must defend their projects at a one-hour public defense.

We have found that this emphasis on individual project work, combined with the ample opportunities for collaborative work in other courses, consolidates the multiple skill sets the program aims to teach.[2]

HUMANISTIC FRAMEWORK

Our program views electronic games as an evolving genre, connected to older traditions of culture and representation. Game development requires a great deal of specific expertise. Vocationally focused university programs and trade schools have seized upon the opportunity to supply the next set of technically trained personnel for the game industry—but we must still determine who will supply the next set of visionaries and artists.

Practical value?

Students often ask humanists how a given course will help them in the real world, especially when they are struggling to find enough reason and will to get through Thomas Mann or Marcel Proust. There is an effective response to the charge that the humanities are useless,

Figure 3. **MobileMallet.** *Created by the Mobile Technologies Group, this project uses data from an accelerometer to create a mobile version of the "Test Your Strength" game found at carnivals everywhere.*

however. Fields like business, medicine, and computer science seem practical because they are predictably useful: We can know in advance how to reap immediate gain from them. By contrast, the humanities are unpredictably useful: We cannot know in advance how they might serve us.

As the name suggests, the humanities help us understand what it means to be human, no matter the contingencies of profession, economics, or current affairs. The humanities offer insights into human experience that we need when industries, armed forces, governments, game engines, middleware, and all else fails. This is the knowledge that helps us recover from heartbreak, make sense of 9/11, and understand betrayal. It is this unpredictable usefulness, this postponed fungibility in the humanities that people so often mistake for uselessness.

In large part, education for the game industry is predictably useful.

In large part, education for the game industry is predictably useful. Studios need skilled workers who can write C++ code, model 3D objects, configure massive networks, and perform a host of other practical tasks. The International Game Developers Association's (IGDA) curriculum initiative provides many suggestions for educational standards of this sort, meant to create technical competence.

The game industry needs technically competent developers, artists, and designers fundamentally versed in the rich subtleties of human experience. This is perhaps the most promising and valuable collaboration academia could provide the game industry: potential developers, artists, designers, and marketers with a meaningful understanding of the human condition and the ability to express themselves through video games. This collaboration is less about the actual than the possible. As such, it requires a leap of faith, more on the part of industry than academia.

Expanding the field

We need to encourage others besides gamers to express themselves through video games, such as artists who have something to say about the world and their condition in it and who choose the medium of the video game as their muse. Well-known game designer and frequent industry detractor Chris Crawford has spoken often about how the game industry has resigned itself to perpetuating a niche market of young males. Often we researchers and developers bemoan the industry's almost impenetrable risk aversion, lamenting that no one seems willing to take even the most nominal chance on a title.

The only way to get the industry to take risks on games that explore the missing themes of human experience—heartbreak, anticipation, jealousy, despair, eternal hope, grief, and so many others—is to nurture inspired students who can in turn inspire others with their vision. French philosopher Maurice Blanchot argues that the work itself leads toward inspiration, rather than inspiration leading toward the work; it is a leap of faith and yet we must use the possibility of finding inspiration as an impetus for searching.[3] If academics can help instill inspiration, the industry will find itself compelled by its undeniable humanity to take risks on unpredictably useful projects—some of which could become massive commercial successes.[3]

On the downside, this is a long-term project. Academia cannot commit to a return-on-investment proposition for inspiration, talent, or art. This isn't just about reaping convenient rewards from university-funded experimental projects, getting cheap labor through internships, or plucking brilliant designers out of short-term certificate programs. It's about taking Blanchot's leap of inspiration and producing to find that inspiration. Given industry's fast-paced, nonstop demands, this is an endeavor those in the ivory tower must undertake on their own, without permission or research funding from game developers or publishers.[4-6]

PROCEDURAL EXPRESSION

The inquiry described as *procedural expression* provides the program with a major research focus: identifying which architectures, representational techniques, and design methods enable creation of richly interactive, generative experiences. The game industry is approaching a development crisis caused by the overuse of nonprocedural assets such as hard-coded scripts, level designs, textures, models, sounds, and animations. Contemporary games such as Electronic Arts' *The Lord of the Rings* franchise contain more asset files than lines of code. Even open-world games such as the *Grand Theft Auto* franchise—lauded for its simulated, procedural worlds—still heavily depend on static assets.

At the recent Game Developers Conference, developers voiced concerns that next-generation game console hardware will only exacerbate this content crisis. The demand for increasingly detailed graphics that will entice consumers into purchasing next-generation consoles means that static assets become more expensive to produce, requiring ever larger teams and making games more expensive. At the same time, consumers want more game play, meaning larger games, thus requiring even more assets to be produced, including graphics, hard-coded levels and scripts, and so forth.

Solving the content crisis

Because it enables new genres of interactive art and entertainment such as high-agency interactive story-

telling, *procedural content* offers traditional games the only way out of the content crisis. Intimately related to AI research, procedural content requires expressing—in machine-manipulable form—knowledge, structures, and processes that describe cultural artifacts such as characters, stories, rhetoric, and visual aesthetics.

Interactive drama, a holy grail of game design, lets players interact with rich autonomous characters and experience a dynamically constructed story that depends on their actions. Building an interactive drama requires solving several challenging research questions in the following areas:

- autonomous characters,
- story management and generation,
- natural-language processing in the context of dramatic worlds, and
- deconstructing and re-expressing particular authored experiences within the multiple AI systems for character, story, and language.

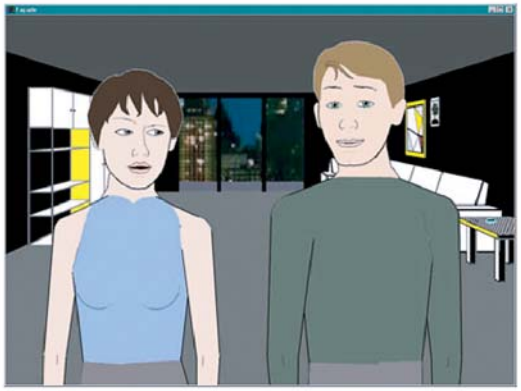

Figure 4.* Façade *interactive drama. By combining autonomous, believable characters with dynamic plot construction, the game gives the player an opportunity to help resolve the hosting couple's marital difficulties—or make them worse.

Figure 4 shows *Façade* (www.interactivestory.net), a game developed with Andrew Stern and released in July 2005, which provides the first fully produced interactive drama to integrate all these capabilities into a downloadable, playable experience. Technologies developed for *Façade* now serve as the basis for continuing research projects at Georgia Tech. For example, Georgia Tech researchers used the custom reactive planning language ABL—A Behavior Language, pronounced "able"—to author the characters in *Façade*. To support future research in autonomous characters, researchers have integrated ABL with the *Unreal Tournament* game engine, and they have written several character examples in the ABL/UT infrastructure.

Developers organize ABL characters as collections of reactive behaviors. These behaviors mix dynamically over time as a function of a character's environment, including its interactions with other characters and human players. Currently, a character's behavior library is static. The individual behaviors themselves do not adapt and change over time, requiring the character author to explicitly specify the complete details for all possible character behaviors.

Work is under way to relieve some of this authorial burden, while still supporting authorial control, by extending ABL to support dynamic behavior generation and adaptation. Ultimately, programmers will use the application to write complex ABL programs and easily specify behaviors where adaptation should take place.[7-10]

Managing drama

Drama management offers another productive area for AI-based game research. This most common approach for authoring interactive stories—still the state of the art in the commercial game industry—requires specifying the interactive story structure as a graph, where nodes correspond to *story pieces* such as scenes, beats, and plot points, while arcs correspond to player choices that move the story from one piece to another. The story author explicitly specifies all possible paths through the story. Unfortunately, the combinatorial nature of story graphs prevents authors from creating stories that are richly interactive at the global level, although there may be sophisticated local interaction within individual story nodes.

In practice, graph-based interactive stories never exceed a few hundred nodes and a few thousand links, and even at this scale they only find use in hypertext works where each node is effectively static and thus requires minimum implementation effort. Further, story-graph approaches do not effectively express soft constraints. Connections between story nodes have dynamic authorial preferences and cannot simply be denied or allowed.

Drama management poses the general research problem of replacing story graphs with a story policy. This policy consists of a story piece library, a model of the desired story structure, and a story piece selection policy—which, given the history of the player's interaction so far, plus the story model, selects which story piece will happen next.

Within the EGL, we've been exploring alternative drama management approaches. Established in 2003, the EGL serves as a home for interdisciplinary research in video games. In this lab, computer scientists, designers, and artists work together to push the boundaries of existing genres and create new electronic game genres. To accomplish this mission, the EGL pursues three interwoven strands:

- novel game designs that create new player experiences;
- new technologies, particularly AI technologies, that enable previously impossible designs; and
- investigations of how games function as a medium, including social, cultural, and representational game aspects.

The EGL houses game research for multiple faculty. Additionally, the game library and game playing equipment—the EGL has every major contemporary and historical game console—serve as resources for our game classes. When representatives of game studios visit our campus, the EGL helps convince them that Georgia Tech is serious about games.

In the context of the EGL, many student projects aim to create new models for procedural content:

- Brian Hochhalter's *Triad* is a generative turn-based interactive story that draws on anime conventions to create an interactive high school romance.
- Nolan Lichty's *Swarm General* is a real-time strategy game that seeks to solve the micromanagement problem by providing players with a GUI interface for creating condition-action rules for autonomous troops.
- Lakshmi Jayapalan's *Wide Ruled* is a GUI authoring framework intended for nonprogrammers to create generative interactive stories based on the Universe story-generation framework.
- Kate Compton's *Infinite Challenge* is a procedural-level generator for platform games that uses heuristics for modulating game play challenge.
- The Game Ontology Project is developing an ontology for game design. This ontology will serve as a conceptual aid for game analysis and design, and game generators could use formalized versions of it.[11]

Generating games

Research in game generation seeks to build AI systems that make design decisions with respect to a game's rules, physical layout, and visual representation. The small amount of prior work in this area tends to be limited to chesslike and tile-based games on the academic side, and to relatively shallow-level generators that randomly combine large-scale human-authored pieces on the commercial side. The goal of game-generation research is not to replace human designers, but rather to

- move human design up the abstraction hierarchy, and thus get a content multiplier by enabling authors to specify processes that generate concrete content;
- facilitate formal game analysis by computationally operationalizing game rules, mechanics, and representations; and
- enable new game mechanics and game genres where the game dynamically morphs and changes as a function of player interaction.

Current work focuses on a game-generation project in the area of serious games, specifically political games that function as political speech. By combining earlier work on computational models of ideologically biased reasoning in the context of story generation with current work in political games, these efforts are directed at creating a case-based reasoning framework in which the system dynamically generates a series of minigames that take the player on a tour through the ideological space associated with a political issue. The specific games generated are a function of how the player has played previous minigames in the sequence.

Students who participate in EGL's research projects are equipped with more than the skills that will make them immediately useful to their employers.

Students who have participated in EGL's research projects have gone on to careers in the game industry. We hope they are equipped with more than the skills that will make them immediately useful to their employers. Having worked on games that push the boundaries of the form will, we believe, give them an approach to design innovation that will not merely launch their careers but last them throughout their professional life.

DIVERSE APPROACHES

Faculty in the Georgia Tech Digital Media program actively participate in many research communities, from game studies to electronic arts to IEEE and ACM interest groups. Even within a single research agenda, such as that promoted by the Digital Games Research Association (DiGRA), developers are clearly tackling the field of game studies and research from several different approaches and, by and large, all offer something interesting. No single theory describes video games in their totality. Instead of narrowing the field by defining it, games research has only made clear that the phenomenon of digital gaming is spreading across a range of areas.

Teaching diversity

Lacking a single perspective on games, our teaching must mirror that diversity. In principle, Georgia Tech balances teaching and research time, and the faculty maintains different but complementary approaches and research foci. This provides a constant reminder that someone's approach is not the only orthodox alternative. This diversity also infuses new ideas into our work

and teaching, challenging us to explain ourselves better to our shared students and to one another.

Instead of providing a one-track pipeline optimized for a single approach to games, the Georgia Tech 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. What we praise as today's cutting-edge game studies might be just a fading snapshot of a developing community.

For Georgia Tech to make good on its claim to educate tomorrow's innovators, teaching today's tools and methods can be only part of that education. Academia must be prepared to step beyond the status quo. Applying, adjusting, and reshaping these tools to new expressive possibilities demands great flexibility from the faculty and the institution.

The game engine effectively operates like a virtual film studio, providing access to virtual lighting, staging, and camera work.

Making machinima

Machinima—whose producers use the images rendered by real-time 3D engines such as computer games to create cinematic pieces of instant computer animation—serves as one example. These results can vary in form and function from a live performance, to events presented in-game, to traditional video clips and other mix forms. Usually, the game engine effectively operates like a virtual film studio, providing access to virtual lighting, staging, and camera work.

Direct access and low costs make machinima a flexible and accessible technology. Filled with promise and rapidly developing, this technique is driven by technical advancements that make production easier and more stable while spreading the practice to a wider range of less technologically versed producers.

The results of widespread machinima production show how the computer is maturing as an expressive medium. Machinima pieces have touched on obvious game-related issues in their own way, dealt with intensely personal experiences, and addressed wider political topics.

Although it is one of several evolving cultural practices, closely connected to games but breaking existing boundaries and adding something new, machinima has not yet consolidated itself on a technical or conceptual level. Its brief history is made up of artistic milestones in the form of landmark productions and technical innovations such as the release of essential coding tools, editors, new 3D engines, or new games. Even machinima's definition is temporary and incomplete.[12] Machinima is inventing itself, and the resulting flexibility of its form poses a teaching challenge.

There are exceptionally few machinima academic publications to build on. Further, the technology changes yearly with the release of tools such as the Unreal 3 engine and landmark titles such as *Half-Life 2* and *The Movies*.

Work on machinima at Georgia Tech involves several different approaches to absorbing this new material. We teach machinima in required courses within the curriculum, as well as in special topic electives and seminars. Joint courses between the College of Computing and the School of Literature, Communication and Culture (LCC) also teach it.

From within LCC, we contextualize machinima in the wider framework of film theory and history, but the conceptual work is done in parallel with practical prototyping and production. As in most of our courses, we present machinima in the context of critical analysis and experimental practice. The changing technology, developing aesthetics, and design issues of machinima call for courses that can shift easily between coding, 3D modeling, and theory.

Balancing teaching and research

The Georgia Tech experience underscores that teaching and research must remain balanced to allow for a curriculum that can accommodate innovation. Topics like machinima can only be kept fresh if their teachers remain involved in the research and connected to emerging communities of practice. A topic like this is too flexible to be cast into one definitive curriculum—extruding the core topics for game studies is difficult enough.

As IGDA's sample curriculum states: "There is no 'silver bullet' approach" (www.igda.org/academia/curriculum_framework.php)—bullets are flying everywhere. Thus, faculty and curricula must remain on the move to foster future changes. Keeping them heavily involved in research facilitates this and helps pull students into faculty members' research projects. Georgia Tech's relatively short-term exposure to machinima research indicates that such student involvement need not stop at the PhD or master's level but can effectively extend to undergraduate students.

Research in machinima has found a home within the EGL and has been the subject of individual master's projects as well as the focus of both group research projects and creative work at the undergraduate and graduate level. That the entertainment industry should see this as a new way of generating content is not surprising, and we are pleased that Turner Broadcasting has funded some of our research.

In addition, our experience reinforces our belief that game studies constitutes an expanding research category.

We must look beyond the state of the art in games. What looks to industry like the "bleeding edge" might be only a threshold for further exploration when seen from academia's longer historical viewpoint and inquisitively experimental perspective. Exploration cannot be limited by the commercial roots of the traditional game industry but must follow the less restricted experimental form.

In machinima's case, the legal issues of engine licensing and commercial use of its artifacts present a major drawback for further commercial development. Although some changes and different marketing models have been introduced, intellectual property rights remain an obstacle. Academia operates largely outside such commercial restrictions and offers a free arena for exploration.

Our experience reinforces our belief that game studies constitute an expanding research category.

Whatever machinima's trajectory is as a media format, it remains closely connected to game studies, not only in terms of technology but also as a developing expressive practice in need of further improvement. It also presents one example of the challenges posed by the dynamic nature of game studies and game curricula.

Game studies, as a humanistic discipline, has no defined limits to its coverage, no single methodology, and no clear historical boundary. Games date to before the dawn of written history and connect us, through play behaviors, with our prehuman ancestors and our fellow animals of almost every species. The study of play, only about 50 years old, has generated a mere handful of books that offer a theoretical approach to playing and games. Indeed, one of the key texts is Ludwig Wittgenstein's famous pronouncement that the category of games contained so many disparate items, from chess to Ring Round Rosy, that it was meaningless.[13,14]

We can argue that games play a formative role in the development of human intelligence and human community at the evolutionary and the individual level[15,16] and that electronic games make us smarter.[14] But electronic games are more popularly understood to reinforce antisocial behaviors and induce addiction. Combating this perception is another area in which the games industry has enlisted the help of academics, with mixed results.

It seems likely that scholarly and preprofessional interest in games will rise with the continued growth of the game industry, the increase in games aimed at adults, the spread of game patterns into education, the growth of multiplayer online games, and the increasing combination of television with online gaming. For the moment, game developers and academics share more lines of open communication than filmmakers and film schools do. There are conferences and symposia that draw people from both cultures, although the Game Developers Conference is priced too high for academics to participate in great numbers.

Game researchers share a common sense of the need to define a critical language for talking about games and a common focus on expanding the practice.[17] Game developers and academics also share a common distaste for the values of corporate management, widely agreeing that the industry's emphasis on higher-resolution graphics and more expensive technologies in the service of clichéd and derivative content—often drawn from other genres—frequently results in unenjoyable game play.

In short, the creation of a curriculum around games is an emerging practice in which research and education, theory and practice, art and commerce, and existing disciplinary boundaries all continue changing in challenging and unpredictable ways. For us at Georgia Tech, our commitment to humanistic frameworks that connect this emerging environment to longer traditions of human culture provides our steadying orientation. We participate in all these arenas from the perspective of theorists and practitioners eager to advance digital games not as an industry or theoretical focus, but as an expressive practice in our own hands, in the hands of our students, and as a collective humanistic practice.

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