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JUNE/JULY 2007

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THE LEADING GAME INDUSTRY MAGAZINE

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TECHNIQUES AND TESTS
FOR SCATTERING OBJECTS

»» **INKING THE CUBE**

EDGE DETECTION
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POSTMORTEM

20 BIG HUGE GAMES' CATAN FOR XBOX LIVE ARCADE

The executive team at Big Huge Games had been dreaming for years of working in the triple-A console game market. Then one day Microsoft came along and offered the group an opportunity to develop an Xbox Live Arcade game, based on the Settlers of Catan license. Though traditionally a real-time strategy game maker, Big Huge jumped at the chance, viewing it as a low-cost way into the console world, where some of the risks could be mitigated. Read on to find out if the company got more than it bargained for!

By Brian Reynolds

DEPARTMENTS

2 GAME PLAN *By Simon Carless* Throwdown

4 HEADS UP DISPLAY Game marketing gurus, why developers really are the young and the restless, and more.

26 SKUNK WORKS *By Bijan Farutanpour* Book review: *Second Person*, edited by Pat Harrigan and Noah Wardrip-Fruin.

FEATURES

7 FOR BETTER OR WORSE: A QUALITY OF LIFE UPDATE

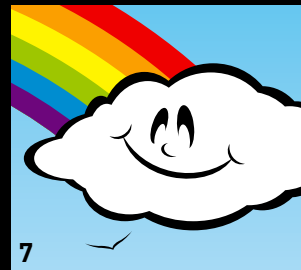
In 2004, a then-anonymous letter writer, "EA Spouse," penned an angry and outraged treatise to the game community chiding Electronic Arts for forcing employees to work egregious amounts of overtime. In the months that followed, development studios, the IGDA, and other outspoken individuals stood up and voiced their opinion of what it means to be in this obsessively dedicated line of work, with most of them calling for industrywide change, too. Nearly three years later, has any of it stuck? Or has the call to action petered out?

By Paul Hyman

13 INKING THE CUBE: EDGE DETECTION WITH DIRECT3D 10

Detecting outlines and edges is particularly useful when a video game uses cell-shaded characters. In this technical feature, Intel's Joshua Doss explains how Direct3D 10 allows programmers to shift the whole process over to the GPU.

By Joshua Doss



7



13

COLUMNS

29 GAME SHUI *By Noah Falstein* [DESIGN] Reflexes and Reflection

30 PIXEL PUSHER *By Steve Theodore* [ART] Slip Me Some Skin

33 THE INNER PRODUCT *By Mick West* [PROGRAMMING] Random Scattering

36 AURAL FIXATION *By Jesse Harlin* [SOUND] The Gospel of Attenuation

48 BUSINESS LEVEL *By Stephen Smith and Lisa Pierson Weinberger* [BUSINESS] Exemption Clause Gap



THROWDOWN

A LOT OF SOCIAL AND COLLABORATIVE WEB SITES have been over-funded by venture capital in the past few months. My favorite example is a social networking site for people with curly hair that got hundreds of thousands of dollars in investment—I kid you not!

So I'm sure a few *Game Developer* readers, alongside myself, have been tut-tutting the excessive hype that surrounds the cornucopia of Web 2.0 applications and how they relate to the game space. After all, collaborating and playing with game-like functionality on the web is fun in small doses, but it hardly replaces a stirring, hi-def multiplayer match of *GEARS OF WAR*, right?

ROUND 1: WEB VS. GAMES

Raph Koster, former Origin and Sony Online designer and a thought leader in the MMO industry, has been speaking out about what people in the game business don't understand when dealing with the online space—and you know, I think he has a significant and rather scary point.

In an interview with Bonnie Ruberg that recently ran on our sister site, *Gamasutra.com*, Koster described his GDC 2007 lecture as follows: "Where Game Meets Web": that's the one where I basically said that everyone in the industry is doomed because the web is stealing their thunder. This industry isn't working with the web very well at all. Basically, the talk was kind of a tour through some of the products that are [seen as] games from outside this industry, games that are doing spectacularly, games that we don't even pay attention to because we don't think of them as being part of our industry."

Koster also pointed out some of the notable titles—both games and what might be termed "virtual worlds"—that have become incredibly popular without many game industry experts even noticing. The *Webkinz* virtual world web site, where one can trade points, play any number of mini-games, and interact with friends after buying a plush Beanie Baby-style toy with an unlock code, is a smash, seeing 2.5 million unique visitors in December 2006.

And if you say, "Pshaw! It's just a free title! Where's the actual money coming from?" then sure, *Webkinz* is mainly cross-promotional. But it certainly seems to help the company sell its main product: plush toys.

There's an even better web-based example: the sometimes ignored *RUNESCAPE*, which just recently reached 1 million subscribers, who each pay \$5 per month.

ROUND 2: RUNESCAPE VS. WARCRAFT

By some reported figures, *RUNESCAPE* is the second most-grossing Western MMO, only behind *WORLD OF WARCRAFT*. Yet hardly anybody in the game business ever discusses the fairly rudimentary browser-based product, which nonetheless has an army of devoted fans. Its advantages include 1) a long life, 2) a smart business model whereby users can play the basic game for free and pay up for forum privileges or to receive access to the majority of the game world, and of course 3) the fact that anybody with a web browser can access the world.

If the same addictive leveling-up style gameplay can be achieved within a web browser, which reaches an infinitely larger audience than most hardcore MMOs, why isn't there a mess of online game companies clamoring for a Flash or Java-based experience that the whole world (wide web) can plug into, rather than a standalone installer that often requires complex graphics cards and a level of trust over and above simply surfing to a web site and registering?

ROUND 3: MOUSE VS. CONTROLLER

The answer, if you think about it, may be scary. If the future of video games is based around collaboration and online play, as so many claim, and the mechanics of collection-based gameplay are so simple that they don't require any specialized video game playing knowledge, then there's a whole branch of the game industry that's about to be made obsolete by the web services industry.

How big is it? How big a deal is it? As soon as we find out exactly what Koster's project at *Area* is, we'll know how far off the deep end he's plunged in search of a new solution.

Meanwhile, ridiculous as it sounds, we all need to pay more attention to plush toys with their own web sites.

BADGE OF HONOR

Finally, I'd like to congratulate everyone associated with *Game Developer* for bringing home a Maggie Award this year for Best Computer Trade magazine. This award represents our commitment to delivering the highest quality information to game developers. ❄



Simon Carless
Editor-in-Chief

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RUSS KLEIN,
PRESIDENT OF GLOBAL MARKETING,
STRATEGY, AND INNOVATION FOR
BURGER KING, ON WHETHER THERE
WILL BE DEVELOPER PROFIT-
SHARING IN ADVERGAMES:

The financial construct around our partnership with Blitz [who developed the Burger King games] is not one I have a command of with every last detail, but my understanding is that it was generally a fee-based structure for final deliverable products with these three games. The rest of the distribution burden was on us.

I think that all of the stakeholders profited. So that model, to the extent that it would be replicable with a new set of content, is a question. I don't know what the next wave of content will be, but if it were to be there, certainly the financial construct is one that I think that all of the stakeholders found profitable.



BING GORDON,
EXECUTIVE VICE PRESIDENT
AND CHIEF CREATIVE OFFICER
OF ELECTRONIC ARTS ON THE
COMPANY'S RECENT ADOPTION
OF UNREAL ENGINE 3:

Renderware didn't get to next-gen, the parts of Renderware that we needed. We actually underestimated Epic early on. They told us, 'We're going to do this, this, and this,' and we thought, 'Oh that's going to be kind of hard.' We overestimated our team. And then we looked up three months later, then six months later, then nine months later and said, 'Oops! We underestimated Epic, again, and overestimated our team.'

So we had a couple of teams that were waiting on Renderware, and actually probably stuck with it for a little too long. Now Renderware is pretty much just a development house.



STEVE ROBERTS,
VICE PRESIDENT AND
GENERAL MANAGER OF
DIRECTV ON THE FUTURE
OF ENTERTAINMENT MEDIA:

Gaming and the gaming industry are forcing traditional media to change on the hardware side and the software side of content. Things we're seeing are the ability to swap content that's downloaded onto the DVR, and then convert it. You'll be able to bring over things from your DVR to your PC. It's the same thing with consoles. In three to five years, I wouldn't be surprised if a next-gen Xbox or the PlayStation 4 had a tuner inside the box. Gaming is driving that consumption of media. People want their content when they want it, where they want it, and how they want it. Things like IGN and Xbox Live are changing media for all of us. It's changing our hardware and how it interfaces with consoles.



RYAN SCHNEIDER,
MARKETING DIRECTOR FOR
INSOMNIAC GAMES ON SONY'S
PUSH TO CALL OUT GAMES AND
TECHNIQUES THAT ARE "ONLY
POSSIBLE ON PLAYSTATION 3":

We try not to get into the hardcore debate of, "Well, you can only do this on the PlayStation 3 compared to the Xbox 360 and the Wii!" because there are always situations where maybe you can. But you cannot argue with the processing power. You cannot argue with the parallel processing and the storage space. There are things that you are able to do on PlayStation 3 that make it advantageous. Whether you can do certain things on 360 or Wii, it's hard for us to say. We've worked exclusively with Sony since the beginning of the company. For us to diss the competition is not something we can do. All we can do is say, "Here's what we're doing with the technology."

THE 411

GAME DEVELOPER'S NEW RESEARCH DIVISION

IN LATE APRIL, GAME DEVELOPER RELEASED AN extended report about compensation in the video game development industry, based on several years' worth of data that had been collected during our annual salary surveys, but which had never

before been released publicly. This exclusive paper marked the launch of a new division of the magazine: Game Developer Research.

The purpose of this new division is to provide game development executives access to

empirical measurement and high quality prediction that has heretofore been absent from the game creation space. While many of the reports will be summarized in significant detail within the pages of *Game Developer*, the

OVER THE HILL? HARDLY!

AVERAGE DEVELOPER FAR FROM SENIOR DISCOUNT

HOW OLD IS THE AVERAGE GAME

developer? I've heard statistics that put Joe or Jane Developer around 30 or 31, with the anecdotal addendum that many developers leave the industry around age 35, when many men realize they want a job that lets them spend time with their family.

From data that have never before been published [collected during *Game Developer's* annual Salary Survey for the 2006 fiscal year], we found this statistic to be fairly accurate. In each of the major disciplines, the average age clusters tightly in the 21 to 39 range: 90 percent of all artists; almost 85 percent of all

programmers; and 88 percent of all designers fall into this segment, with relatively even distribution between the 21 to 29 and 30 to 39 segments.

However, we found one exception. Producers are much more likely to be between 30 and 39 years old (55.7 percent) than between 21 and 29 (25.3 percent).

Audio personnel also didn't fit the typical pattern: 28.7 percent are between 21 and 29 years old; 44.3 percent are in the 30 to 39 range; almost 21 percent are between 40 and 49 years old; and just more than 5 percent are 50 years old or older.

—Jill Duffy

AVERAGE AGE OF U.S. GAME DEVELOPERS ACROSS ALL DISCIPLINES*

AGE	PERCENT OF DEVELOPERS
21 or younger	0.8
21-29	39.6
30-39	44.6
40-49	11.7
50 or older	3.4

*Includes Art, Programming, Design, Audio, Production, QA, and Business and Legal.

A FEW GOOD FRIENDS

Game Developer announces new advisory board



Game Developer's advisory board (l-r):

Hal Barwood, Ellen Guon Beeman, Brad Bulkley, Clinton Keith, Mark DeLoura, and Ryan Lesser.

AS THE SAYING GOES, YOU CAN TELL A LOT ABOUT A person by their friends. Similarly, you can tell a lot about a high-tech trade magazine by its advisory board. We, the editors of *Game Developer*, recently refreshed our list of "friends" to add some new blood, alongside a few familiar faces.

For technical consideration, we now welcome to the board Brad Bulkley, lead programmer at Neversoft, who won our hearts with an article on streaming worlds back in the June/July 2006 issue. Joining Bulkley is Clinton Keith, High Moon Studios' chief technical officer, who espoused the virtues of Scrum in a February 2007 *Game Developer* article.

On the more artistic front, we welcome Ryan Lesser, art director at Harmonix, who designed the brilliant and blazing illustration on the February 2006 GUITAR HERO cover. Designer-at-large and generally opinionated gentleman Hal Barwood will remain on the board, as will Microsoft's Ellen Guon Beeman. Last but not least, we've added Mark DeLoura, technical director for Ubisoft in San Francisco and former editor-in-chief of the magazine circa 2000.

Our thanks go out to all these busy people who have agreed to help us make the magazine better, or at least keep it on track.

—Brandon Sheffield

CALENDAR

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(tour of studios in area, plus ChinaJoy)
China
July 8-13
Price: \$4,800
www.pearlresearch.com/china.html

complete data and year-over-year analyses will appear exclusively in the research papers themselves, which are available for purchase at www.gdmag.com/research.

Profits from *Game Developer* Research will directly benefit *Game Developer* magazine, enabling the editors to continue serving the community with candid developer-written postmortems of triple-A games, in-depth technical

articles, exclusive interviews, and analysis of prominent news and trends.


The next *Game Developer* Research report, due out this June, will address the 2007 *Game Developer* Census, which will measure the entire game development population of North America for the first time. The paper will also include the contact information of development studios, for those interested in offering products and services to them.

In the coming months, *Game Developer* Research also plans to investigate the tool purchasing habits of game developers, as well as the state of various sub-sectors of the game industry, such as the serious games market, virtual worlds, and MMO games. To learn more about *Game Developer* Research, or to access the latest report, visit www.gdmag.com/research.

—staff



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FOR BETTER OR WORSE

A QUALITY OF LIFE UPDATE

» **IT'S HARD TO BELIEVE THAT TWO AND A HALF YEARS HAVE** passed since EA Spouse posted her now-famous open letter in November 2004 complaining about working conditions at Electronic Arts.

These days, Erin Hoffman is no longer EA Spouse but a designer at Troy, NY-based developer First Playable Productions creating Nintendo DS games.

Hoffman hasn't forgotten what it was like when her husband (then fiancé) endured an extended crunch period at EA, averaging 85-hour work weeks from 9 a.m. to 10 p.m. seven days a week.

How have quality of life conditions changed throughout the game industry since then? For the better or the worse?

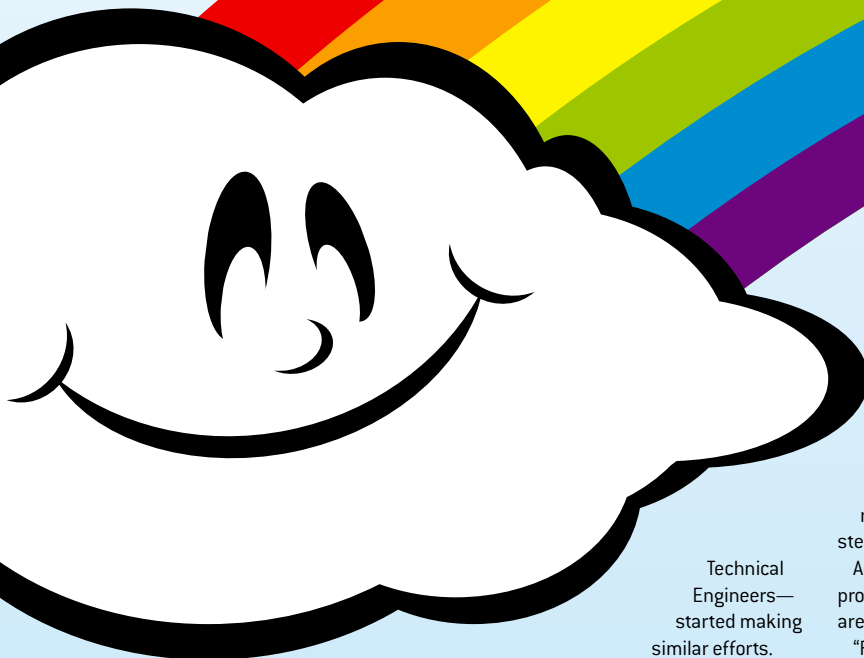
STRENGTH IN NUMBERS

Back in 2004, working conditions in the game industry were such that at least one union, the Seattle-based Washington Alliance of Technology Workers, made no bones about the fact that it was eyeing the game development community.

The local of the Communications Workers of America began reaching out to employees of large game publishers via online forums and job boards "to tell them the advantages of joining a union," said Marcus Courtney, the president of Washtech, as it is known. "Not a lot of white-collar workers understand the union process and what we have to offer." Courtney added that he wouldn't be surprised if other unions—such as the Screen Actors Guild, the American Federation of Television and Radio Artists, and the International Federation of Professional and

PAUL HYMAN was the editor-in-chief of *CMP Media's GamePower* and currently writes a weekly column on the video games industry for *The Hollywood Reporter*. He's covered gaming for more than a dozen years. Email him at phyman@gdmag.com.

QUALITY OF LIFE



CHANGE AT EA

Management at Electronic Arts is adamant about the fact that big changes have occurred at the industry's largest publisher. Gabrielle Toledano, senior vice president of human resources, wasn't yet employed at EA when the EA Spouse letter hit, but she is well aware of its impact.

"At game companies, when there's a product release deadline, there's crunch time," she says, "and it became clear from the blogs and the EA Spouse letter that employees felt there was just too much work time. There may have been specific managers during that period who weren't good managers who were demanding that. We've taken quite a few steps since then to improve conditions."

According to Toledano, much of the emphasis now is on pre-production, the stage at which it is determined what resources are needed from the start of the project through to the finish.

"Proper planning enables you to set expectations and budget correctly at the beginning so there's less of a crunch time," she says. "That's a big piece of the solution."

There has also been a heavy emphasis on management training and working on company values "like integrity, collaboration, teamwork, and creativity," she adds. "And, frankly, we removed people from their positions who were managing

Technical Engineers—started making similar efforts.

But, says Courtney today, there hasn't been much

progress and the unionization efforts are "still in the very early stages. We have contacted employees at Microsoft, especially those who work on Xbox, but we haven't had any breakthroughs, that's for sure."

He described current unionization efforts as "less strong" than previously.

"Organizing is a very slow process," he explains. "What happens in the initial stage is windows of opportunity open. One of those windows was the situation at Electronic Arts, which just sort of popped. There was initial excitement ... but now people have moved beyond those early conversations and we are currently in a wait-and-see stage."

Courtney admits that one reason why the process has slowed is that, frankly, some conditions have improved for game developers. The economy is on the upswing, loss of jobs has bottomed out, and positive signs like the creation of new jobs are apparent.

"But there are still overtime pressures," he says, "as well as fears that you could lose your job at any time because developers are trying to cut costs by outsourcing, both domestically and internationally. Everyone is wondering how safe their job is once they finish their ship cycle. Will management decide to send the work elsewhere? And the truth is that people do lose their jobs. There are constant cost-cutting measures going on."

In Courtney's opinion, initiatives like the EA Spouse open letter have their positive effects, particularly if they cast a light on conditions not openly discussed previously.

"Electronic Arts responded to that letter," he says. "They said things would change. But have they done enough to eliminate the need for organizing? We are only a couple of years into it, so I think employees are still waiting to see."



Erin Hoffman, also known as EA Spouse



Gabrielle Toledano, senior vice president of human resources at Electronic Arts

"What defines quality of life in a small studio is going to be drastically different from what impacts a studio of even 100 people, let alone a company the size of EA."

ERIN HOFFMAN, A.K.A. EA_SPOUSE

their teams inappropriately." The result is that people are putting in less overtime which is confirmed, says Toledano, by regularly scheduled "TalkBack surveys" and focus groups that ask employees to give feedback on working conditions.

Looking back, according to one EA spokesperson, the industry had grown very quickly and, admittedly, the company's size and revenue were "outpacing EA's practices. The game industry is a very competitive environment where, for a long time, people would take pride in the hours they worked. There was a certain immaturity in working practices and we needed to mature those practices and institutionalize better systems. To some extent, the EA Spouse letter accelerated some of the action plans we had intended to pursue."

Toledano also attributes culture change to leadership change. "About 12 months ago, almost every member of the CEO's direct staff changed," she says. "That's not to say that the people who are no longer with us were at fault. They weren't. But you automatically have a cultural shift with new management. And so



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QUALITY OF LIFE



we weren't really paying attention to the work-life balance the way we are today."

IGDA'S CERTIFICATION PROGRAM

Erin Hoffman says she is constantly receiving emails from the people in the trenches, especially from the trenches at EA. What she's learned is that nothing is hard and fast at a company as large as EA with its numerous studios and locations.

"What I hear is that each studio operates differently and, even within each studio, there are certain teams where things work well and certain teams that are really bad," she says, "but there's definitely an effort to weed out the bad situations. From what I understand, the Los Angeles studio has made a really big turnaround, for example. I've heard mixed comments from Vancouver, and I consistently hear bad things about Tiburon [in Orlando, Fla.]. In fact, one thread at our GameWatch.org site refers to Tiburon as 'the poster child for the industry's quality of life problems.'"

But these so-called quality of life problems go far beyond long hours and they exist throughout the industry. Which is why, Hoffman says, she's become active in several projects, including GameWatch.org, a message board where developers can speak out on a variety of quality of life issues, including benefits, overtime, diversity, and compensation, as well as which studios are doing the best and worst job of creating great places to work. As of this writing, GameWatch.org has close to 2,000 registered users with almost 800 postings.

In addition, the site expects to soon feature a rating system that objectively measures each game development studio as to which are the best places to work.

Hoffman has also become active in the IGDA's Quality of Life Committee and, especially, on a project known as Employment Contract Quality of Life Certification (ECQC). Its goal is to first gather up those elements that make for the best employment practices at a studio and then translate them into a set of employment contract provisions. IGDA-affiliated studios interested in becoming ECQC-certified would incorporate the provisions into their employment agreements and then submit that agreement to the IGDA. Once approved, the studio would be able to call itself "IGDA Quality of Life Certified."

According to the IGDA, certification would provide "a level of comfort to potential hires and also provide the studio with a significant advantage in the industry talent pool." To assure compliance, IGDA members can verify that the agreement they receive from a studio is the version that's certified, and they can report any inconsistencies.

"I think this is a fantastic program," observes Hoffman, "one that is entirely voluntary, very positive, and a great way to approach the quality of life issues."

But whether studios apply for certification depends heavily on how good a job the ECQC task force does at creating its model employment contract.

there's no question that, within the last 12 months, we have a new culture here at EA, and a lot

of that is attributable to the head of the studio who has a very open, consensus listening style."

DOWN IN THE TRENCHES

EA's new group studio manager is Nick Earl who admits that crunch periods haven't been eliminated entirely.

"There will always be a crunch period," he says. "But it can now be measured in days, not weeks, and that's a very big difference. We've become much more efficient in terms of preproduction so that we're no longer throwing people and man-hours—or man-months—at projects. We are much more thoughtful about how we spend our time."

Earl credits EA's Game Development Framework (GDF) for easing much of the pain. He describes GDF as a "series of processes that have been fused together to create a soup-to-nuts approach to creating games.

"While there are different variables for each of our studios because each studio builds different types of games, the general philosophy is one of milestones and checkpoints and making sure that you don't go into production until you've checked off all the boxes for preproduction," he says. "It's a far more efficient and thoughtful way to develop products than previously."

Earl began working on GDF approximately two years ago and he says it has influenced every project started in the last 18 months. He admits that the EA Spouse letter influenced the creation of GDF, but only to an extent.

"I think there's no denying that EA Spouse certainly got our attention," says Earl, "but it was just one of the variables in the equation. I mean, I was working on a product myself during that period as an acting executive producer, and I lived the crunch period firsthand. It became obvious to me that there was a lot of stress in the system. It was never so bad, however, that it was totally and utterly destructive to people's lives; in fact, some people actually loved working that intensely. I recently re-read the EA Spouse letter and I've got to tell you that it's just so exaggerated. In my role as an executive producer I was working the same exact hours as everyone else. It wasn't as bad as EA Spouse said but, yes, I'll admit



Marcus Courtney,
president of Washtech



"One thing the committee is being very careful about is to work closely with small studio heads to make sure it's not introducing restrictions that are too prohibitive for a small studio," says Hoffman. "Part of the biggest problem with quality of life issues is that what defines quality of life in a small studio, especially a startup, is going to be drastically different from what impacts a studio of even 100 people, let alone a company the size of EA with 1,000-plus people."

PLANS MOVE FORWARD

But it could be 12 months or so before the program is ready for primetime, says Tom Buscaglia, who chairs the ECQC committee. Buscaglia, who calls himself "The Game Attorney," is a principal at Vashon Island, WA-based T.H. Buscaglia and Associates.

"We'll be sending out a survey to all of our affiliate studios to get feedback before we launch," he explains. "We want to have

unionization efforts, Washtech's Courtney perceives the ECQC as "the first stage of union formation—but with a different look."

"What you have here is a lot of white-collar professionals who believe they need to reinvent the wheel of unionism in a way that will be something different than working under a contract," he says. "The idea of collective bargaining isn't for them, so they feel they need to do it in a different way that still meets their needs. And so the IGDA is trying this voluntary code of conduct. But the more I learn about it, the more I see it as the very first step towards unionization. Under Federal law, if two or more employees work in concert to improve wages, hours, and working conditions, that's considered union activity."

Over time, Courtney predicts, the industry will recognize that they need something more than a voluntary code of conduct; they'll need guaranteed quality of life.

"I recently re-read the EA_Spouse letter and it's just so exaggerated. It wasn't as bad as EA_Spouse said but, yes, I'll admit we weren't really paying attention to the work-life balance the way we are today."

NICK EARL, EA GROUP STUDIO MANAGER

strong buy-in but, at the same time, in order to get buy-in, we don't want to set the standard so low that it's meaningless."

Certification would be made on a studio-by-studio, not publisher-by-publisher, basis. And so, at a multi-studio publisher, some studios might sign up for certification, others might not.

"There are clearly different working conditions at different studios within the same company," says Buscaglia, who hopes to have strong ECQC compliance. If, however, sufficient complaints are made about a studio, his committee would notify that studio of these allegations and threaten to yank their certification if the conditions didn't improve. "We haven't decided yet how many strikes would mean you're out," says Buscaglia, "but three strikes within a year's period sounds right."

Unfortunately, notes Buscaglia, even though overtime is still the biggest quality of life issue within the industry, ECQC won't be able to dictate working hours. "We couldn't figure out how to do that," he says, "but at least we intend to require a published pre-stated expectation policy, as well as a formal crunch policy, so that prospective employees know what they're getting into."

INDUSTRY REACTION

A big question is which, if any, of the EA studios will apply for certification. Like most of the industry, the company hasn't decided that one yet.

"I actually don't know much about the program," comments EA's Earl, "so I'm not really sure we've got a position on it yet. I think it's really too early to comment."

While the IGDA has made it clear that, as a professional organization, it doesn't intend to become involved in

QUALITY OF LIFE CRYSTAL BALL

Courtney believes that whatever responses employers have made to concerns about quality of life issues will be short-lived, "a quick reaction just to get them over the EA Spouse crisis. But, in the long run," he says, "those gains will erode because employers will once again be pushing employees to do more for longer lengths of time for less pay."

"You are looking at an industry that needs to move fast, produce more, and grow market share," he adds. "There are profit pressures, globalization pressures, and pressures to trim costs, and all of those will have a serious negative impact on employees' quality of life."

But, at EA, Toledano swears that "the employee experience is at the very top of my charter. At the very top. You will see EA become known as one of the great places to work. The morale is absolutely going up. These are change-management processes, and they don't happen overnight."

Nevertheless, speaking not for the IGDA but for himself, Buscaglia says he "honestly believes that, at some studios—especially the larger ones and those owned by the three or four top publishers—the employees would be better off if they were unionized. And that's simply because there's strength in numbers."

At publicly traded companies, he explains, the number one priority isn't the employee—it's driving the bottom line due to obligations to shareholders. "That's why it becomes very easy to allow quality of life to become a very low priority. I do believe that, unless you're a Will Wright or some other superstar, you have absolutely no bargaining power alone."

He doesn't expect game developers to go that route, however. "Unions have a pretty bad name," he says. "They've poisoned their image in the minds of many, particularly white-collar workers."

And what about EA Spouse who almost three years ago stirred up the industry and turned the issue of employees' quality of life into a cause celebre? "I don't know that I'm 100 percent for or against unionization," says Hoffman. "But I'd definitely be willing to talk to Washtech. I'm curious about what they think they can do."

"The studios have gotten smarter and realize they need to treat their people better, which is what we all wanted, so the need for a union seems to be diminished. Unless they can make an active case for how they can further enhance our quality of life, I'm not quite sure people are so ready to jump on board." ❧



Tom Buscaglia,
"The Game Attorney"



Nick Earl, group studio
manager at Electronic Arts

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INKING THE CUBE

EDGE DETECTION WITH DIRECT3D 10

EDGE DETECTION TECHNIQUES ARE FUNDAMENTAL TO

non-photorealistic rendering algorithms. Two of the fundamental algorithms used in non-photorealistic rendering algorithms are silhouette edge detection and crease edge detection. The silhouette edge is the part of a model where the front facing triangle borders a back facing triangle. A crease edge is found where the angle between two front facing triangles is beyond a certain application-defined threshold.

In the past decade, many different techniques have been used to detect and draw these edges. Each method has its strengths, as well as room for improvement, but none of them provides an accurate representation of edges detected and created entirely on the GPU. This article discusses a GPU-based implementation of edge detection and inking using the geometry shader model available in DirectX 10 capable hardware and provides a walk-through of the geometry shader implementation and the additional capabilities it provides (see Figure 1).

EXISTING WORK

Edge-based inking (see Marshall in References) uses a preprocessing step to build a unique edge list for the model being evaluated on the CPU. Each triangle is decomposed into edges, which are then stored in a hash table. The table can be compacted by discarding all edges that are not unique.

Each edge contains information about the vertices on the edge, as well as a flag entry. This flag entry identifies the edge as being a silhouette, crease, or other type of edge and is initially set to an arbitrary value and updated at runtime. The face normals must also be computed for each triangle and stored in the edge list in this preprocessing step.

The runtime portion of this technique begins with updating the face normals (if using an animated model). Computation of the view vector takes place in this step, and the edges are tested using the view vector (V) and the face normal (N_1 and N_2). This process will determine if they are silhouette edges by

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Send comments about this article to jdoss@gdmag.com.

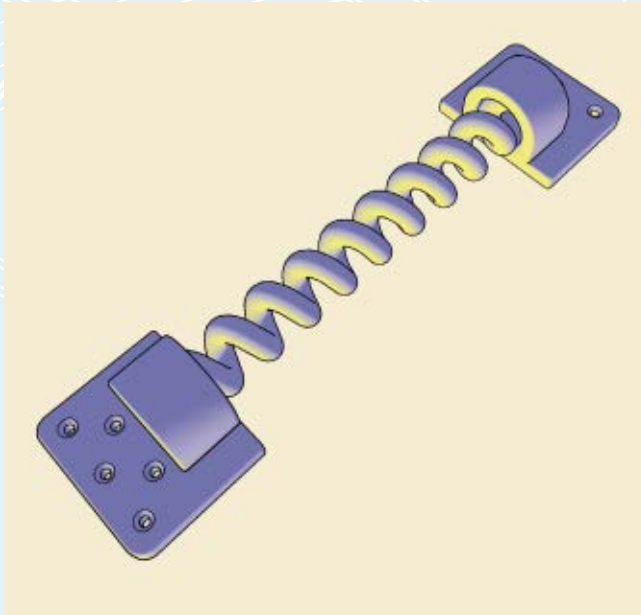


FIGURE 1 This model of a spring has a simple Gooch shading applied, along with the edge detection techniques in this paper.

testing to see if the sign of the cosine of the angles between the face normals and view vector differ: $(N_1 \times V) \times (N_2 \times V) \leq 0$ (also see Figure 2).

After the silhouette edges are found with this technique, the edge flags are updated to label the edge as a silhouette edge. The next step is to detect crease edges by testing to see if the cosine of the angle between two adjacent triangles joined by the edge being tested is above a certain threshold. If an edge is detected as a crease edge, the edge flag is set to indicate this, testing with the equation: $|N_1 \times N_2| \leq \cos?$

To determine whether to draw or ink an edge, iterate over the edge list and render only the edges with the silhouette and/or crease edge flag set to true. The render state should be set up so that the line thickness is of a higher value than the default; so the edge is visible and of a visually appealing width.

This method requires a graphics API that allows line thickness to be set explicitly for visually appealing results. Unfortunately, it creates a challenge for game developers since Direct3D does not allow for the line thickness to be explicitly set by the application.

To get around this, a different technique was offered for Direct3D: programmable vertex shader inking. Shader inking is possible with both the Direct3D and OpenGL APIs and is dependent only on having a programmable vertex shader. The dot product of the vertex normal and the view vector are used to index into a one-dimensional texture, which then gives a varying thickness line around the model's silhouette edge.

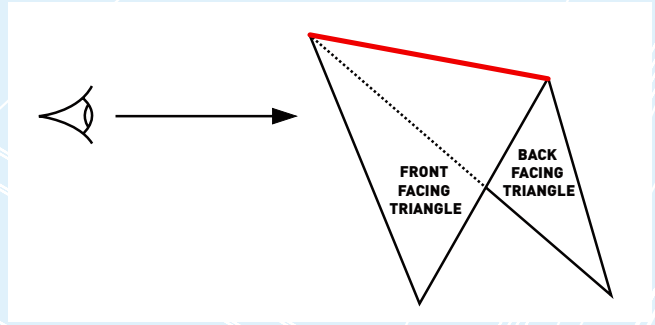


FIGURE 2 A silhouette edge is an edge shared by a front and back facing polygon.

This technique is fast, as it runs entirely on the graphics card (see Marshall in References), and it offers some stylization of the lines as the polygons on the edge show varying thickness along the silhouettes, depending on the polygon's angle with respect to the view vector.

Unfortunately, using shader inking has at least three drawbacks. For one, it uses only the vertex normal. Second, it can miss certain silhouette edges. And third, the varying edge thickness is very difficult to control.

IMPLEMENTATION IN DIRECTX 10

Since DirectX 10 got its geometry shader, programmers are able to calculate face normals on the GPU, allowing for accurate detection methods for both silhouette and crease edges without the preprocessing step and the bus overhead resulting from frequent CPU to GPU communication. Nvidia devised this application and presented it at Siggraph 2006 (see Tariq in References) with respect to detecting and extruding silhouette edges. Here, we will output new geometry for the edges, applying strict control over their thicknesses (see Figure 3).

The first step is to create a mesh with adjacency information. This is done by creating a vertex buffer with three vertices per

LISTING 1

```
float3 faceNormal = normalize(cross(
inputVertex[2].position - inputVertex[0].position,
inputVertex[4].position - inputVertex[0].position
));

float3 viewDirection = -inputVertex[0].position;

float dotView = dot(faceNormal, viewDirection);

if(dotView < 0)
//The triangle is front-facing, check to see if it contains a
//silhouette edge.
```

The HLSL implementation of the front facing triangle test is shown.

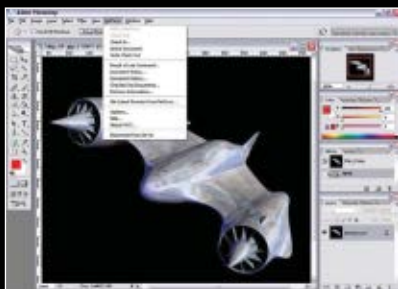


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primitive, and then creating an index buffer containing the adjacent vertices in the proper winding order. The primitive-type triangle with adjacency must be declared in both the host code and the geometry shader constructor. As a result, the geometry shader gets access to vertex information from three triangles: the primary triangle, and the three adjacent triangles for a total of six vertices.

With this information we should test the primary triangle to see if it's front-facing by calculating the dot product of the face normal and the view direction. If the result is less than zero, we have a front-facing triangle and need to check whether it contains a silhouette edge (see Gooch et al. in

References). This test is performed in world space coordinates. (See Listing 1.)

We test the three vertices containing an adjacent triangle with the shared edge by taking the dot product of the adjacent triangle's face normal and the view direction. If the result is greater than or equal to zero, we have a silhouette edge. To detect a crease edge, we simply calculate the dot product of the primary triangle's face normal with each adjacent triangle's face normal. If the result is less than an application defined threshold value, we have a crease edge.

Once we know we have an edge, we need to create the extruded geometry. We do this by creating fins in the direction of the normal of an application-specified constant thickness, then loop twice over each vertex, and simply replicate the vertex and transform it in the direction of the normal vector for each vertex that exists as a point along the silhouette edge. (See Listing 2.)

LISTING 2

```
//The face normal of each adjacent triangle is calculated in
//order to test whether it contains the adjacent edge. The
//prefix vs designates view space coordinates, the prefix ws
//indicates world space coordinates and the prefix ps //indicates
//perspective correct world view space //coordinates.

float3 wsAdjFaceNormal =
normalize(
cross(normalize(vertA.wsPos - vertC.wsPos),
normalize(vertB.wsPos-vertC.wsPos)));

float dotView =
dot(wsAdjFaceNormal, vertA.wsView);

if(dotView >= 0.0)
{
for(int v = 0; v < 2; v++)
{
float4 wsPos = vertB.wsPos +
v * float4(vertB.wsNorm,0) * g_fEdgeLength;
float4 vsPos = mul(wsPos, g_mView);
output.psPos = mul(vsPos, g_mProjection);
output.wsNorm = vertB.wsNorm;
output.EdgeFlag = SILHOUETTE_EDGE;
Stream.Append(output);
}
for(int v = 0; v < 2; v++)
{
float4 wsPos = vertC.wsPos +
v * float4(vertC.wsNorm,0) * g_fEdgeLength;
float4 vsPos = mul(wsPosition, g_mView);
output.psPos = mul(vsPosition, g_mProjection);
output.wsNorm = vertC.wsNormal;
output.EdgeFlag = SILHOUETTE_EDGE;
Stream.Append(output);
}
Stream.RestartStrip();
}
```

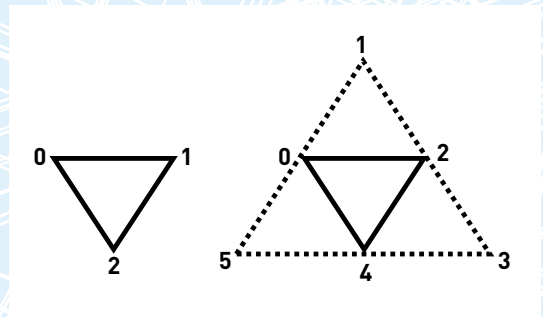


FIGURE 3 The HLSL implementation of the detection and extrusion algorithm for silhouette edges is shown.

LISTING 3

```
for(int v = 0; v < 2; v++)
{
float4 wsPosition = Vertex.wsPosition +
v * float4(Vertex.wsNormal,0) * EdgeLength;

float4 vsPosition = mul(wsPosition, WorldToView);
vsPosition.z -= ZBiasEpsilon;
output.psPosition = mul(vsPosition,
ViewToProjection);
output.wsNormal = vertB.wsNormal;
output.EdgeFlag = CREASE_EDGE;
Stream.Append(output);
}
```

The creation of the crease edge geometry takes into account the epsilon value to z-bias the geometry and eliminate z-fighting.

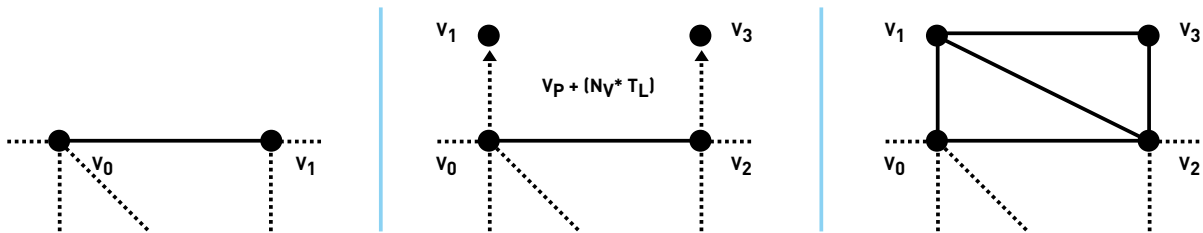


FIGURE 4 The three steps in the extrusion of an important edge: identify the edge itself (left); walk the vertices and output one in the original position and another in the direction of the normal a distance T as defined by the user (middle); and create new geometry (right).

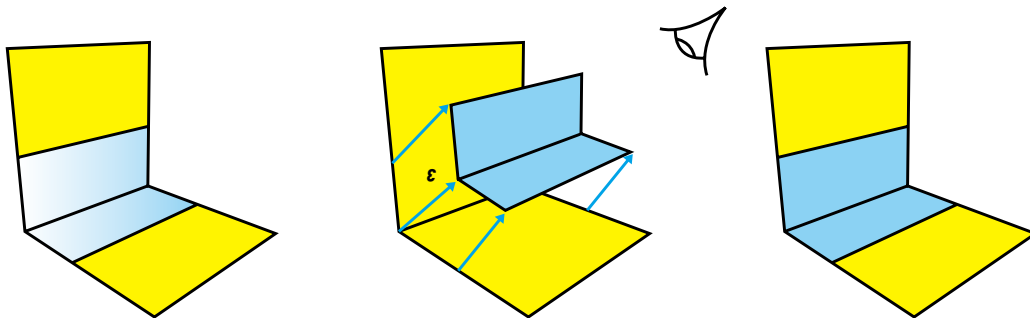


FIGURE 5 Coplanar geometry drawn in a second pass results in z-fighting. To address this we transform the vertices a small distance ϵ toward the viewer (exaggerated in figure for illustrative purposes) giving a much more visually appealing result.

A crease edge can be either a ridge or valley edge. A ridge edge has an angle between the face normals that is either equal to or greater than 180 degrees, while a valley edge has an angle less than 180 degrees. Since we extrude along the vertex normal, z-fighting may occur when we have valley edge with an angle near 90 degrees because the vertex normal in this case is coplanar with the face of the adjacent triangle. In order to solve this problem, we apply a z-bias to the affected edge by transforming the geometry a distance ϵ in the direction of the camera. [See Listing 3.]

The final step is to designate an edge type similar to the edge flag described earlier, by setting an enumeration in the pixel shader input struct stating the edge type. This will enable us to color the edge and allows for explicit stylization and lighting based on edge type (see Figures 4 and 5).

RESULTS

The choice to extrude geometry in the direction of the vertex normal gives a visually appealing silhouette edge in most cases. However, there is a visible gap if the model causes abrupt changes in the direction of extrusion when walking the vertices as they near a hard edge.

A hard edge is an edge where the triangles forming the edge share vertices with orthogonal normals. For example, a cube contains hard edges along its entire silhouette. A visual gap is

noticeable at the transition point where the geometry changes from a silhouette edge (which is not also a hard edge), to a silhouette edge (which is a hard edge).

If a hard edge is present and inked as well, it occludes the transition point in most views. In practice, this visual gap is

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INKING THE CUBE



FIGURE 6 Increasing the line thickness increases the visible gap as the coincident vertex of a hard edge abruptly changes direction.

likely to be of little importance since both crease edges and silhouette edges are inked in most non-photorealistic rendering applications. The gap effect increases as the line thickness increases—it's not visible when the line is of typical thickness but is quite obvious when the thickness is large (see Figure 6).

Aligning the fins to be perpendicular to the eye, instead of extruding along the normal, should also hide the discontinuity, although it would introduce z-fighting since there's no guarantee the silhouette would be rendered on a different plane than the geometry. One way to handle this predicament is to bias the z component of the silhouette's vertex position by a factor epsilon.

FUTURE WORK

It may also be worthwhile to explore implementing a more complex edge constructed as a closed manifold surface. While this would take significantly more resources, seeing as the amount of additional geometry required would increase greatly, it would allow for very complex stylization of the edges.

Silhouette and crease edge detection and extrusion on the GPU gives us several possibilities for future work. Stylizing the edges so they look similar to edges drawn by a human artist could also be possible within the geometry shader. It's possible to do some quick real time edge stylization by biasing the extrusion direction or applying texture maps to the new geometry, but more advanced techniques could also be used in order to create stroke styles, ink styles, varying width, "shock" silhouettes, "dashed" silhouettes, "shattering" silhouettes, and other techniques in real time with DirectX 10 using the new capabilities of Direct3D 10 and Shader Model 4.0. ❖

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BIG HUGE GAMES' CATAN

FOR XBOX LIVE ARCADE



EARLY IN MAY 2006, MICROSOFT APPROACHED BIG HUGE Games with what at the time seemed a completely ludicrous notion: Were we interested in developing an electronic version of the acclaimed board game Settlers of Catan for the Xbox 360, to be released on Xbox Live Arcade?

To understand why working on such a product seemed crazy to us, you have to realize that until that point, Big Huge Games was a company that had created nothing but massive real-time strategy games; in fact at the time Microsoft approached us, RISE OF LEGENDS had just gone gold.

Although we had talked about it, we had never made a console game of any kind. And just when we thought the project was as unfit for us as could be, there was this little financial term: no publisher advances whatsoever. For a company that had for years lived on its publisher advance checks, it all seemed off the wall.

We were aghast at ourselves for considering the offer seriously at all—taking on a game in a new-to-us genre, on a new-to-us platform, using a new-to-everyone distribution model. We were expected to self-fund the project using our own all-too-scarce corporate savings—and if that's not the definition of corporate suicide, it's at least one of the important case studies.

The icing on the cake was that, according to Microsoft (in an, "Oh, by the way ..." kind of clause), the IP holders are very particular about the way they want the artificial intelligence for the game to be done, and they want to sign off on it.

We came to our senses and realized this was one project we were going to have to turn down. We were set to call Microsoft the next day and tell them we weren't interested. Except, what we actually did was return the following day to start working on a pitch to show Microsoft and Catan GmbH at E3 the next week.

What changed was that we realized what a great opportunity CATAN really could be for us, and that we were at a good place in time to try something totally new. We had discussed for years how important it was for us, strategically speaking, to add console games to our range of work. But it can be pretty hard to land a triple-A console contract if you aren't already a veteran console developer. Now that we had an opening, it would have been foolish to pass it up. In a similar vein we desperately needed to port our engine from the PC to the Xbox 360, and a mini-project like this let us do it while partially offsetting some of those costs.

WHAT WENT RIGHT

1 FAMILIARITY WITH THE LICENSE. We were familiar with the Settlers of Catan license and knew that it had all the elements of a gateway game, meaning it can attract both hardcore and casual players alike. New players are able to learn the game quickly and easily, so they can begin having fun almost immediately. At the same time, experienced players know that the game holds great depth and replay-ability. (For more on diversifying a player base, see Richard Garfield's "Getting Lucky," *Game Developer*, November 2006.)

BRIAN REYNOLDS

is the CEO of Big Huge Games. You can reach him at breynolds@gdmag.com.

CATAN



Just as important, several key members of our team were

intimately familiar with Catan. As project lead, I not only love the “Euro game” genre in general, but I play Settlers of Catan at the tournament level (I once brought home the first place trophy in a regional tournament). Since I’m also an experienced AI programmer, having written the AI for CIVILIZATION 2 and ALPHA CENTAURI, and substantially architected much of the AI for RISE OF NATIONS, this was a match made in heaven. We felt confident that we could create an AI that would keep players challenged. Between our programming experience and my specialized knowledge of the game (in terms of understanding pacing, rules, and which parts of the game players found the most fun), we felt like we had a substantial head start in terms of designing the user interface and managing the pace of play.

2 RELATIONSHIP WITH THE IP HOLDER. The game designer of the original Settlers of Catan board game, Klaus Teuber, had reportedly been thinking about an AI for the game. He had made “some Excel tables,” and, as the folks at Catan Gmbh explained it, would be happy to send them to us if we were

interested. We worried that this “suggestion” was the sound of the other shoe dropping.

Thankfully, when we opened the first document, it turned out to be a gold mine. It was the most detailed and complicated Excel spreadsheet we had ever seen. Apparently Teuber had put months of thought and all his experience with the franchise into developing a computer AI. He had scores of insightful ideas about how one might break down the problems of Catan into formulas and algorithms.

Overnight, one of our original fears about the project became one of its greatest triumphs. Those Excel tables saved us from reinventing the wheel, and we jumped straight to a mature stage of development on AI issues. We freed up extra bandwidth to make the hardest difficulty level of the AI extremely challenging and to add additional features, such as giving each of the different AI personas a unique personality.

At the same time, as fans of the game ourselves, it was quite a treat to exchange emails with Teuber on a weekly basis and discuss ways to improve the AI and present the game. When we sent him the first prototype, he replied, “Wow, it took me four games to beat it!” From that point, we knew everything was going to work out.

3 OVER-PREPARED GRAPHICS ENGINE. It’s no exaggeration to say that humming beneath the hood of CATAN is the graphics engine of a triple-A game. We literally took the same

GAME DATA

DEVELOPER
Big Huge Games

PUBLISHER
Microsoft

PLATFORM
Xbox 360 Live Arcade

RELEASE DATE
May 2, 2007

DEVELOPMENT TIME
1 year

PEAK NUMBER OF FULL-TIME DEVELOPERS
20

SOFTWARE USED
Microsoft Visual Studio 2005, Perforce, Visual SlickEdit 6.0, Altova XMLSpy 2005, 3ds Max
SIZE OF PROJECT
2,585 files; 777,426 lines of code; 69,376 lines of code outside of library level; 14,280 lines of code in catan.cpp in which the full prototype was originally written

engine that had powered all the graphics and special effects of *RISE OF LEGENDS* (a real-time strategy game with hundreds of units and thousands of polygons on the screen at a time and substantial cinematic sequences that are rendered at 30fps) and used it to power an Xbox Live Arcade version of a turn-based board game.

The Big Huge Engine was developed in house, so we incurred no licensing fees, and all the programmers were intimately familiar with its ins and outs. Our tools and art pipeline were already mature, too. We never had to question whether the graphics were going to run smoothly, which allowed us to concentrate on making the whole experience look crisp and run beautifully.



The User Test Lab at the University of Baltimore helped polish the interface of *CATAN*.

4 SHORTCUTS. To make an Xbox Live Arcade game in a very short time, we needed to devise some shortcuts to our typical work methodologies. As real-time strategy game developers, we've grown used to big budgets, big teams, and lots of logistical support from our publisher. At the same time, we had no user test lab, no usability engineer, and no way to recruit and screen participants.

In a twist of fate, the game's producer had not long before made contact with faculty at the University of Baltimore, where it turns out they had just built a brand new user test lab right in our hometown. So we cut them a deal: In exchange for letting us use the university's lab and students, the students would gain experience watching a user testing expert run real usability sessions.

Another key area where we economized was audio. We negotiated one substantial freebie when Microsoft agreed to let us use any sounds we liked from *RISE OF NATIONS* in *CATAN*. The sounds for *RISE OF NATIONS* were developed and recorded at a very high level of quality, and though you might not expect it, they turned out to be very appropriate for *CATAN*. They're zany and over-the-top and generally a lot of fun. We only had to make a few new sounds in house to account for missing elements. Fans of *RISE OF NATIONS* can listen and figure out which sounds in *CATAN* came from which places in *RISE OF NATIONS*!



5 LEARNING EXPERIENCE. We undertook the *CATAN* project partially as a way to learn the ropes of console development. We learned all sorts of lessons, both technical and otherwise, while producing this project. We learned more about working with the controller. We learned about resolution and color on different types of television sets. We learned how the Xbox Live matchmaking system works. We learned how to design console interfaces. And we learned about the certification process.

Indeed, one could say that our experience has already paid off many times over, because at the same time we were developing *CATAN*, we were pitching a full-sized console role-playing game to publishers. When the inevitable question, "What have you done on console?" came up, it was rewarding to have a positive experience to relate to them. Having *CATAN* under our belts was a definite confidence booster as we began building relationships with publishers. When we signed our big deal with THQ this year, it became clear that the fact that we took this first step into the console world on our own was a key element in convincing the publisher that we would be a good bet.

WHAT WENT WRONG

1 LACK OF LEADS. In our minds, *CATAN* was a small and informal project wedged between other major projects. Sometimes informality and smallness worked well for us, but in terms of managing the project, we could have used a lot more structure.

Our biggest mistake in this regard was failing to assign a full-time lead programmer or lead artist to the project. We assigned individual programmers and artists piecemeal and left them largely without much of the traditional guidance and oversight they would expect from a lead.

Not having a solid management structure meant that things tended to fall through the cracks. There was no one to set goals for the programming team or art group. There was no one to assert what needed to be done day to day, or week to week, or month to month. The employees sometimes drifted, unsure what they should work on next, spending too much time on assets that were unimportant, neglecting elements of the game that were actually critical. And when a new problem or deadline appeared, there was no leadership group to assess the situation and make assignment changes.

2 TECHNICAL DIFFICULTIES. Since we were obviously doing everything we could to economize on costs, we took a somewhat informal approach to developing the code for *CATAN*. We didn't lay careful plans and then develop a *CATAN* "engine"—we just threw stuff together as quickly as possible to make the game work. Not that we were sloppy; we're experienced professionals! But our strategy was definitely keep it simple and make it quick.

This informal approach to game coding caused substantial problems when it came to implementing a stable multiplayer version of the game. The fast and loose code structure didn't lend itself well to standard multiplayer approaches and made debugging the problem cases extremely difficult. There were too many discrete places the game needed to call into the network code to allow messages to be processed, and this made it too easy for the haphazard real-world timing of the internet to disrupt the delicate synchronization between the different players' machines.

Likewise, these timing issues were very hard to reproduce in a debugging situation, and we eventually had to stop and write a special I/O replay tool that could precisely record and accurately

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recreate all the real-world timing events of a game when played back on a debugging machine.

3 UNDERDEVELOPED PROJECT SCHEDULE. I know, I know. We were working in a new genre on a new platform—surely we planned for some extra time! The answer is we did plan extra time, just not nearly enough. We actually made very good estimates about how long it would take to create most of the key components: game rules, AI, interface, artwork. However, we substantially underestimated how long it would take to stabilize the multiplayer component. Likewise, our engine port turned out to take considerably more effort than we'd really planned. The problems we encountered with the publisher's pipeline and then in the test and certification process (see points 4 and 5 below) each contributed in their own way to drawing out the process months longer than we had planned.

4 XBOX LIVE ARCADE PIPELINE. When Xbox Live Arcade first debuted, its success exceeded far beyond anyone's initial expectations. The world watched as the first few notable games, such as *GEOMETRY WARS*, hit the system and unexpectedly became wildly popular. Suddenly, everyone wanted a piece of the Live Arcade action, and the tiny team within Microsoft was so swamped with so much new content, they just couldn't push it all through the pipeline with the manpower and resources they had.

From our perspective, getting through the Live Arcade production pipeline in 2006 was completely hectic. This manpower and resource shortage facing the Live Arcade group inevitably created bottlenecks in our development process. At one point, we shipped our first attempt at a code complete milestone build, only to find out that no one had yet run a milestone acceptance test on our previous submission, the alpha build. Because our contract with the external testing company specified that they wouldn't start testing until the alpha build had been accepted, we were stuck making builds with no way to test them!

Similar problems cropped up throughout the development process. For example—and this may be the most egregious example—we didn't have a signed publishing contract for *CATAN* until the week before we went into final certification. It was literally the deadline of final certification that ultimately got the contract through the legal process. I'm pretty sure the declaration "Never work on a game until you have a contract" is a hard and fast rule, but if we had followed it, we literally would have never even gotten started on *CATAN*.

In the end, we were reasonably confident that Microsoft wanted the product, and because we weren't getting any advance checks from them anyway, we took a leap of faith and essentially completed nearly the entire product with no paperwork at all.

5 TEST AND CERTIFICATION WAKE-UP CALL. The certification process is a well-known and significant rite of passage for console developers. As newbies to the console world, we



Without assigned leads, the development team wandered in the wilderness a bit.

approached it with carefully measured trepidation. We wanted to test our game very thoroughly before entering certification, so we hired an external testing company for this purpose. Still, we were aware that we were entering somewhat unknown territory.

One of the larger problems occurred in the late stages of our testing process. As the bug list trickled down to those last few TCR failures, a combination of time zone issues and testing methodology conspired to significantly push back our schedule. Since Big Huge Games is located on the East coast and our testing company was on the West coast, there was a three-hour time difference. To work most effectively, we used the early part of our day to complete a new build, and sent it to them so they could spend the later part of their day testing and validating.

The problem is, if the testers ran into a TCR failing bug, they immediately stopped testing that build! Instead of continuing to test for more issues in that build, they simply failed the build, sent a note asking us for a new build, and moved on to other projects. But of course, it was three hours later on the East coast, and had all gone home for the evening, which meant we didn't find out that the build failed until the following morning. Also, because the testers stopped testing after they found one failure case, we had no way of knowing whether there were more failure cases in the same build. Needless to say, this was a very frustrating problem, which probably added a couple weeks at least to our final testing phase.

SEIZE THE DAY

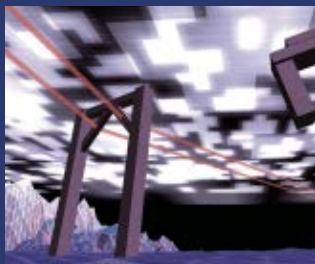
CATAN was an exciting opportunity for us that came along when we happened to have some money and time available. It was refreshing for the team to spend a few months working on a new type of game, and it has been invaluable to our company in gaining critical console experience.

We tried to bring all our love for the original board game to bear on the electronic version, and we think we've delivered an extremely high quality product that will stand out crisply on the Xbox Live Arcade platform. We're clearly beneficiaries of having landed an excellent license, and the friendly collaborative relationship we developed with the IP holder paid huge dividends for everyone concerned. We brought some great technology to the table, and we thoroughly accomplished our strategic goal of porting our engine to the console and gaining console experience. ❖





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- The Rapidly Maturing Genre of Online Gaming, Richard Garriott, NCsoft



DESIGN

- Emerging Issues in Games Design Masterclass, Ernest Adams
- Level Design – Managing the "big picture", Pascal Luban, Game Design Studio



PRODUCTION

- Production Masterclass, Don Daglow, Stormfront
- Revitalization of Middleware, Mike Gamble, Instinct Technology and Paul Kruszewsk, Engenuity



CODING

- Crowd Control: Production Pipeline for MotoGP07, Matt Rubin, Climax Racing, Disney Interactive
- Physics in Alan Wake, Petteri Salo, Remedy



BUSINESS

- Risky Business – Managing Risk in Business, Vincent Scheurer, Sarassin LLP
- Small Developers Survival Guide Masterclass, Mark Morris, Introversion Software and Andrew Eades, Relentless Software



ART

- Textures and Filters in the HD Era, Beverley Bright, Bizarre Creations
- Viva Pinata: Visual Style and the Creative Spark, Ryan Stevenson, Rare



AUDIO

- Surrounded – NexGen Multi-channel Sound, Rik Ede, Gamesound
- Music For The Masses – a NexGen Music Composition & Production Masterclass, Richard Jacques



WORLD VISION

- Opinion Jam 2007, Ste Curran, Kuju Entertainment
- The Future of Game Work, Jason Della Rocca, IGDA

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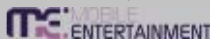
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BOOK REVIEW: SECOND PERSON

PAT HARRIGAN AND NOAH WARDRIP-FRUIIN, EDS.

AS A WORD OF ADVICE, WHEN

meeting a boyfriend's or girlfriend's parents for the first time, it's wise to stay away from the sticky subjects of art, politics, and religion. There are certain subjects that defy definition and unanimous agreement, and if the conversation ends up there, you know you're in for a long evening.

The topic of video game design falls squarely into that category: whether story is important to a video game, whether video game design is an art form, whether video games themselves can and should be studied and analyzed like DNA in a laboratory are all subjects ripe for heated discussion and debate.

Perhaps not surprisingly, the last is already a forgone conclusion. An emerging academic field, called ludology, analyzes video games from a social science and humanities perspective. The field of ludology invariably intertwines with the field of "narratology"—the analysis of the underlying structure of all narratives.

This leads to the main subject of a new book from The MIT Press called *Second Person*, edited by Pat Harrigan and Noah Wardrip-Fruin. The title comes from the "you" (the second-person point of view) that is the player in a video game as well as the person for whom the story is told. The book is a collection of articles by writers, scholars, artists, and game designers who examine story and role playing in various types of games, from tabletop role-playing games, to massively multiplayer games, to card games, and board games.

Researching the importance of story in video games, one discovers some interesting, extreme, and famous opinions. John Carmack, for example, the designer of *Doom* and *Quake*, is famously quoted as saying, "Story in a game is like



Second Person from The MIT Press [\$40].

story in a porn movie. It's expected to be there, but it's not that important."

A counterpoint to this view would be *Dungeons & Dragons*, the most role-playing and story-centric game of them all. Thirty-one years after its invention, *Dungeons & Dragons* is arguably the most popular and financially successful brand on the traditional game market today, and the story is the game.

Clearly, there's a range of successful games that cover the entire spectrum of story and role-playing. To argue that story is important or story is not important in video games is a moot discussion, on par with art, politics, and religion—and thankfully, that's not what *Second Person* tries to do.

The book is not 100 percent a how-to guide for designing better video games, but rather is a thought-provoker, spanning both the theoretical and the practical.

One memorable chapter is one in which Jordan Mechner recounts making Ubisoft's *Prince of Persia: The Sands of*

Review by Bijan Forutanpour

TIME. He shares both the technical and creative process of crafting the story and narrative elements. The chapter includes some great game design advice and 10 strict rules Ubisoft applied in making the game. Some of the more pertinent rules are:

- keep cinematic cut scenes brief, well-written, and tightly edited.
- story is important, but it is not king.
- gameplay is king, and story is only meant to support it.
- keep the story simple.
- screenwriting must be like programming: "Efficiency is a cardinal virtue."

Other contributors to the book include Greg Costikyan (Manifesto Games), Jane McGonigal (ILOVEBEEES), and Chris Crawford [organizer of the first Computer Game Developers' Conference, which later became the GDC].

For readers interested in a more academic study of video and non-video games and interactive fiction, *Second Person* is a must-read. For game industry professionals, the book is not for everyone, but it does contain very interesting chapters that may serve as little more than food for thought. ❖

BIJAN FORUTANPOUR is a senior graphics programmer who has worked in the visual effects and game industries for 12 years, four of them specifically in video games. When he's not writing graphics code, he's thinking about writing graphics code. Email him at bforutanpour@gdmag.com.

BOOK REVIEW



STATS

The MIT Press

Second Person: Role-Playing and Story in Games and Playable Media

Edited by Pat Harrigan and Noah Wardrip-Fruin
March 2007
408 pp.

\$40.00 (cloth)

ISBN: 0-262-08356-6

product news.....

PARTICLEILLUSION 3.0.5

FOR MAC OS X

WONDERTOUCH

Wondertouch recently released a universal binary version of its particle effects application, ParticleIllusion 3.0, for Mac OS X. ParticleIllusion is used predominately by artists and computer-graphics animators to simulate smoke, dust, and other particle-based effects. The new release is a free update that runs natively on both Intel- and Power PC-based Mac computers.

www.wondertouch.com

HYDROENGINE

BLADE INTERACTIVE

The HydroEngine, from Manchester, U.K.-based Blade Interactive, is a new fluid dynamics engine for games, which will be featured in the upcoming PlayStation 3 and Xbox 360 title HYDROPHOBIA. Blade Interactive is calling its system "a physically accurate real-time fluid dynamics engine for games development." Emphasizing the flow of water rather than just surface effects, the HydroEngine can simulate the mass movement of liquid. A splashing video demonstration is available on YouTube, and more information can be found on the company's web site.

www.bladeinteractive.com

MX-F40 AND MX-F20 WITH VICON VEGAS SENSOR

VICON

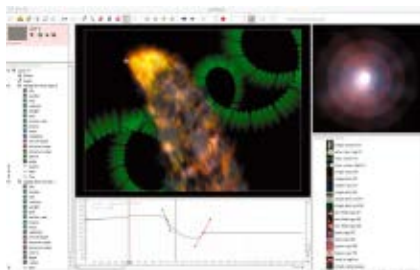
Motion-capture services provider and camera company Vicon released news in April for a new component called the Vicon Vegas Sensor. Billed as "the world's first camera sensors designed specifically for motion capture," the Vegas Sensors will be included in Vicon's new MX-F40 and MX-F20 cameras, which are designed specifically for motion capture purposes due to their extremely fast shutter speed. The MX-F40 can capture 370fps at a pixel resolution of 4 million, while the MX-F20 can capture up to 500fps at a pixel resolution of 2 million.

www.vicon.com

QA WIZARD PRO 2007

SEAPINE SOFTWARE

Seapine Software has a new automated software-testing tool called QA Wizard Pro 2007. The product, an "application lifecycle management" solution, is a fully revised version of its predecessor (QA Wizard 4) rather than an updated point release. QA Wizard Pro 2007 aims to enable QA teams to test more of an application



Particleillusions' particle effects solution is now available for Mac OS X.

and test it more thoroughly, while decreasing the amount of time spent doing so. Product highlights include better debugging capabilities, a powerful scripting language, a global application repository for sharing test assets, support for remotely running scripts, and dual mode script editing. Owners of the QA Wizard 4 software who are on current maintenance contracts will receive QA Wizard Pro 2007 at no charge.

www.seapine.com/qawizard.html

BORIS BLUE 2.0

BORIS FX

In April, Boris FX, an integrated effects technology developer primarily in the video and film space, announced Boris Blue 2.0. The tool is a real-time motion graphics application that now supports Avid (known best among video game developers for its Softimage XSI) plug-ins, meaning Avid users now have access to an OpenGL hardware rendering solution. Version 2 also adds new features for composing effects in 3D and new deformers and filters. Nvidia hardware, which sits behind the Boris Blue design, helps to keep the system running at high performance. Boris Blue 2.0 is available for \$995.

www.borisfx.com

TIRA JUMP 2007 PLATFORM

TIRA WIRELESS

Mobile market technology and services provider Tira Wireless in May released an updated version of its Jump platform, a system used for porting games across a variety of handsets. By enabling code re-use and other enhancements, the upgrades to the Jump platform primarily focus on increased productivity, particularly for Java and Java Micro Edition content development and deployment.

www.tirawireless.com

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» GAME SHUI

REFLEXES AND REFLECTION

TO PLAY A GAME MEANS TO OVERCOME A series of challenges. The skills needed to master those challenges fall into two general categories: reflexes (success through action by perfecting split-second timing and reacting to threats immediately without conscious thought) and reflection (skills involving strategy, planning, and at their extreme, deep and systematic contemplation).

THE RULE

Balance the amounts of reflexes and reflection the player needs to succeed

in a game so that the two components complement and support each other.

The majority of successful games blend the two approaches. If you want to reach a wide audience it's a good idea to

allow the player to succeed through at least a reasonable mastery of both skills while occasionally progressing using primarily one or the other.

THE DOMAIN

This is a game design process rule (or a "meta" rule), as well as a variety rule, concerning how much variation to allow in games.

EXAMPLES AND COUNTEREXAMPLES

Most RPGs achieve the balance required of this rule pretty well. A player who excels at hitting the right buttons quickly and moving fast can do well but will have to also solve some quests and plan to spend experience and loot on a balance of skills and helpful inventory items.

Platform games require not only good reflexes for timing jumps and shots, but also some strategy and tactics to pick the best path through the world. Action-adventure hybrids, such as *TOMB RAIDER*, also mix reflex play with reflective puzzling, and RTS games by their very definition balance the real-time action with thoughtful strategy.

But what about the extremes? If a game is primarily dependent on fast reflexes, the player should still be able to succeed with minimal strategic thought. Examples include fighting games like the *VIRTUA FIGHTER* or *MORTAL KOMBAT* series.

Conversely if you make a game that heavily emphasizes reflection, planning, and strategy, it should have little or no requirement for fast action. The *CIVILIZATION* series, other turn-based strategy games, and most classic adventure games as well as board games, such as chess and go, fall into this category, with the action component dropping all the way to zero (but more on that below).

TRUMPS

This is a rule that can be bent or broken in several ways without ruining the game it applies to. Some games incorporate sub-games that are all fast action or all strategy, and help to achieve balance in the main game. *WARIOWARE*, for instance, is made primarily of many little pure reflex games, but encourages a modest amount of reflection outside of them.

People also have a tendency to reflect about reflexes. Even with a physical fast action task, we may pause afterward to consider what we did right or wrong and

how to do it better next time. This happens often in the process of learning sports or martial arts and occurs in video games about them, too.

READER CHALLENGE

There's an interesting quirk in this rule that I'll pose as a challenge to you, readers.

Let's start with some simple math for a given game. If you rate the amount of reflex and reflection required to succeed on a scale of 1 to 10, the product of the two should logically be around 30. 5.5 is halfway between 1 and 10, and 5.5x5.5 is about 30. A balanced game would have each at around 5 or 6, and let a player who is better at one than the other use their best skill to their advantage.

The 30 rule-of-thumb holds if you have a heavy-duty action game that goes up to a 10 in reflexes, suggesting it should have about a 3 in reflection. Even a game like *VIRTUA FIGHTER*, which is heavily dependent on split-second reflexes, requires a modest amount of strategy and thought to make choices about the combination of moves or how to employ the strengths of one character against the weaknesses of another.

But this formula breaks down in the other direction. The heavy-duty strategy games like *CIVILIZATION* or chess require no fast reflexes at all, and their variations that have introduced it (like multiplayer *CIVILIZATION* or speed chess) appeal only to a relatively small subset of their pure-strategy devotees.

It seems that when you get far over in the direction of pure reflective and thoughtful play, the desirability of any reflex-based play drops to zero. There's no inherent reason the balance has to be symmetrical but I suspect that there's another trumping rule in action here that would explain why it's sometimes desirable to have pure strategy in a game, but not pure action. I'll publish any astute suggestions from readers in a future column. ❖



WARIOWARE has a balance of reflex and reflection.

NOAH FALSTEIN has been a professional game developer since 1980. His web site, www.theinspiarcy.com, has a description of *The 400 Project*, the basis for these columns. Also at that site is a list of the game design rules collected so far and tips on how to use them. Email him at nfalstein@gdmag.com.



STEVE THEODORE

PIXEL PUSHER

SLIP ME SOME SKIN

Skin shaders from subcutaneous to epidermal

HISTORICALLY, GAMES HAVE DONE A

lackluster job selling the physicality of living creatures. We game artists have always excelled at designing scary dragons, cute talking animals, and an endless succession of improbably endowed female heroines—but making them look *alive* has been a steep hill to climb.

The relentless march of rendering technology has made this fact inescapable. Once upon a time, a Gouraud-shaded Lara Croft looked at home in her pixelated, low poly world. But now that every rock has nice light mapping and every tree a detailed normal texture, having skin that shades like plastic suddenly seems awkwardly retro. So this month we're going to enter the greasy, blotchy world of skin shading for real-time graphics.

Skin shaders present two very different but also very intractable problems, one scientific and the other psychological. On the scientific physical side, skin is a very complex substance. It's a multilayered collage of fat, blood, specialized skin cells, and hair, each of which reacts to light in a different way. Light doesn't just bounce off skin; it bounces around inside it as well. While it's scooting around in there, the light also interacts with hidden features like bone and muscles, all of which adds up to a very challenging problem to solve in a few lines of HLSL.

Far tougher for the poor artist is the psychology of the audience. Typical video game players won't know if you've put

too few plasma conduits in a starship's ion manifold, but they do have a lifetime of experience looking at other human beings. Dr. Masahiro Mori's theory of The Uncanny Valley tells us that human beings are incredibly perceptive about images of other human beings, and that they're extremely critical of small mistakes (for more, see "Uncanny Valley," *Game Developer*, December 2004).

Audiences respond far better to a blatant cartoon than to a near-perfect but subliminally flawed image of a person. A tiny mistake in coloration that would be imperceptible on, say, a model of a car will be read as an off-putting skin condition when applied to a human.

HOW SKIN WORKS

Human skin is amazing stuff. For something that consists mostly of water, it's incredibly tough and flexible. Optically, it works almost like a layered Photoshop image. There are three distinct layers that filter and reflect incoming light in distinct ways. Skin color is a composite of all three working together. In case your memory of high school biology class has slipped, here's a quick refresher on the way skin works.

The outer layer is the epidermis. It's actually quite translucent. The color comes from a pigment called melanin that helps screen out harmful UV radiation. The melanin tints the light that passes through the epidermis to the deeper layers. The amount and type of melanin in the skin causes the most obvious differences in skin color between different ethnic groups.



FIGURE 1 Even with all the lighting removed, this image shows how the melanin pigment in the skin saturates and darkens contours.

The second layer is the dermis, a network of connective fibers and blood vessels. The blood vessels in this second layer also tinge the light that enters the skin. When you're excited or overheated, the blood vessels expand, causing a reddish flush in the skin. When you're frightened or cold or tired, the reddish tint is reduced and the skin is tinted by bluish, oxygen-depleted blood.

The bottom layer is the hypodermis, which consists mostly of fat. It's the final opaque backstop for any ray of light that enters the skin. By itself, this layer would be a pale yellow. It's this yellow hue interacting with the blue venal blood in the dermis that creates the greenish look of seasickness, a hangover, or the aftereffects of an 18-hour WORLD OF WARCRAFT raid.

STEVE THEODORE has been pushing pixels for more than a dozen years. His credits include *MECH COMMANDER*, *HALF-LIFE*, *TEAM FORTRESS*, and *COUNTER-STRIKE*. He's been a modeler, animator, and technical artist, as well as a frequent speaker at industry conferences. He's currently content-side technical director at Bungie Studios. Email him at stheodore@gdmag.com.

COLOR EFFECTS

The Photoshop-like layering of these three segments produces the skin's overall color (see Figure 1). The effect of melanin and blood on the skin color increases when seen at a low angle, since the light has to pass through more of the outer skin layers before it reflects off the hypodermis. This is why portraits with soft ambient light still show distinct modeling around the cheeks and nose—these areas are being seen at a low angle and the light is passing through a thicker slice of pigment before bouncing out again. See Figure 2.

Simulating melanin shading, which darkens and saturates the skin when viewed from a low angle, is pretty simple. For generic skin, you can simply blend between two colors using the viewing angle of the skin (or a “Fresnel falloff” in shader-speak). For more precise control, you could substitute a color ramp instead of a simple blend. The trick, of course, is to combine this effect with a texture map that contains hand painted details; in general, you could achieve a fair approximation just by multiplying your texture against a melanin color appropriate to your subject, which will darken and saturate as the skin faces away from the camera.

Even if you can't afford a separate tinting pass for your skin shader, understanding the effect is still handy. Since low-angle views become more saturated and redder, you can accentuate folds and wrinkles with a faint reddish blush without actually



FIGURE 2 Simple skin lighting: Light enters the skin and is reflected with tints from the epidermal melanin and blood vessels in the dermis.

painting in fake shading that would undercut nice normal-mapped lighting.

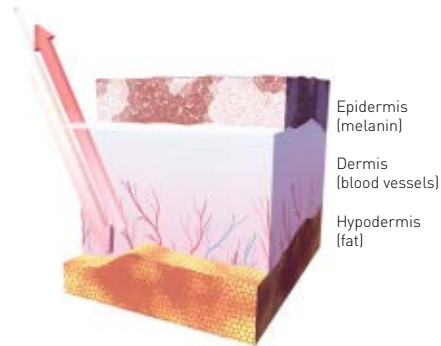
SSS

Sub-surface scattering (SSS) (see Figure 3) has been a buzzword since Nvidia's *Dawn* demo debuted in 2002. It's a fancy way of saying that some of the light bouncing around between the skin layers comes out elsewhere than it came in. This extra lighting is critical for capturing the soft, organic feel of living skin.

The cheap method is to treat the subsurface effect as a second diffuse lighting pass. Ordinary Lambert lighting falls off to nothing as incoming light approaches a 90-degree angle to the normal of the surface. For fake subsurface shading you can extend that falloff beyond 90 degrees, so that the light goes over the horizon (see Figure 4, page 32).

To keep from over-brightening or “blushing” the surface that faces the light, you'll need to subtract some of your subsurface color from the regular surface texture. Usually this means using a deep red or dark brown for the subsurface

FIGURE 3 Sub-surface scattering: Some light bounces around within the skin and emerges far from the point of entry, more heavily tinted by blood and skin pigments.



lighting and turning the surface skin texture slightly bluish. The subsurface lighting can also be masked with a texture that highlights especially translucent areas (the cheeks or ears, for example) and masks bonier, more opaque ones such as the forehead. The drawback to the over-the-horizon trick is that it doesn't automatically self-shadow. It typically catches a few faces on the model that ought not to be lighted at all.

A more correct method performs the extra lighting in a texture, rather than on the model's geometry. In this trick, you bake the lighted surface of the model into a temporary texture and then run something like a Photoshop Maximize followed by a blur on it using a pixel shader. When appropriately tinted and added back into the real surface texture, the blurred lightmap bleeds light outward along the surface of the model with a close approximation of the way light travels along real skin.

Unfortunately, this method is considerably more demanding because it forces an extra render pass and requires memory to store the temporary textures. It's probably a good choice for games with resources to spare and heavy focus on realistic characters.

If that's still not enough to keep your coders busy, you could point them at ATI's 2006 paper on “goeey material” shaders, which adds parallax maps to heighten the effect of peering into a translucent volume. (See Resources, page 32.)

SPECULARITY

If you went through puberty, you know that real skin is typically covered with a thin film of waxy oil, which adds a slight



FIGURE 4 This comparison between a standard Phong (left) and a skin shader (right) emphasizes how subsurface scattering softens the shading around the light horizon of an object.

specular reflection in addition to ruining teenage complexions. The intensity of the reflection varies a great deal with the density of oil glands, which anyone who survived high school will remember sadly tend to cluster in the infamous T-zone, the T-shaped area between the chin and the temples. However, skin always shows specular effects at glancing angles. Like clearcoat on a car, the skin oil is more reflective when viewed edge-on than when seen squarely.

Ideally, a skin shader will have separate specular passes, one for the simple sheen of oily skin and a separate pass for those low-angle grazing highlights beloved by cinematographers everywhere. If actually calculating the grazing light is too expensive, you can at least try adding a simple Fresnel backlight, preferably with some controls to handle the intensity and falloff of the extra lighting. In most cases, a pale blue backlight makes a decent stand-in for global ambient lighting.

Like the SSS hacks above, a Fresnel rimlight doesn't automatically self-shadow, so it will be inclined to pick up light where it shouldn't. A simple fix for faces is just to mask out problem areas like the wings of the nostrils, the inner ear, and the eye sockets with a texture.

SIMULATING SKIN

Even in a non-scientific outline, simulated skin has some pretty complex phenomena, and nobody has yet succeeded in "solving" them with a simple, fast, one-size-fits-all solution. As

usual, the "best" shader is the one that works best for the unique combination of artistic aims, gameplay, and runtime resources in your game.

As you look through the techniques named here (or elsewhere), pick the ones that serve your artistic goals and the needs of the game without worrying that you're doing it wrong. For the foreseeable future, all solutions to this problem are going to be inspired hacks rather than scientific solutions, so don't let fear of being inaccurate stop you from chasing the look you need.

In developing video games, the technology can let you do almost anything you could imagine—it's only those pesky details like time, manpower, and resources that get in the way. If you don't expect a lot of heavy duty coding support, you can still get past the worst last-gen looking plastic people with a little care.

Adding a very faint red or pink self-illumination to a standard Blinn or Phong type shading model goes a long way toward differentiating flesh from mechanical objects. If you can't get a fancy Fresnel term to support glancing specular highlights, try using a camera-space reflection map that's mostly black with a faint gray or cyan horizon around the outer edge. Slightly over-saturating the wrinkles and folds of a face can help to provide a little illusion of life as well.

While none of these tricks is going to turn heads at ILM, they're better than nothing and you can probably hack them in without any programmer time at all.

SKIN'S AWAY!

As we've noted often in the past, the endless torrent of cool new graphics technology is both a blessing and a curse for game artists. A new toy is a wonderful thing to play with, but as I sat up in the wee hours trying to make sense of my company's fancy new skin shader system, I couldn't completely suppress some nostalgia for the old days of tiny palletized textures and models with outlines jagged enough to cut your finger. When it seems like every pixel has been replaced by a slider or a checkbox, it's

easy to miss the immediacy and simplicity of the old ways.

Leaving aside for the moment the curious question of why artists who make their living on what everybody else thinks of as the outer frontiers of technological innovation have such strong Luddite genes, it's worth stopping to ask just what you get back for all the labor and mind-twisting jumps of perception you need to keep up with modern graphics.

If you need a short answer, it's simply "life." The life of a paid commercial artist has been surprisingly similar since the first Renaissance prince commissioned a portrait for PR purposes: to create a snapshot of a moment in time. Capturing the fleeting mood that defined a unique combination of space, light, and color is of course no picnic, but we can say that it's a fairly well understood problem.

The revolution we're living through today is that we no longer have to capture individual moments; we create entire worlds that play out before the viewer's eye. The process of capturing all of those possibilities—the dynamic interactions of characters, objects, lighting, effects, gameplay, and sound—won't let us rest on our laurels, or our pixels. ❖

RESOURCES

Joel Styles' web site
www.jistyles.com/main.php

ATI's paper on "Goopy Materials"
<http://ati.amd.com/developer/siggraph06/Oat-RenderingGoopyMaterials.pdf>

Nvidia's library of skin demos (particularly *Dawn* and *Adrienne*)
www.nzone.com/object/nzone_downloads_nvidia.html

Ben Cloward's web site
www.bencloward.com

Canfield Imaging Systems (maker of devices for dermatologists)
www.canfieldsci.com/FileLibrary/RBX%20tech%20overview-LoRz1.pdf



RANDOM SCATTERING

IN PROCEDURALLY GENERATED OR

procedurally augmented scenes, a common problem is how to scatter something around in a way that looks natural. For example, a landscape might have trees that are evenly scattered, either sparsely as on an African savanna or densely as in a forest. Also, trees are generally surrounded by other vegetation, which is also scattered.

Suppose you are tasked with developing algorithms to facilitate this scattering. This article looks at various approaches and problems you might encounter.

JUST RANDOM?

Let's say you take the simplest approach first. Given a number of trees and an area to put them in, simply scatter them randomly across that area. It's very easy to implement this to see how it looks. Just pick n random positions in a square. Figure 1 shows the result for a group of 110 objects, in this case, dots that represent individual trees. [To see the code used to generate the figures in this article, visit www.gdmag.com.]

Problems with this first solution are immediately apparent. Several of the dots on Figure 1 overlap, meaning the geometry of the trees would intersect. There is some strange clumping going on, with trees showing up in little lines of three or four. Then there are several wide-open spaces, and a few trees off by themselves. This might work for some odd species of plant, but it's not what we were going for.

We might at first assume that there's a problem with our random number generator. Why else would these strange clumps occur? Is the random

number generator tending to favor certain numbers? Unfortunately, it's not that simple.

This is what random numbers look like. If you pick a bunch of random numbers in a certain range, it's highly likely that some of the numbers will be close to each other. This is related to the birthday paradox: it only takes 23 people in a room for there to be an even chance of two people having the same birthday.

RANDOM NATURE

Consider what's actually being simulated. What does it look like and how has it arrived at this state? Can we model it using the underlying processes that occurred in nature? Or is it better to create some more abstract model simply based on our observations?

Let's first back up and think about what's happening.

Most plants grow from seeds. A seed falls on the ground, sprouts and grows, absorbing nutrients from the soil, air and sun. Where each seed falls will determine whether it survives. More mature plants that are nearby will compete for the available nutrients, sucking them away from the sprouting seeds. Mature plants can also block sunlight from seedlings and even reduce the quality of the air. Certain plants go further, releasing chemicals into the ground that inhibit the growth of other plants.

As a simplification, we can think of the area around a tree as having an exclusion zone, where other plants are not likely to survive. To implement this premise, we simply scatter the trees as before, but now for every tree that's placed, we check whether its location is too close to another tree. If it is, then we pick another spot and try that. If we can't find a spot after a number of attempts, we would declare the area full and stop trying. Figure 2 shows the results of this implementation using the same number of dots (trees) as Figure 1.

Figure 2 contains some very interesting differences. For example, the overlaps

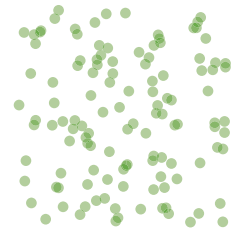


FIGURE 1 The green dots represent trees randomly scattered on a plane, viewed from above. Although the scattering is entirely random, it looks neither random nor natural.

and strange groupings have all but vanished. However, there are still a few open spaces with what look like paths leading through the forest. I suspect these are actually artifacts of the algorithm, with spaces of 1.5 times the minimum space being unlikely to be filled, and hence growing into these paths.

This solution might also have performance implications. Since we need to check every tree against every other tree, the naive algorithm is $O(n^2)$ complexity, which can become rather expensive. However, it's reasonably straightforward to optimize this with a bucket method, essentially reducing it to $O(n)$.

RANDOM COMPLICATIONS

This simple model works reasonably well, but the distribution is still patchy. What's going on? Well, obviously in real-life, trees do not have "kill zones" surrounding them. Rather they have something more like an inhibit field, where the successful growth of a tree is exponentially more unlikely the closer it is to other trees. The success of a tree is a function of the sum of all the other trees' inhibit fields at that point.

Secondly, trees don't grow one at a time in nature; they grow over the course of several years, with new trees germinating every year. Old trees die and

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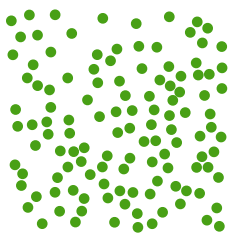


FIGURE 2 If a tree is too close to another tree in a randomly scattered pattern, we can move it elsewhere. Although the result is more natural looking, clumping can still occur, which may or may not be desirable.

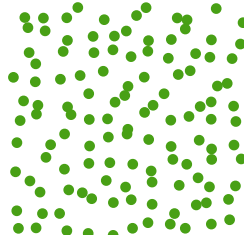


FIGURE 3 The trees here in this random perturbation-style scatter start off in a regular grid and are moved randomly by a small amount. The result is a very even distribution.

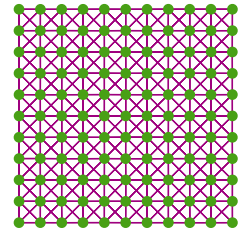


FIGURE 4 The spring mass system is shown here in its initial state. Each tree is connected to its neighbors by springs of random rest length.

open up space, which other trees then fill, competing for the space. Over many generations, this natural renewal of trees evens out the distribution, making it even and natural.

While natural tree distribution over the course of several decades is something we could simulate, this is for most games unrealistically expensive. We really don't want to be running a simulation of a forest ecosystem just so we can get an even distribution of trees. We need to look at creating a simple model of the results without regard for the underlying physical process.

TELEOLOGICAL VS. ONTOGENETIC

Two competing methodologies in procedural content generation are teleological and ontogenetic. The teleological approach creates an accurate physical model of the environment and

the process that creates the thing generated, and then simply runs the simulation, and the results should emerge as they do in nature.

The ontogenetic approach observes the end results of this process and then attempts to directly reproduce those results by ad hoc algorithms. Ontogenetic approaches are more commonly used in real-time applications such as games. (See "Shattering Reality," *Game Developer*, August 2006.)

Step back for a second. What we want are trees that are randomly scattered, not overlapping, yet still evenly distributed. What if we started off with the trees perfectly evenly distributed (say on a square grid), and then simply move each tree a random amount, but not so far that they can overlap?

This solution actually works quite well. If we spread the trees out on a grid with a distance D between each tree, and we move each tree in the x and y directions by a random amount between $-D*0.4$ and $D*0.4$, then we know no two trees can be closer than $D*0.2$. See Figure 3 and Listing 1, which contains the algorithm.

Figure 3 looks something like a cross between the pure random scatter and the minimum distance scatter. The trees are evenly distributed, but we still see some minor clumping, including two trees that overlap slightly. But overall this algorithm produces much nicer looking results than our first attempt, and it's simpler and cheaper to implement than the second.

It also has another advantage: It is repeatable. Repeatability is important in a spooling environment where you

want each patch of ground to look the same in the same location. When you see a couple of trees, then leave the location and return later, you would expect to see the same two trees in the same place. We can accomplish this in a game environment by using the low order bits of the original x, y position of the tree as a seed for your random number generator. This can then be used to generate both the positional offset and the full appearance (the geometry and textures) of our procedural tree. Thus any tree generated from that unique point will always visually be the same unique tree in the same place whenever you return to it.

MASS-SPRING SCATTERING

A common method in the literature of distributing objects in a non-overlapping manner is to essentially connect each object to its neighbors by a spring and then "relax" the positions of the objects so that the springs take care of the constraints and the factors influencing distance. Figures 4 through 6 show this process.

First in Figure 4, the trees are arranged in a regular grid with springs between them. Each spring has the same initial length (different for diagonals), but has a random rest length. The spring mass system is then iterated several times (40 times in this example; see Figure 5); we then remove the springs, leaving the trees in their final positions (Figure 6).

The relaxing method has a number of problems. For one, it's a more complex method to implement. Second, it requires tweaking to get good looking results.

LISTING 1

```
void CreateScatter(float x, float y, float w, float h, int rows, int cols)
{
    float xd = w/cols;
    float yd = h/rows;
    for (int ix = 0; ix < (cols+1); ix++) {
        for (int iy = 0; iy < (rows+1); iy++) {
            float p = 0.4f;
            CreatePoint( Vector2((x+xd*ix+rndf(-p,p)*xd,y+yd*iy+rndf(-p,p)*yd));
        }
    }
}
```

Scatter by random perturbation of point on a grid, as in Figure 3.

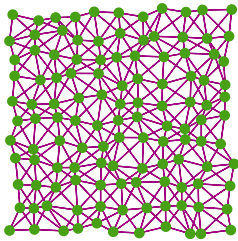


FIGURE 5 The spring mass system is shown after running 40 iterations.

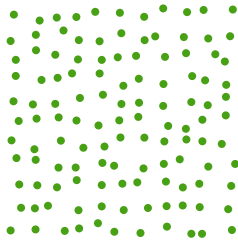


FIGURE 6 The tree distribution pattern from the spring mass system is shown with the springs removed.

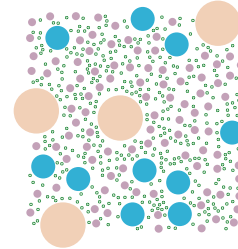


FIGURE 7 Random scattering is shown here with proximity constraints for four different sized objects.

Third, there are problems at the boundaries of the area we are trying to cover. Because the spring mass system's rest state is unlikely to be similar to the start state, the boundaries of the system end up either shrinking inward or expanding outward, unless the system wraps or additional constraints are added.

DIFFERENT SIZED TREES

So far, we've been trying to evenly scatter a bunch of identically sized objects. What if we want to have objects of differing sizes, with differing growth inhibit zones? The mass-spring system is not so suitable for this task, as it's not trivial to get an initial regularly spaced configuration (although it can be done). Instead, we could change to a particle system in which each object repels every other object according to some function of distance that is in keeping with their mutual zones of exclusion—and an additional constraint is applied to keep them all together. This is obviously an expensive operation, as it requires multiple iterations of $O(n^2)$.

Alternatively, we can go back to the random scattering method where we simply move the object to a new and random position if it gets too close to any other object. This approach requires essentially a single iteration of $O(n^2)$, since there are generally very few collisions. It can also be optimized much closer to $O(n)$ by using buckets for proximity, as mentioned earlier. Figure 7 shows the results of such an algorithm.

Of all these methods, only the random perturbation is trivially amenable to reproducible procedural landscape

generation in arbitrarily small amounts. Since the other methods need to generate a specific number of trees at once, you would need to fill an entire segment of the environment. To avoid visible boundaries between regions of trees, these segments should conform to natural boundaries within the environment, such as rivers or roads. Since simple positions are not very memory intensive, this method works well for large segments. It's also an ideal process to put on a low priority thread as part of a "procedural spooling" system [see "Procedural Spooling," *Game Developer*, February 2007].

THE FOREST, THE TREES

Random scattering in nature is not really random. A complex set of underlying rules governs the pattern, even if humans can only see the results as random; however, an image of pure mathematical randomness doesn't look "natural" at all.

Sometimes simple solutions work out better than complicated ones. In this case, to scatter a forest of trees, we found that applying a very simple exclusion zone around plants achieved a nice random distribution of different sized


plants. For most situations, this is reasonably quick and compares well to more complex solutions that involve relaxing spring systems. ❖

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» AURAL FIXATION

THE GOSPEL OF ATTENUATION

I'M AN EVANGELIST OF SORTS. FOR YEARS now, I've been waging my own one-man war against what I see as a major drawback to the vast majority of game audio engines: Far too many middleware and proprietary audio engines suffer from an extremely limited selection of fade shapes.

With the exception of dialogue and one-shot audio instances, most in-game audio undergoes either a fade or a crossfade in one form or another. More often than not, game audio engines only present audio implementers with a linear fade shape. Some of the less flexible engines go so far as to hard code a linear fade set to a specific time (such as one second) as the only available option for all fades within the game.

This is a tremendous disservice to anyone trying to create a rich and dynamic audio palette. For audio content authors, editable fade and crossfade shapes are indispensable tools inherent to every digital audio workstation. Pro Tools, Logic, and Cubase, and even some of the most basic shareware and freeware audio editing applications contain a choice when it comes to fade shapes. However, Audio Implementers have a whole different set of tools—such as Wwise, FMOD, Miles, and XACT—and these almost never offer anything other than a Linear fade shape for playing fades back within the game engine.

The solution is relatively simple and relatively light in terms of programmer work-hours, though. By expanding the

options to include two additional fade curves, audio implementers gain a great deal of flexibility and creative control.

LINEAR CURVES

The linear curve shape is the only fade curve that has a standardized name. It is without a doubt the most commonly used curve for fading or crossfading game audio. However, while it definitely has its uses, the linear curve can be clunky and fairly artless when implemented.

Linear fades work really well with either very short fades or very long fades. For any fade being measured on a scale of milliseconds, linear fades are great. Fades of that short a duration are too fast to necessitate any finesse in the shape of their curves. Linearity also works well for long fades, such as transitions between two different ambient sound effect loops as the player walks from one room to the next, or transitioning between segments of a vehicle's engine hum.

LOGARITHMIC CURVES

The logarithmic curve can also be called a convex log curve, a trigonometric curve, or Preset Curve 3 (according to Pro Tools' fade editor). Whatever its name, a logarithmic fade out curve attenuates slowly at first while performing a much steeper fade closer to the end of the process. The inverse is true for a logarithmic fade in.

When applying a linear fade to any audio file that already includes a natural fade in or out, a double fade will be applied to that file. Logarithmic curves are great for solving this problem. Natural reverb tails or music files that begin with glissandos or crescendos will all be unnaturally affected by the use of a linear fade curve. In this situation, logarithmic curves will retain much of the file's natural fade and create a much more realistic result. This can be particularly helpful when crossfading

between non-beat-based interactive music, such as orchestral or ambient electronica cues.

EXPONENTIAL CURVES

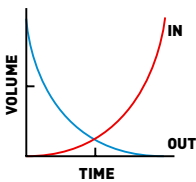
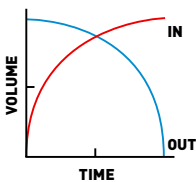
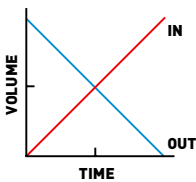
Like the logarithmic curve, the exponential curve suffers from a lack of standardized nomenclature. Exponential curve, concave logarithmic, and Pro Tools Preset Curve 5 all define the same fade shape. An exponential fade out is characterized by a rapid initial falloff of volume that gives way to a more gradual attenuation for the remainder of the fade's duration. Again, the inverse is true for an exponential fade in.

Using this fade shape for crossfades results in a large volume hole in the middle of the fade which is neither realistic nor all that useful in practice. But in order to find a very common and very helpful use for exponential fade curves, we only have to look as far as broadcast radio.

In radio, verbal banter from the DJs is constantly ducking the music bed and very often uses an exponential curve to do so. Lifting this concept directly from radio, we can use exponential curves for the ducking of music and sound effects when delivering critical in-game dialogue to the player. A specific fade volume percentage and time can be set globally for all ducking, and all critical dialogue subsequently benefits from smart implementation that gets distracting background noise out of its way.

FADED GLORY

Take the time to integrate a variety of fade shapes into your audio engines. Demand more from those in charge of coding your tools. Don't let the quality of your work's presentation be detracted by something as simple to fix and implement as fade options. In the end, you'll find new creative solutions to implementation issues that may have stumped or dissatisfied you in the past. ❧



From top to bottom: linear, logarithmic, and exponential curves are shown.

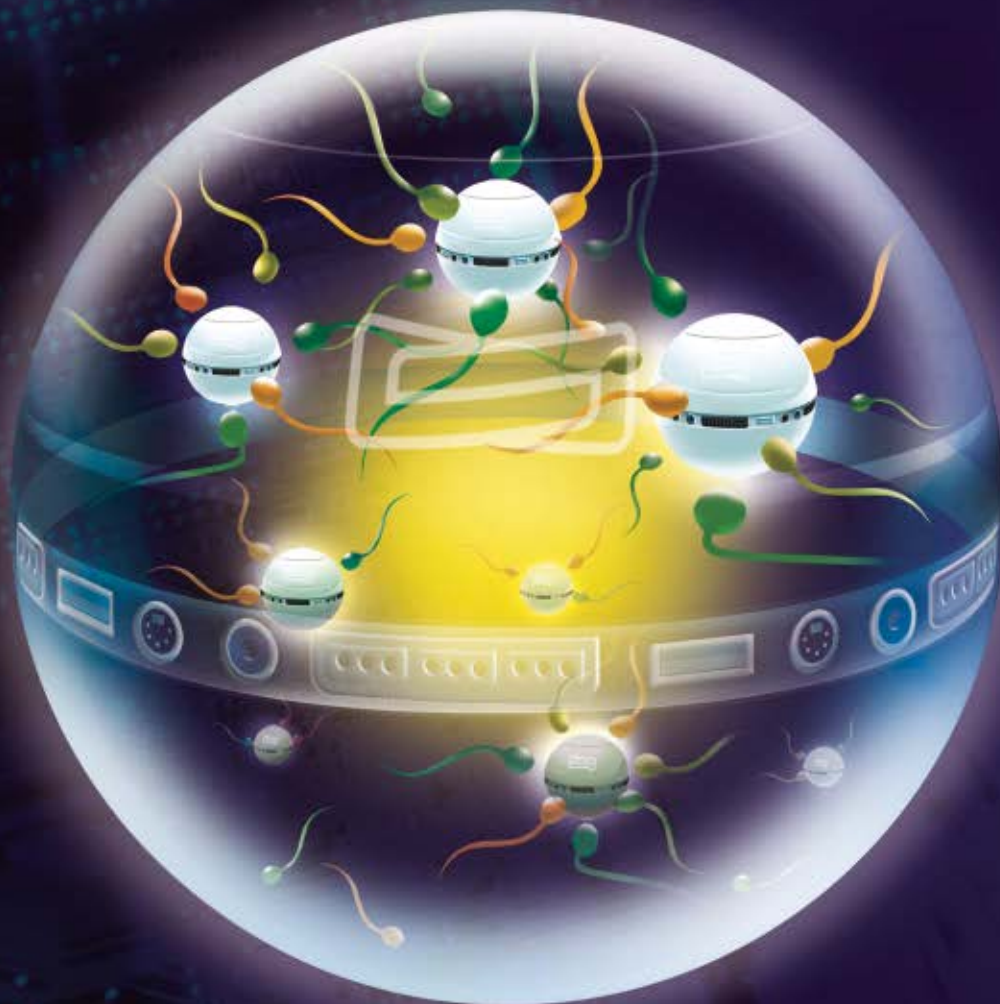
JESSE HARLIN has been composing music for games since 1999. He is currently the staff composer for LucasArts. You can email him at jharlin@gdmag.com.



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The DP600 integrates easily into an existing file-based network infrastructure. Once connected and configured, the DP600 becomes an intelligent processing node that can be easily adapted to day-to-day operations and work flow.

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Ease of Use

The DP600 and its processing engines can be controlled in three ways to suit specific user requirements.

- **Manual control:** Users can set up and initiate "processing jobs" on an individual or batch basis from a simple-to-use Web browser interface.
- **Third-party control via Web services:** To enable system integration at any level, the DP600's processing engines are also available as a set of Web services. This allows developers to integrate these engines directly into their work flow to create a seamless user experience without impacting day-to-day operations.
- **Automatic hot folder ingest process:** Users can create "hot folders" and predefine a work-order profile for each one. The profile governs the DP600's behavior with specific media types. All media files moved to a hot folder will be automatically processed based on the folder's profile and delivered to a user-defined folder upon completion. Hot folders are easy to set up and use and can greatly speed integration time within some facilities.

The DP600 will be available in summer 2007.

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Trinigy is known for excellent technical support and customer services. In order to further improve our services on the American market, Trinigy will be opening a US Office in San Francisco, CA in the second half of 2007. Daniel Conradie, one of the firm's founders and its current Director of Development, will be relocating to head the new office. TRINIGY US will be dedicated to provide highly competent, immediate support as well as customization services to American-based game developers and publishers.

Details will be announced soon – stay tuned.

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SpeqG™

**100 million
gaming phone alliance**

100 Million Gaming Phone Alliance

QUALCOMM has taken the lead in forming the 100 Million Gaming Phone Alliance, which brings wireless gaming industry leaders—mobile operators, device manufacturers, content developers and publishers—together to drive the development and adoption of high-performance 3D mobile gaming. Alliance partners collaborate to ensure high-volume, high-quality and cross-platform consistency for 3D mobile gaming worldwide.

Common Handset Specification to Drive Worldwide Growth of 3D Mobile Gaming

As the leader of the 100 Million Gaming Phone Alliance, QUALCOMM is directing the development and agreement of SpeqG, a standards-based, time-tested and widely adopted mobile device specification. The specification has been established to assist mobile operators and manufacturers in providing mobile devices that meet the expectations of developers and game consumers. The specification also suggests several areas where the minimum levels can be increased, leading to better performance and competitive advantage.

Over 40 commercial device models are already on the market meeting the core specification requirements. As Alliance members, content developers and publishers receive access to early documentation, development devices and tools, technical support and training, distribution of demo content and marketing opportunities.

Contributing to a Healthy Mobile Gaming Eco-System

Each sector of the mobile gaming industry plays a critical role in building a healthy and profitable marketplace for mobile gaming. Content providers create commercial titles tuned to take full advantage of the Alliance's specification for handsets. Mobile operators provide 3G networks and require handsets to comply with the Alliance specifications. Handset manufacturers deploy Alliance-compliant handsets that also incorporate gaming friendly features such as hardware-accelerated graphics, better form factors and consistent input functionality. To maximize these contributions, the Alliance encourages participation in joint marketing efforts such as preloading game content to stimulate consumer interest and providing demos of new applications like multi-player gaming.

Benefits for Members of the Alliance

Each member of the Alliance benefits through increased revenues driven both by increased consumer demand and greater efficiency in the development and deployment of content. Content providers enjoy a lower development cost per title per handset model. Mobile operators enjoy increasing demand for incremental services. And handset manufacturers deliver feature-rich differentiated devices with lower development costs and higher value to consumers.

Two Performance Tiers for Handset Devices

To assist alliance members in bringing new content to market that successfully targets deployed handsets, SpeqG outlines specifies two performance tiers:

Mainstream—for cost-effective, high quality interactive gaming and graphics application experience

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Learn more about the 100 Million Gaming Phone Alliance at www.SpeqG.com

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The Digital Game Expo Conference will be held at Wake Tech in Raleigh, NC, the southeast hub for game development! It's open to the

public and targeted toward all levels of Game Developers. The expo will feature top speakers and student development competitions. For more information, contact Walter Rotenberry at wrotenb@waketech.edu.

*This project is partially funded by the NSF DUE-0602801



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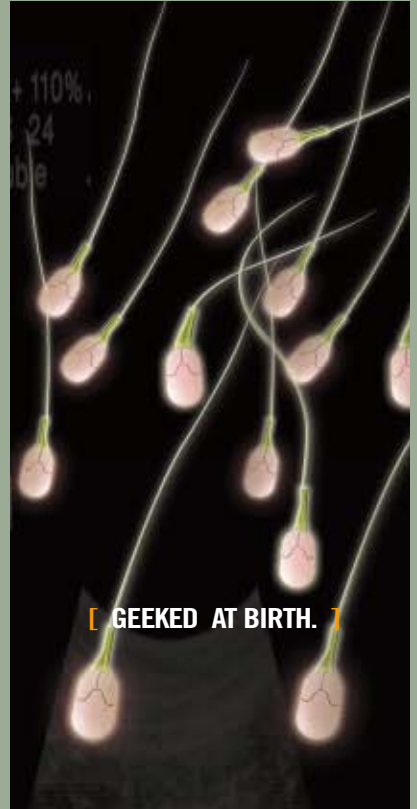
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The Collective Inc.	43	RAD Game Tools	C4
Critical Moves USA	6	RealNetworks Inc.	40
Develop	25	Replay Solutions LLC	C3
DigiPen	44	SGI	3
Dolby Laboratories	38	TechExcel Inc.	12
Electronic Arts	28	Trinigy GmbH	39
Epic Games	9	University of Advancing Technology	47
Full Sail Real World Education	46	Vancouver Film School	45
Gamecaster	28	Vicious Cycle Software	C2
Game Connection	37	Wake Tech Community College	43
HP	19	Xoreax Software Ltd	35

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» BUSINESS LEVEL

EXEMPTION CLAUSE GAP

AS ANY GAME STUDIO EXECUTIVE KNOWS, employment-related expenses make up the vast majority of their budgets. This expenditure comes down to paid hours, and it takes a lot of hours to develop a game. As such, it's virtually impossible to develop a game without requiring employees to work more than 40 hours per week during some of the development schedule. And unless those employees are exempt, they must be paid overtime, and overtime is extremely expensive.

CALIFORNIA EXEMPTIONS

Until recently, game companies in California were given very few overtime exemptions into which to classify their employees. Two major exemptions already existed (one for executives and one for administrative staff), but the vast majority of employees aren't executives or administrators. After these two, there's the so-called "professional" exemption.

The professional exemption contains two subcategories that, at first glance, seem applicable to many game studio employees—the "computer software" exemption and the "learned or artistic" exemption. Unfortunately, these exemptions are very fact-specific, making it risky for studios to classify employees as exempt despite the significant role that such employees play in the successful development of the game.

To properly classify employees at a game development house, executives need to understand the ins and outs of each categorization.

COMPUTER SOFTWARE EMPLOYEES

In California, in order to classify an employee as exempt under the computer software exemption, the employer has to be able to prove, first, that the job description meets the criteria for "computer software" classification, and second, that the employee's hourly rate of pay is not less than \$49.77 per hour for every hour worked in 2007 (with the hourly rate increasing on January 1 of each year). In a sense, this "exemption" is not really an exemption at all.

If the employee works 50 hours in a given week, the employer must show that the employee was paid at least \$2,488.50 for that week. If the employee's hours vary from week to week, the employer will have to predict accurately in advance what the average number of hours per week would be for that employee and ensure that the employee's salary is at least \$49.77 per hour, multiplied by the average number of hours. The employer cannot simply set the employee's salary at \$49.77 per hour, multiplied by 40 hours per week.

As a result, this exemption is really only applicable to highly compensated employees. For example, if an employee averages 50 hours of work per week, his or her annual salary would have to be set at \$129,402 or more in order to qualify for the computer software exemption. Simply put, that is too high a price to pay for many game development employers.

LEARNED OR ARTISTIC EMPLOYEES

For that reason, game studio executives in California often look to another aspect of the professional exemption—the learned or artistic exemption. Prior to late 2006, the California Department of Labor Standards Enforcement (DLSE) interpreted the learned or artistic

exemption to require that the "employee have an advanced degree above a B.A. or B.S. degree."

Given the nature of the video game industry, it is generally the case that game development employees do not have such advanced degrees. Therefore, game developers were unable to classify most of their employees as exempt under this rule, leaving them with no other option if the computer software exemption did not apply.

VIDEO GAMES AS ARTISTIC ENDEAVOR

This all changed in December 2006. At that time, the California DLSE changed its interpretation of the learned or artistic professional exemption to now only require that the employee have "advanced knowledge," which can come from post-high school education and/or work experience.

In addition, to qualify within the artistic professional exemption, the employee must be involved in work "that is original and creative in character in a recognized field of artistic endeavor ... which depends primarily on the invention, imagination, or talent of the employee."

In December 2006, the DLSE incorporated "newer evolving media such as music synthesizers and computer graphic and art design programs" into its working definition of "a recognized field of artistic endeavor." These two clarifications to the artistic professional exemption now make it easier for game developers to classify their employees as exempt.

If an employee who works in the game industry does work that is original and creative in character in a recognized field of artistic endeavor, which includes computer graphics and art design, and has advanced knowledge from post-high school education and/or prior work experience, then the employer may be able to classify that person as exempt. ❖

STEPHEN SMITH is the chairman of the litigation department at Greenberg Glusker in Los Angeles. He specializes in the representation of publishers and developers in the video game industry.

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