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## POSTMORTEM

### 20 ADVENT OF ADVERGAMING: BLITZ GAMES' BURGER KING GAMES

In a mere seven months, Blitz Games produced three small titles across two platforms (Xbox and Xbox 360) for restaurant giant Burger King. Burger King had very specific ideas in mind for *BIG BUMPIN'*, *POCKETBIKE RACER*, and *SNEAK KING*, ideas that Blitz didn't always agree would make for great gameplay. Senior designer Edward Linely shares how Blitz learned to work within some of these restrictions, while also learning a thing or two from the creative minds at Burger King.

By Edward Linely

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Two mid-level game developers walk into a bar. One makes about \$62,000 per year and the other cashes in only \$53,000. Which one is the designer and which is the artist? If you've ever wanted to sneak a peek at your colleagues' paychecks, now is your chance. In this sixth annual Salary Survey, *Game Developer* has collected and crunched the figures for you, comparing job titles, years of experience, education, location, bonuses, and other factors that affect a developer's pay.

By Jill Duffy

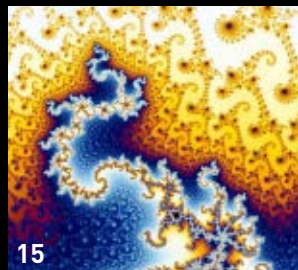


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### 15 OPTIMIZING CELL CODE

The Xbox 360 has six hardware execution threads running on PPU architecture. On the PlayStation 3, the Cell processor has two PPU execution threads and eight symmetric processing elements. With advancements in hardware this dramatic, clearly game developers need to rethink how they optimize code. In this case study, Martin Linklater of Sony Computer Entertainment Europe, Liverpool gets close to the metal with the PlayStation 3 Cell processor, examining how to best exploit the power of this parallel hardware.

By Martin Linklater



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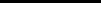
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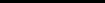
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## RISE OF THE GAME ENGINE

### REAL-TIME MIDDLEWARE IS REALLY STARTING TO

take off at all levels of the food chain, from AI through path finding to physics and beyond. The growth of middleware is significant for a multitude of reasons, but primarily, it's good news for developers because it takes a lot of the pain out of game development.

Within middleware, the most fascinating area to watch is the game engine market. As it turns out (in case you haven't heard), a great game engine is vital to next-gen game creation. The industry is getting really close to the stage where adapting the previous generation's engines to next-generation projects is simply too time-consuming, expensive, or risky for some developers and publishers.

### EPIC PROPORTION

To me, the biggest missed opportunity in the game tools market of the past few years has been the failure of any firm to keep up with Epic and Unreal Engine 3 in terms of next-gen engine licensing. Epic has created a tremendously high-end engine, as showcased in *GEARS OF WAR*, and its combination of graphic thrills and solid underlying technology has taken the business by storm. The company has proven the prestige of this engine in action and has made multi-SKU development relatively straightforward.

In fact, the latest announced Unreal Engine 3 licensing deal as of press time, as reported on sister web site *Gamasutra.com*, was for a North American-developed game by publisher Capcom, and referenced that the engine has been licensed by "Activision, Electronic Arts, Microsoft Game Studios, Atari, Real Time Worlds, Namco, Midway, Silicon Knights, VU Games, THQ, and Sony Online." And that's just the tip of the iceberg, to be honest. Epic's move to market dominance has been extremely impressive and aggressive.

### IN THE RING

But why, given that the Xbox 360 launched 18 months ago, have major competitors been so thin on the ground? I was actually asked to write a feature for *Official Xbox Magazine* earlier this year on that subject, and so I had a chance to investigate in a little more depth which third-party engines have formally announced that they are powering Xbox 360 games.

The total is surprisingly small. Emergent's *Gamebryo Element* is probably one of those closest to challenging the Unreal 3 Engine, with a heavily modified version powering Bethesda's *THE ELDER*

*SCROLLS IV: OBLIVION*. Buena Vista Games has also licensed Emergent's engine for next-gen consoles.

Another company that's attempting to move in on the space is Vicious Cycle with its in-house Vicious Engine. Vicious Cycle has been using the engine for PSP game development (*DEAD HEAD FRED*) and has made an initial thrust into the engine seller's market on this platform predominantly. But the company is now rapidly morphing the tool to also target next-generation consoles.

Valve's Source Engine now looks like it's being well tweaked for multi-SKU development, although the company's relatively recalcitrant nature means that, from my perspective, they're hardly out there looking for licensees in a front and center manner, preferring to license the engine to close partners and work on the actual game design with them.

There's also *GarageGames* (with *Torque*) and *BigWorld* (with its MMO engine technology), who are also ramping up notably, plus a number of others.

### YOU ARE YOUR TOOLS

The way I see it, most people who are making and selling game technology adopt the perception that working with a great engine puts developers most of the way to a producing a great game.

Given that, you need to be a dedicated, independent technologist to step back and realize that licensing your game engine is possibly even better business than just making a game. Epic, which is led by a technologically-oriented developer (Tim Sweeney) and some savvy business folks, is having its cake and eating it, too, by making a cutting-edge engine for its own games and licensing it at the same time. I believe that a lot of people have missed a big opportunity by not doing the same.

Then again, there's one major issue with game engines: "the RenderWare problem." Building one engine so deeply into a development process can be risky if the company in question is ripe to be purchased or potentially dwindle its support over time. Epic is such a large, historically independent, and relatively platform/company-agnostic developer that neither of these fates feels likely.

Maybe that's the implicit assurance that money can't buy. But change is inevitable, and I'm expecting to see much more investment and competition in this market in the near future. ❖



Simon Carless  
Editor-in-Chief

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**FRONTLINE**  
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## GDC IN QUOTES



### PHIL HARRISON

President, Sony Computer Entertainment Worldwide Studios, on whether Blu-ray is as important to the PlayStation 3 as DVD was to the PlayStation 2

#### I THINK BLU-RAY DISCS AS A MOVIE FORMAT IS VITAL

for PlayStation 3, but it's more necessary as a game format, as I've said many times. We need that extra space. [We] know from talking to developers what the demands are for storage space, and they are having to compromise on other systems in order to fit their games onto DVD. I think the difference between PlayStation 2 as a DVD player and PlayStation 3 as a Blu-ray player is—and I'm going to get shot for saying this—but with the PlayStation 2, we didn't make the best DVD player. For PlayStation 3, it's the best Blu-ray disc player. That's a big difference.

### JEFF MINTER

Founder, 25-year independent game developer Llamasoft, on an unusual game proposal

#### THE WEIRDEST REQUEST FOR MAKING GAMES I'VE EVER HAD IS I WAS

once asked by a research place at the University of Wales to develop video games for sheep. It was some study into the cognitive abilities of sheep, I guess. I couldn't take the job because I was busy with other stuff, though. The toughest part would have been figuring out what kind of interface we could use. There would probably be lots of "Avoid the barking dog."



### SHANE KIM

Corporate vice president, Microsoft Game Studios, on Microsoft's game efforts in Japan

#### WE NEED TO DO BETTER IN JAPAN FOR A COUPLE OF REASONS. ONE, IT'S A BIG MARKET. TWO, WE KNOW THAT IN ORDER TO DO MORE THERE, WE HAVE TO DEVELOP MORE

great Japanese content with great Japanese developers, which is why the partnership with [FINAL FANTASY creator] Hironobu Sakaguchi is so important. It's also really important to do well there because there are great Japanese developers there ... so DEAD RISING, LOST PLANET, and other titles that are coming over from Japan—I think other developers and publishers are looking at the success the 360 is having in the West, and realizing that it's an important business opportunity for them.

### TAKESHI SHIMADA

Manager of development support and platform software engineering, Nintendo, on Japan's late adoption of universal tools

#### THERE WAS A PERIOD WHEN WE WERE DEVELOPING MIDDLEWARE THAT

couldn't be used by all groups at Nintendo [including first and second parties], but over time we came to match other groups' workflows to be able to provide middleware and tools that fit into their workflows as well.

If you look at how tools are being utilized to get teams ahead, I do feel like the U.S. is a frontrunner in terms of tool development and matching the workflows of a variety of teams. I found that I had to develop these tools very flexibly. There were constant demands for different things from different teams that I had to take into account, so it was very much an evolutionary process to get to this point.

## CAPTURING MOTION, CAPTURING CHANGE

LATE LAST JULY, ONE OF THE biggest breakthroughs in motion-capture technology debuted at the annual Siggraph conference: a system that gathers intricate facial animation data without using any dot markers. The news from Steve Perlman's company Mova was so huge, it stole the front page of *The New York Times*' Technology section the day it was announced. And what wasn't to love? Perlman, a former Apple Computer engineer who previously co-founded WebTV Networks, brought forth an innovative solution for a pain point that

had been weighing down 3D art and animation for years. The system, called Contour Reality Capture, uses glow-in-the-dark face paint, which can be applied not only to skin but also to cloth, and made for great press photos. And not even one full year into the launch, the company has announced a Contour version 2.0.

Meanwhile, as Perlman was stealing the spotlight, a small company in New York was in the last stages of developing its own markerless motion-capture technology. Andrew Tschesnok and Jonathan Rand, CEO and president,

respectively, of Organic Motion announced their system by the same name at the Game Developers Conference in March. Like the Contour system, Organic Motion uses no body suits and no dot-markers; but instead of focusing on facial animation, Organic Motion captures full body movement.

Tschesnok and Rand, who have been working on the technology for about four years, showed me the system's set up recently, which is what one will receive when purchasing the system, which will be available in September for



about \$80,000. There is a large cubicle stage, swathed in white backdrops and surrounded by 10 cameras on rigs. On a nearby table sits a large black and purple box about the size of two or three old VCR players stacked on top of each other and a television monitor. A few extra light bulbs dangle from the rigs, but there's not

much more to it than that. As shown to me, the whole system ran off ordinary electrical outlets.

On a nearby table, the duo had set up a PC running MotionBuilder [the system is Mac-compatible, too]. When an actor finally entered the scene, he extended his arms into a T-formation, and within a few

# GEARS, AQUARIA EARN TOP AWARDS AT GDC

## GEARS OF WAR, THE XBOX 360 SHOOTER FROM

Epic Games and Microsoft Game Studios that has set the bar for next-gen graphics, won Best Game at the Game Developers Choice Awards, hosted by the Game Developers Conference in San Francisco last month. The title also picked up awards for Visual Arts and Technology.

Clover Studios and Capcom Entertainment's OKAMI and Nintendo's Wii SPORTS fared well, too, receiving awards for Character Design and Game Design, respectively, as well as one each for Innovation. The Innovation award was also shared by Bostjan Cadez, developer of the Flash game LINE RIDER.

Other award winners included Harmonix Music Systems and RedOctane's GUITAR HERO II for Audio, Nintendo's THE LEGEND OF ZELDA: TWILIGHT PRINCESS



for Writing, and TITAN QUEST developer Iron Lore Entertainment, which picked up the award for New Studio.

Shigeru Miyamoto, creator of the Mario, Zelda, and Donkey Kong franchises, was awarded the Lifetime Achievement award, and Manifesto Games co-founder Greg Costikyan received the Maverick award. Composer George "The Fat Man" Sanger accepted the Community Contribution award for his work encouraging interactive audio innovation. Alexey Pajitnov, creator

and developer of TETRIS and pioneer of the casual games industry, was named this year's First Penguin, an honor given to industry pioneers.

Among new independent games, Bit Blot's dreamlike 2D underwater adventure game AQUARIA won the \$20,000 Seumas McNally Grand Prize for Best Independent Game at the 2007 Independent Games Festival (IGF) Awards.

In total, the IGF handed out \$50,000 in cash and prizes to the lucky winners, including Queasy Games for its abstract shoot 'em up title EVERYDAY SHOOTER, which grabbed the awards for Design Innovation and Excellence in Audio. Upcoming Xbox 360 Live Arcade title CASTLE CRASHERS won for Excellence in Visual Art; Three Rings' online title



BANG! HOWDY, came out on top in the Technical Excellence category; and stylish Flash-based point-and-click puzzle adventure SAMOROST 2 triumphed in the Best Web Game category.

An Audience Award, adjudicated from public voting at major consumer game web site GameSpot.com, which was taken home by The Behemoth's CASTLE CRASHERS.

GameTap, an IGF sponsor, awarded \$20,000 in advances for indie games to appear on its PC subscription download service, with EVERYDAY SHOOTER earning a \$10,000 advance and \$5,000 going to Cryptic Sea's BLAST MINER and Naked Sky Entertainment's ROBOBLITZ.

—Staff

seconds, a rig of his figure appeared on the screen. Organic Motion can also gather data to create not just a rig, but also a mesh and texture, although the technology can only output very low-resolution files at the moment (about 500–5,000 triangles for the mesh).

Both Organic Motion and Contour have their limitations. For example, Mova specializes in faces—and while its technology generates unmatched photorealistic results (the company has contributed to EA's THE GODFATHER and FROM RUSSIA WITH LOVE, as well as Stormfront Studios' ERAGON), the application doesn't really fit the needs of studios that want to capture the full human form in motion. Organic Motion, on the other hand, is capable of analyzing movement, but it can only do so in a limited space and with only one actor at a time, though the company says it is

working toward supporting two actors by 2008.

Vicon, which is among the most senior companies of motion-capture technology, hasn't done away with dot markers yet. Its systems don't use Day-Glo face paint, and its trained actors still suit up as elaborately as scuba divers. However, because the company is a leader in existing technology, it has improved upon its base design in a number of ways that often accurately reflect customer needs. For example, Robin Pengelly, business development manager for Vicon, recently told me that Electronic Arts expanded its mocap stage to an outdoor arena-like space, using 86 cameras to capture a football scene of multiple actors. Scalability, in fact, is one of Vicon's strong suits. Price point, however, is not.

Yet, in trying to keep up with the innovative competitors breaking forcefully into the market, Vicon

has come up with a lower-cost solution (about \$50,000) for smaller studios, hoping to attract them to their tried-and-true methodology. The FKextreme (FK for forward kinematics) solution uses much of the same technology as Vicon's more robust offerings, only toned down to keep the price affordable. Although Vicon is still stuck on dot-markers, the company has improved much of its base technology in recent months, improving processing time by as much as 75 percent, for example, increasing data throughput by 55 percent, and automating the majority of data clean up.

Vicon has kept one foot in step with the innovators by selling its cameras to Mova (Organic Motion uses its own cameras), though Pengelly would not specifically comment on whether Vicon is developing its own markerless system.

—Jill Duffy

## CALENDAR

### Indie MMO Game Developer Conference

Minneapolis Convention Center  
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April 14 and 15

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[www.mmogamedev.info](http://www.mmogamedev.info)

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Fairmont Olympic Hotel  
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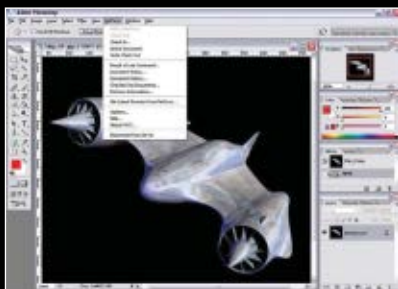


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# GAME DEVELOPER'S » jill duffy 6<sup>TH</sup> ANNUAL SALARY SURVEY

**\$73K. THAT'S THE NEW MAGIC NUMBER FOR U.S. GAME** developers, their average annual salary across all years experience and all disciplines in 2006.

Of course, 73,000 is just a number. It's not a perfect bar against which to measure all other game developers' salaries, since the cost of living varies drastically between states like California, Texas, and North Carolina. And surely developers who have more than five or six years of experience ought to set their sights higher than 73K, while new recruits should aim a bit lower.

To account for these and many other variables, *Game Developer* has brought you, the game developer community, this comprehensive salary survey, now in its sixth year. We analyze average salaries by discipline and across different

levels of experience. We look at which developers, by state, are more likely to own their homes—an indicator of healthy income against cost of living. We compile information from European and Canadian developers and compare their salaries in USD to income in the U.S. And this year, we even asked salary survey respondents to tell us their highest level of education, wondering whether there is a correlation between degree earned and income.

This year's salary survey compared to last year's contains information from almost 20% more developers, and as such is likely the most accurate report to date. (The full methodology, including number of respondents, is printed on page 13.) And although we create the survey as a service to developers, we certainly couldn't do it without you.

**JILL DUFFY**, managing editor of *Game Developer*, has written the annual "Salary Survey" for three years. She also has an advice column on [GameCareerGuide.com](http://GameCareerGuide.com) for prospective video game developers. Email her at [jduffy@gdmag.com](mailto:jduffy@gdmag.com).

## PROGRAMMING

### IN 2006, PROGRAMMERS EARNED

roughly the same overall average income across all levels of experience and title as they did in 2005. The average salary fluctuated by only about \$1,000. 73% of programmer respondents said their salaries increased from the year prior, while 20% said they remained constant. Programmers also remain the highest paid among the disciplines, excluding businesspeople.

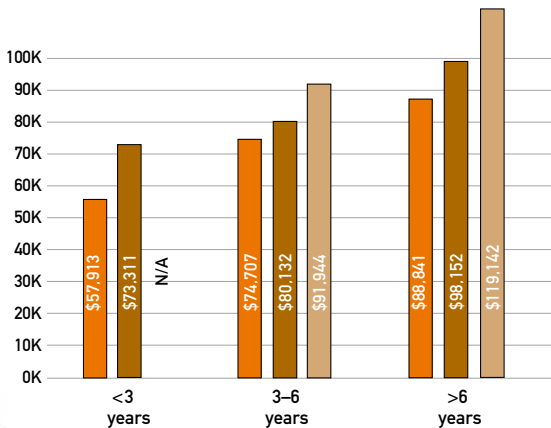
We found that programmers, alongside businesspeople, were the most likely group to hold a master's degree (18%), though the degree didn't necessarily correlate to an increase in base salary. Programmers with some college education earned on average \$87,235; those with a baccalaureate earned \$77,596; those with some graduate study earned \$82,073; and masters earned \$86,371. (See page 13 for more.)

Across all programming job titles, the group claims a very high income commensurate with experience: those with six or more years earned an average of \$121,924. The newer hires, those with three or fewer years under their belts, claim little more than half that: \$65,833. If you're a programmer, it pays to stick around.

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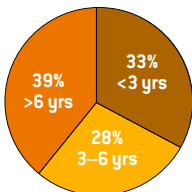
### Programming salaries per years of experience and position

■ programmer/engineer ■ lead programmer ■ technical director



### ALL PROGRAMMERS AND ENGINEERS

#### Years experience in the industry



#### Percent receiving additional compensation

71%  
Average additional compensation \$12,924

#### Type of compensation

Annual bonus .....59%  
Project bonus .....29%  
Royalty .....21%  
Stock Options .....44%  
Profit Sharing .....17%

#### Gender Stats for Programmers

Gender	Percent represented	Average salary
Female	3%	\$71,071
Male	97%	\$81,186

#### Receive some benefits 90%

Type of benefits received  
Medical .....99%  
Dental .....92%  
401K/retirement .....88%

## ART AND ANIMATION

### ARTISTS, LIKE PROGRAMMERS, EARNED

close to the same overall average salary in 2006 as in 2005. In fact, only the average salaries of mid-level art directors (with 3-6 years' experience) and very experienced lead artists and animators saw a significant increase.

2006 did see a turn in numbers in terms of how long artists and animators stay in the game business. Last year, 41% reported having 6 or more years experience compared to only 35% this year. Only 26% were relatively new to the business last year (having fewer than 3 years experience), where as this year the number grew to 32%.

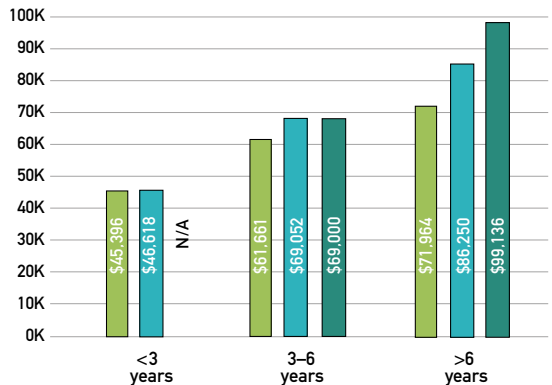
In terms of education, artists who hold a master's degree did report higher average salaries (\$73,284) than those with a bachelor's (\$63,123). But as with programmers, artists and animators with some college or some graduate work seemed to do just fine too, claiming average salaries of \$69,103 and \$69,674, respectively.

When compared to other disciplines, artists don't take home too much additional income (\$9,787), but it's on par with what designers receive (\$9,666).

AVERAGE SALARY  
**\$65,107**

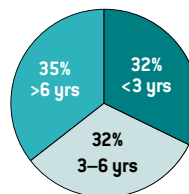
### Art and animation salaries per years of experience and position

■ artist/animator ■ lead artist/animator ■ art director



### ALL ARTISTS AND ANIMATORS

#### Years experience in the industry



#### Percent receiving additional compensation

66%  
Average additional compensation \$9,787

#### Type of compensation

Annual bonus .....48%  
Project bonus .....35%  
Royalty .....31%  
Stock Options .....42%  
Profit Sharing .....20%

#### Gender Stats for Artists

Gender	Percent represented	Average salary
Female	9%	\$55,234
Male	91%	\$66,104

#### Receive some benefits 90%

Type of benefits received  
Medical .....100%  
Dental .....94%  
401K/retirement .....84%





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## GAME DESIGN

### GAME DESIGNERS DON'T SUFFER FROM

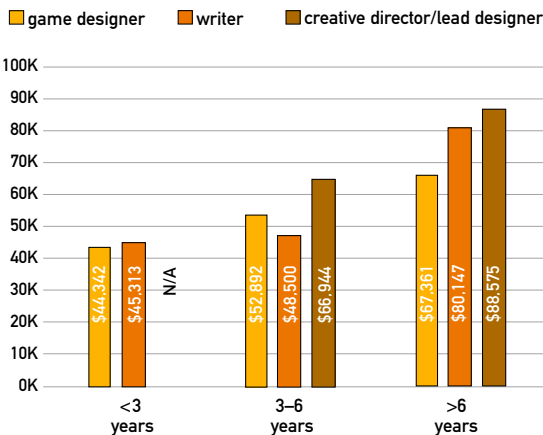
the ups and downs of other departments when it comes to their income. The average salary of a game designer has fluctuated only a small amount over the past three years, staying within a \$5,000 range. However, since last year, many designers showed lower incomes: the average salary of writers with less than 3 years' experience dropped by \$6,631 and writers with 3-6 years dropped \$12,500; game designers with 3-6 years dropped \$1,885; creative directors/lead designers dropped \$5,181; and the average salary of an experienced designer dropped by \$2,452.

A very large percentage (27) of survey respondents in the design discipline said their salaries did not change since the year prior, which leaves designers only above O/A in this regard.

On a less disgruntling note, the number of women in the design field has held steady at 7%, and on average, female designers only make \$7,434 less than their male counterparts, which isn't nearly as ghastly as the spread in other disciplines.

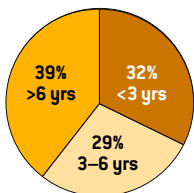
**AVERAGE SALARY**  
**\$61,538**

Game design salaries per years of experience and position



### ALL GAME DESIGNERS

#### Years experience in the industry



#### Gender Stats for Designers

Gender	Percent represented	Average salary
Female	7%	\$54,597
Male	93%	\$62,031

Percent receiving additional compensation **64%**

Average additional compensation **\$9,666**

#### Type of compensation

Annual bonus	48%
Project bonus	37%
Royalty	28%
Stock Options	41%
Profit Sharing	21%

Receive some benefits **88%**  
Type of benefits received

Medical	99%
Dental	94%
401K/retirement	83%

## PRODUCTION

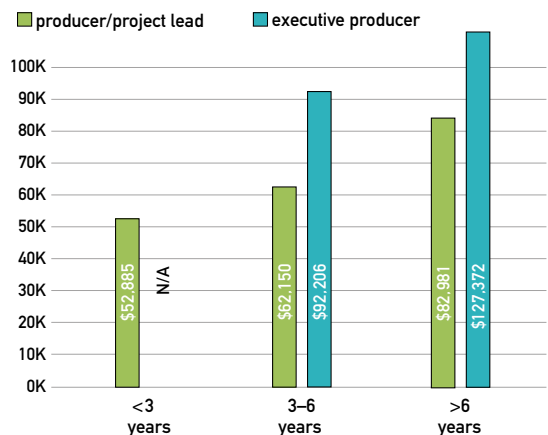
### THE PRODUCTION DEPARTMENT HAS SEEN

an interesting trend over the last three to four years, one that I'm going to guess is the result of needing more producers but not wanting to pay them astronomical salaries. The trend is that more and more producers are less and less experienced. In 2004 (reporting incomes from 2003), we found 61% of producers had 6 or more years experience, compared to 49% last year and this year. And in 2004 a mere 13% of producers had fewer than 3 years' experience, compared to 18% last year and 34% this year. Hiring lesser experienced producers, either as assistants or project leads, may be what caused the overall average salary of producers to drop by just over \$3,000 since last year.

What's a U.S. game producer to do? You can always move abroad! In both Canada and Europe, producers claimed average salaries that were significantly higher than programmers, something that has never been seen stateside (see page 13).

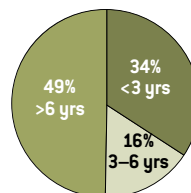
**AVERAGE SALARY**  
**\$77,131**

Production salaries per years of experience and position



### ALL PRODUCTION

#### Years experience in the industry



#### Gender Stats for Producers

Gender	Percent represented	Average salary
Female	18%	\$67,031
Male	82%	\$79,375

Percent receiving additional compensation **72%**

Average additional compensation **\$13,195**

#### Type of compensation

Annual bonus	70%
Project bonus	24%
Royalty	15%
Stock Options	50%
Profit Sharing	14%

Receive some benefits **93%**  
Type of benefits received

Medical	98%
Dental	94%
401K/retirement	87%



# QUALITY ASSURANCE

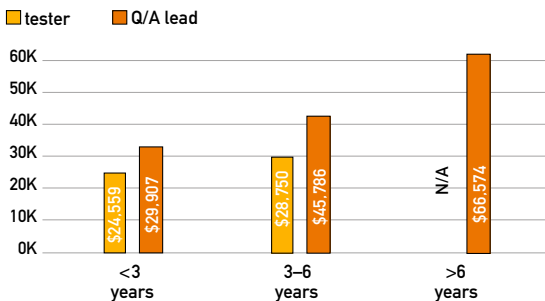
## GAME TESTERS DON'T GET NO LOVE. THEY

are the runts of the industry, and everyone—including the people who determine their paychecks—knows it. It's no surprise that the Q/A department pulls in the lowest average salary, has the lowest chance of receiving additional income (like a bonus), is the least likely to have a graduate degree, and is the least likely to earn benefits, though on that last note, a good chunk of them [72%] in fact do. The overall average salary of a game tester this year, across all levels of experience, increased by only \$651 since last year. The Q/A crew in Canada and Europe is pretty much on par with the U.S. group as well.

Q/A leads with 6 or more years experienced pulled in on average \$5,264 more than last year whereas salaries for entry-level testers remained virtually unchanged. The most interesting aspect about the data from Q/A employees is how many of them have been in the job for 3 years or more: 55% in 2004, 62% in 2005, and 67% this year. What's more, the experienced lead takes home more than double the salary of an inexperienced tester, and therein lies the incentive for sticking around ... that and getting to break games all day.

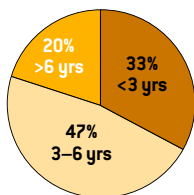
**AVERAGE SALARY**  
**\$37,861**

### Q/A salaries per years of experience and position



### ALL Q/A

#### Years experience in the industry



Percent receiving additional compensation 47%

Average additional compensation \$5,564

#### Type of compensation

Annual bonus ..... 66%  
Project bonus ..... 17%  
Royalty ..... 4%  
Stock Options ..... 38%  
Profit Sharing ..... 17%

#### Gender Stats for Testers

Gender	Percent represented	Average Salary
Female	5%	*
Male	95%	\$37,917

Receive some benefits 72%  
Type of benefits received

Medical ..... 97%  
Dental ..... 92%  
401K/retirement ..... 82%

\*Average salary for females not available due to low sample size.

# AUDIO

## GAME AUDIO SPECIALISTS' AVERAGE

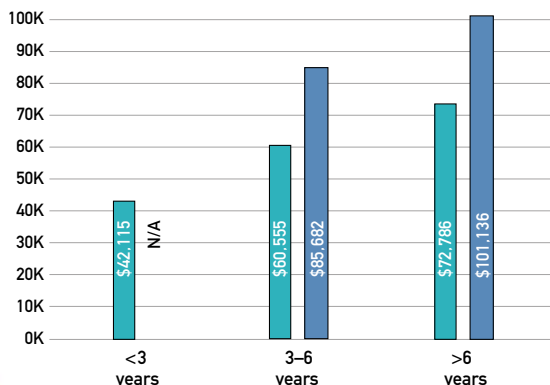
salary across all levels of experience and title rose by only a few hundred dollars this year over last, from \$69,361 to \$69,935. Due to our general knowledge of the industry and anecdotal evidence, we can speculate that the majority of audio professionals working in the game industry are not employed full time but rather find work as contractors or freelancers. Even extremely large studios will often have on staff only one or two people who are dedicated solely to sound.

**AVERAGE SALARY**  
**\$69,935**

The audio group as a whole represents the smallest discipline in game development, making up only about 4.4% of our U.S. respondents in this salary survey. Audio specialists are the second least likely group to receive additional income beyond their base salaries and the second least likely to receive benefits (second to Q/A in both cases).

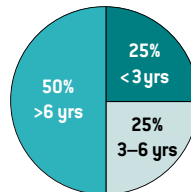
### Audio salaries per years of experience and position

■ sound/audio designer or engineer. ■ sound/audio director or composer/musician



### ALL AUDIO

#### Years experience in the industry



Percent receiving additional compensation 62%

Average additional compensation \$11,824

#### Type of compensation

Annual bonus ..... 54%  
Project bonus ..... 23%  
Royalty ..... 32%  
Stock Options ..... 37%  
Profit Sharing ..... 15%

#### Gender Stats for Audio Personnel

Gender	Percent represented	Average salary
Female	10%	*
Male	90%	*

Receive some benefits 79%  
Type of benefits received

Medical ..... 97%  
Dental ..... 89%  
401K/retirement ..... 81%

\*Average salary by gender not available due to low sample size.

## BUSINESS AND LEGAL

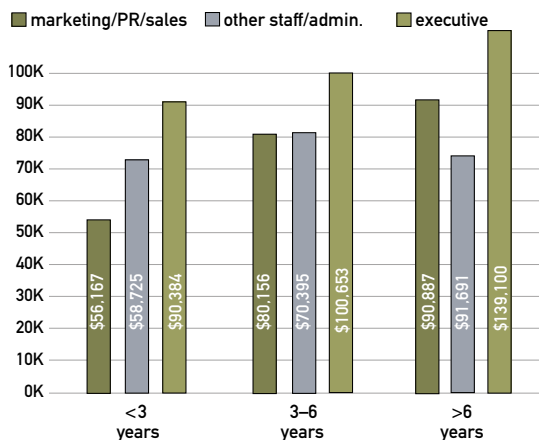
### THE BUSINESS SECTOR OF THE GAME

industry is a strange amalgamation of high-level executives and lower-level administrators or secretaries. It comprises PR specialists, sales associates, human resources personnel, and marketing directors. It's no wonder that between them all, they are the group most likely to make use of profit sharing incentives and stock options, but are the least likely to receive a project bonus. They also see just about as many women in their ranks (17%) as the production department (18%), although that's still quite a drop from last year's representation of female business and legal employees (27%). The overall average salary for U.S. businesspeople in the game industry went up only slightly this year over last by just less than \$3,000.

Experienced executives (with 6 or more years' experience) reported a much higher average this year over last: \$139,100, up from \$126,091. Other highly experienced professionals and administrators saw an equivalent increase, from \$74,022 to \$91,691.

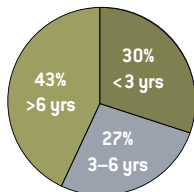
AVERAGE SALARY  
**\$95,596**

### Business/Legal per years of experience and position



ALL BUSINESS/LEGAL

### Years experience in the industry



Percent receiving additional compensation **76%**

Average additional compensation **\$20,251**

### Type of compensation

Annual bonus ..... 64%  
Project bonus ..... 16%  
Royalty ..... 14%  
Stock Options ..... 51%  
Profit Sharing ..... 27%

### Gender Stats for Businesspeople

Gender	Percent represented	Average salary
Female	17%	\$83,470
Male	83%	\$98,143

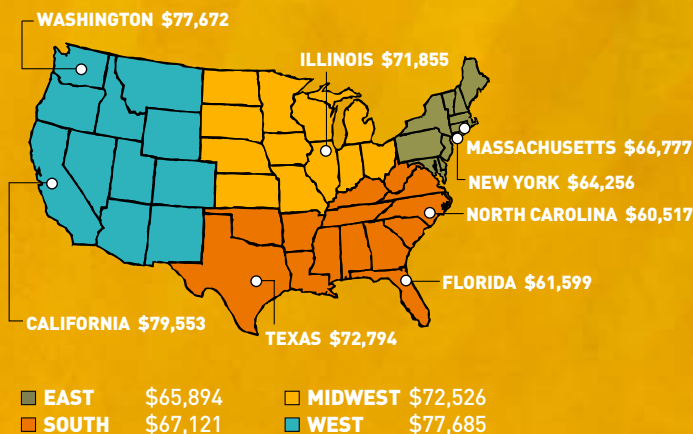
Receive some benefits **84%**

Type of benefits received  
Medical ..... 99%  
Dental ..... 91%  
401K/retirement ..... 81%

## NATIONAL TRENDS

TOP 10 STATES FOR GAME DEVELOPERS ACROSS ALL DISCIPLINES AND LEVELS OF EXPERIENCE BY AVERAGE SALARY

RANK	STATE	AVG. SALARY	PERCENT WHO OWN HOMES	AVG. SALARY OF HOMEOWNERS
1	California	\$79,553	36%	\$101,151
2	Washington	\$77,672	64%	\$90,545
3	Oregon	\$77,375	51%	\$93,026
4	Georgia	\$76,694	63%	\$90,921
5	Texas	\$72,794	62%	\$83,537
6	Illinois	\$71,855	57%	\$83,592
7	Maryland	\$71,554	54%	\$85,000
8	Nevada	\$69,091	73%	\$75,000
9	Colorado	\$68,333	64%	\$82,500
10	Virginia	\$67,200	42%	\$96,750



## AVERAGE SALARY FOR HOMEOWNERS VS. NON-HOMEOWNERS BY REGION

	EAST	WEST	MIDWEST	SOUTH
HOMEOWNERS	\$85,593	\$95,275	\$85,000	\$78,448
NON-HOMEOWNERS	\$52,500	\$66,175	\$52,998	\$49,259

## AVERAGE SALARY BY REGION BY DISCIPLINE

	EAST	WEST	MIDWEST	SOUTH
ARTISTS	\$54,871	\$70,777	\$65,019	\$59,025
PROGRAMMERS	\$79,542	\$86,128	\$76,310	\$72,500
DESIGNERS	\$51,686	\$65,012	\$63,511	\$60,617
AUDIO	-	\$71,844	\$72,885	\$66,944
PRODUCTION	\$70,833	\$80,956	\$79,417	\$62,935
Q/A	\$30,776	\$38,879	\$45,565	\$31,447
BUSINESS/LEGAL	\$86,929	\$98,731	\$98,294	\$92,130



## METHODOLOGY

### WITH THE HELP OF RESEARCH FIRM AUDIENCE

Insights, we sent email invitations to *Game Developer* subscribers, Game Developers Conference 2006 attendees, and Gamasutra.com members in January 2007, inviting them to participate in our annual salary survey.

Although we received well over 5,600 unique responses worldwide, not all who participated in this survey provided sufficient compensation information to be included in the findings. We also excluded cases in which the compensation was

given at less than \$10,000 USD, and the highest salary range was limited to \$202,500 USD to prevent a limited number of outliers from distorting the true central tendency of the computed average salaries in each category. We further excluded records missing key demographic and classification information.

Finally, this report includes U.S. compensation mainly, plus additional consolidated figures for respondents from Canada and Europe (see International Data, below). The total sample

reflected in the data presented for the U.S. is 3,130, for Canada 593, and for Europe 1,086.

The sample represented in our salary survey can be projected to the overall game developer community with a margin of error, for the aggregate U.S. statistics, of plus or minus 1.7% at the 95% confidence level. The margin of error increases for specific subgroups reported within this community.

## HE SAID, SHE SAID: THE GENDER REPORT

### DESPITE THE VIDEO GAME INDUSTRY'S

proclamation that it is forward-thinking, non-conformist, and unconventional, the national statistic that women make roughly \$0.90 on the dollar to men holds true just as plainly here as in any other industry. In the disciplines of programming, art, and production, the mean salary for men across all levels of experience was more than \$10,000 higher than for women. The gap between male and female designers was

slightly smaller at only about \$7,400, while the boys in business and legal raked in about \$14,700 more—before bonuses. Even the babes in the production department, where women hold a much higher percentage of positions than programming, art, or design, still took home about \$12,000 less than their male counterparts on average.

What will it take for women to approach management in a united front and demand a flat

10% increase in annual salary? Particularly in the game industry, where women just barely make up 10% of the overall industry, women should be valued for the diversity of experience they can bring to a team; companies need to create incentives for female game developers to stick around. Paying them equally to their male brethren would go a long way as a first step.

## EDUCATION IN THE U.S.

### HIGHEST DEGREE OF EDUCATION ATTAINED BY U.S. DEVELOPERS BY DISCIPLINE

	SOME COLLEGE OR ASSOCIATE'S	BACHELOR'S DEGREE	SOME GRADUATE	GRADUATE DEGREE
PROGRAMMING	19%	54%	9%	18%
ART	31%	58%	3%	8%
DESIGN	32%	50%	8%	10%
PRODUCTION	25%	50%	10%	15%
AUDIO	28%	54%	7%	11%
Q/A	41%	51%	5%	3%
BUSINESS	21%	49%	12%	18%

### AVERAGE SALARIES BY EDUCATION LEVEL FOR U.S. DEVELOPERS BY DISCIPLINE

	PROGRAMMING	ART	DESIGN	AUDIO	PRODUCTION	Q/A	BUSINESS
ASSOC. DEGREE	\$68,676	\$65,413	\$51,563	•	•	•	•
SOME COLLEGE	\$87,235	\$69,103	\$58,627	\$85,595	\$73,396	\$38,883	\$80,658
BACHELOR'S DEGREE	\$77,596	\$63,123	\$59,799	\$68,750	\$76,021	\$34,692	\$95,000
SOME GRADUATE	\$82,073	\$69,674	\$72,222	•	\$75,588	•	\$110,671
MASTER'S DEGREE	\$86,371	\$73,284	\$69,611	•	\$83,622	•	\$101,071

### THE MATTER OF EDUCATIONAL STANDARDS IN

game development is tricky. On the one hand, the first round of game developers from 20 or more years ago may or may not have had much higher education; programmers and designers were often self-taught technophiles who invented games [more than "made them" in the sense that we know today] using self-developed technologies. And art and quality assurance departments didn't even exist for the first so many years of video game development.

Today, on the other hand, private institutions offer training courses specific to careers in game development, gearing students with the precise technology and hands-on skills they will use on the job. The nature of education has

changed as dramatically as the skill sets needed by professional developers.

Also, many developers who do go on to earn post-graduate degrees don't necessarily do so in game-related departments, finding inspiration and insight in not just the computer science and fine art departments, but also in the humanities and social sciences.

For the first time in the history of this survey, we asked respondents to record their highest level of education, which was matched up against reported salary. The findings aren't neat or clear cut, perhaps indicating that more un-measurable attributes, like talent and personality, take precedence for employers come salary negotiation time. ❖

## INTERNATIONAL DATA

Average salaries in Canada, Europe, and the U.S. across all levels of experience and titles within disciplines (all reported in U.S. dollars)

	U.S.	CANADA	EUROPE
ART	\$65,107	\$54,370	\$45,807
PROGRAMMING	\$80,886	\$62,596	\$53,703
DESIGN	\$61,538	\$48,391	\$46,156
AUDIO	\$69,935	\$51,029	\$46,406
PRODUCTION	\$77,131	\$64,087	\$60,158
Q/A	\$37,861	\$33,452	\$35,139
BUSINESS	\$95,596	\$66,500	\$70,560

Most European respondents were from the United Kingdom (42.6%), Germany (9%), France (7.7%), Spain (7.3%), and The Netherlands (5.8%). Most Canadian respondents were from Quebec (36.4%), British Columbia (35.2%), and Ontario (15.7%).

### Average Canadian salaries\* in top 4 reporting provinces

ALBERTA	\$51,462.26
BRITISH COLUMBIA	\$63,074.16
ONTARIO	\$59,381.72
QUEBEC	\$53,125.00

\*REPORTED IN USD

An extended version of the "Game Developer Salary Survey," including detailed data for year-over-year results from 2004, 2005, and 2006, will be made available for purchase through the CMP Game Group Game Developer's Research division: visit [www.gdmag.com/research](http://www.gdmag.com/research). This detailed report, "The Game Developer Salary Report: 2004–2006," will be available beginning March 26.

— THE 2<sup>ND</sup> ANNUAL —

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» martin linklater

# OPTIMIZING CELLCODE

## IN ORDER TO OPTIMIZE GAME CODE, A PROGRAMMER

must understand how the underlying hardware is executing the program logic. As successive generations of CPUs come and go, optimization characteristics subtly change. Recently we have experienced a move to much more parallel CPU architectures than have been available previously. The Xbox 360 has six hardware execution threads running on PPU architecture. The PlayStation 3 Cell processor has two PPU execution threads and eight symmetric processing elements. Clearly, techniques for optimizing code on this new generation of hardware will be slightly different from the previous generation.

This article is a case study covering the optimization of a simple program on the PlayStation 3 Cell processor. As program optimizations are built up, I hope to shed some light on how simple techniques can exploit the power of this parallel hardware and reap huge performance gains, as well as provide a couple of hints as to what processes would potentially benefit.

## THE CELL PROCESSOR

The Cell processor found in the PlayStation 3 was made in a joint venture by Sony and IBM and has attracted a lot of attention due to its unique architecture. The Cell combines a powerful general-purpose dual core CPU with eight symmetric processing elements (SPEs). The combined processing power of the CPU is around 200 Gflops, or more than 30 times that of the PlayStation 2 CPU (the Emotion Engine). The catch is that you can't just recompile your PlayStation 2 code and expect it to run 30 times faster than before—you have to change some code architecture to get at the power.

When I said that the Cell in the PlayStation 3 has eight SPEs I was not quite telling the whole truth. To increase fabrication yields, Sony ships PlayStation 3 Cell processors with only seven working SPEs. And from those seven, one SPE will be used by the operating system for various tasks. This leaves six SPEs for game programmers to use.

---

### MARTIN LINKLATER

*is the lead programmer of WIPEOUT for PlayStation 3, working for SCE Studio Liverpool in the U.K. He has been a professional game programmer since 1993. Email him at [minklater@gdmag.com](mailto:minklater@gdmag.com).*

## MANDELBROT

Since I was a teenager, I have been interested in and fascinated by the Mandelbrot set and fractal mathematics. For those not familiar with the Mandelbrot set here is a quick overview.

The Mandelbrot set was discovered by Benoit Mandelbrot in 1981. Mandelbrot had been studying complex number functions using a computer and discovered that iterating over a specific complex number equation and plotting the results on standard 2D Cartesian axes created a wonderful and mysterious shape. This shape has since been known as the Mandelbrot set.

For me, the wonder of the Mandelbrot set came half from its inherent beauty and half from an appreciation of the amount of processing power needed to generate views of the set. Ever since I learned about this beautiful piece of mathematics, I have been on a quest to find the fastest program for generating it. See Figure 1 for a picture of the Mandelbrot set.

When I started learning how to program the PlayStation 3, an obvious test case for me was to write a Mandelbrot set generator on the Cell. Since I had great fun writing this program and learned a lot about how to write fast code on the Cell from it, I decided to share my experience with others.

## PROBLEM SCOPE

At the time I wrote the Mandelbrot generator, my main area of interest was finding out how the SPEs worked and how fast I could make them. Since the PPU element in the Cell is a fairly traditional processor, I will not be covering PPU techniques at all. The thing that makes the Cell unique is its SPEs, which were designed with lightning fast execution in mind.

Since the TV on my desk at work only supports a maximum of 720p output I will be using the standard 720p resolution (1,280\*720) for rendering the Mandelbrot set.

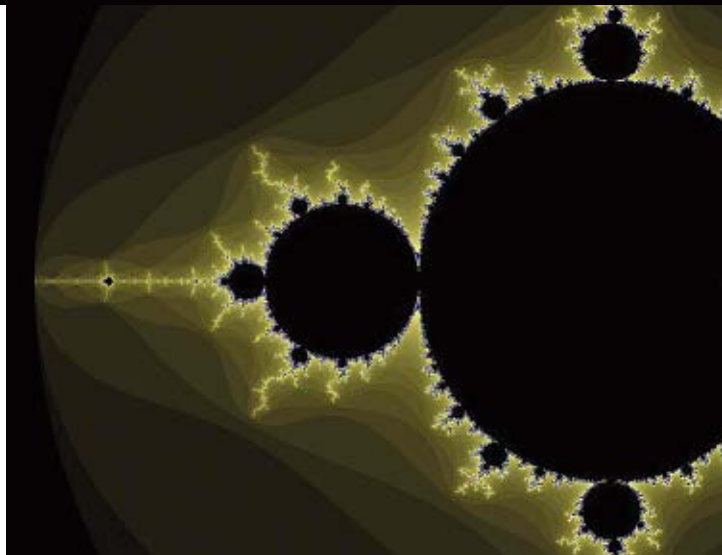


FIGURE 1 When the Mandelbrot set is graphed, it creates this beautiful image.

## IMPLEMENTATION

The basic technique I will use for generating Mandelbrot sets on the Cell is to break the problem down into bite-size chunks and distribute the workload over all six available SPEs. Since the 32 bit screen buffer at 720p comes in at about 3.6MB and each SPE has only 256KB of local memory I will break the screen into 18 buffers of about 200KB each. Since the six SPEs work in parallel, each SPE will process three chunks. Once each chunk is generated, the data is transferred to the screen buffer using DMA, and the SPE begins work on the next chunk.

## BASIC ALGORITHM

The simplest algorithm to use for generating the Mandelbrot set is to iterate over each pixel in the image and work out which color it should be. For each pixel, we iterate over the Mandelbrot equation and count how many iterations it takes before the magnitude of the number explodes to infinity.

One of the characteristics of the Mandelbrot set is that numbers with a magnitude of more than two are guaranteed to explode to infinity. I will be iterating over the equation and counting how many iterations it takes before the magnitude of the numbers passes two. Pixels that are actually within the

## LISTING 1 Pseudocode for one screen pixel

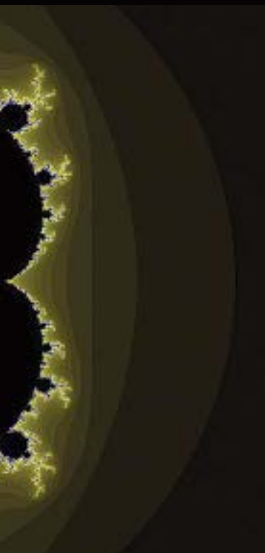
```
complex c( seedX, seedY );
complex x( 0.0f, 0.0f );

int iter = 0;
int iterLimit = 256;

do {
    x = x + c;
} while( ( magnitude( x ) < 2.0f ) && ( iter < iterLimit ) );
if( iter == iterLimit )
    PlotPixel( screenX, screenY, black );
else
    PlotPixel( screenX, screenY, colour(iter) ); testResult2 =
    spu_cmpgt( boundaryTest2, floatFour );
```

## LISTING 2 Interleaved instructions

```
real = newReal;
real2 = newReal2;
realSquared = spu_mul( real, real );
realSquared2 = spu_mul( real2, real2 );
imagSquared = spu_mul( imag, imag );
imagSquared2 = spu_mul( imag2, imag2 );
boundaryTest = spu_add( realSquared, imagSquared );
boundaryTest2 = spu_add( realSquared2, imagSquared2 );
testResult = spu_cmpgt( boundaryTest, floatFour );
testResult2 = spu_cmpgt( boundaryTest2, floatFour );
```



Mandelbrot set itself never escape and always have a magnitude of less than two regardless of iteration count. For these pixels I have a max iteration count and will abort the pixel and color it black. See Listing 1.

Running this simple algorithm generated an image of the Mandelbrot set at around 2 frames per second. Not that bad, but certainly not that great either.

### OPTIMIZATION 1: BETTER SPE DMA

Looking at the current behavior of the SPEs, we find that the SPE is either transferring data to the screen buffer via DMA or calculating

new data. A more optimal approach would be to calculate data while the previous block of data is being transferred out. Since the current output blocks are greater than 200KB in size and there is only 256KB of memory available to an SPE, we cannot calculate one block while transferring the previous block.

The solution is to halve the size of the output blocks and double buffer them. While one block is being transferred out using DMA, the other is being calculated. Doing this means that rather than breaking the screen in to 18 chunks of 200KB each, we break it up into 36 chunks of 100KB each. Each SPE now calculates six chunks, up from the previous three.

Using smaller output buffers and parallelizing the DMA give a moderate performance increase, but since the DMA load wasn't that heavy to begin with, we still haven't gained much performance.

### OPTIMIZATION 2: SIMD

The SPEs in the Cell processor support a processing technique known as Single Instruction, Multiple Data (SIMD). Put simply, a single instruction can perform operations on up to four pieces of data at once. This multiple data processing is just as fast as processing one piece of data and can quadruple the throughput of your code.

The next stage of optimization is to include SIMD processing in my Mandelbrot renderer. With the SIMD mathematics in place, the Mandelbrot generation becomes nearly four times faster. But we still have more work to do.

### OPTIMIZATION 3: BOUNDARY CHECKS

The next optimization will be algorithmic. The Mandelbrot set exhibits a very handy characteristic in the way the math works. It's not the most intuitive thing to describe, but put simply, the gradient of iteration depth always points toward the Mandelbrot set itself. And if you have a boundary with a consistent iteration depth you can flood fill the containing space with the same iteration value.

It's a bit tricky to grasp at first, so here's another explanation: If you find an enclosed area in the set where all the boundary pixels have the same iteration depth, you can fill the interior pixels with that value without having to work them out explicitly.

I'm sure what I've just said could be challenged by more proper mathematicians, but in practice, the above optimization yields exactly the same results as calculating each pixel explicitly.

Since I'm dividing the screen buffer into 36 blocks, each one spanning the full width of the screen, each block is 1,280\*20 pixels. It seems reasonable to use a 20\*20 resolution to implement the current optimization. Take a look at Figure 2 (page 18) to see how using this optimization allows you to skip the calculation of lots of screen pixels. Note that in Figure 2 rather than filling the contained areas in with the correct color, I am filling it in with black so you can see where the optimization is working.

### OPTIMIZATION 4: ELIMINATING PIPELINE STALLS

So now we have four pixels being processed at once thanks to the SIMD, and we have a reasonably efficient algorithm to fill in the holes in the set. But we're still not as fast as we can be.

As CPUs have become faster and more complex, hardware designers have had to introduce extra stages to the execution pipeline. Put simply, there are a number of instructions passing through the silicon at once, each at different stages of completion. With a very tight iterative loop like our Mandelbrot calculations this can be problematic.

When an instruction relies on the result of a previous instruction, the previous instruction must pass through the instruction pipeline before the next instruction can begin its journey. If we look at the disassembled SPE code we have so far and cross reference the instruction latencies, we can calculate how many cycles are being wasted "waiting" for the previous instruction to be completed. See Table 1.

You can see that nearly half of our SPE cycles are spent waiting for the previous instruction to complete.

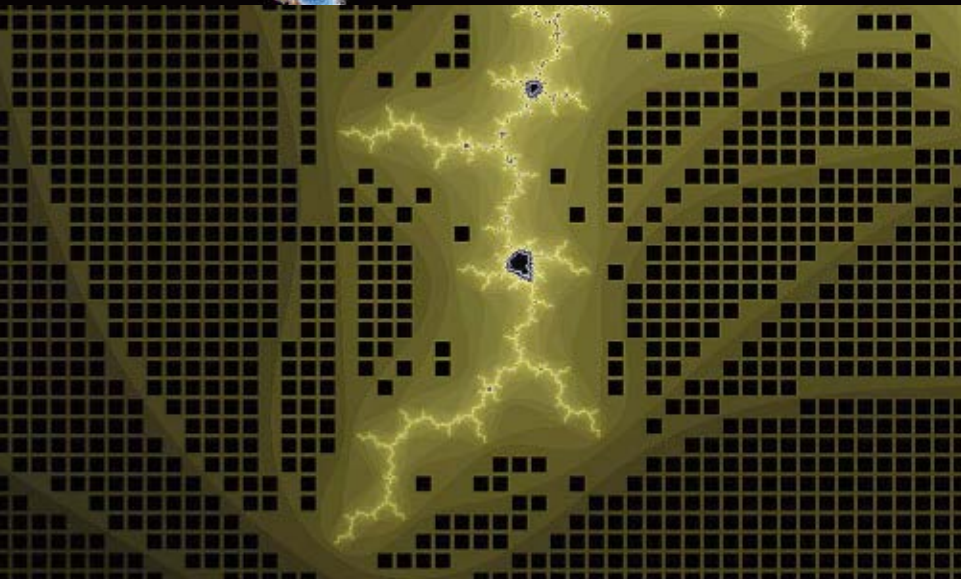
TABLE 1: Pipeline Stalls

INSTRUCTION	LATENCY	WASTED CYCLES
fm \$9,\$8,\$8	6	3
fm \$3,\$5,\$16	6	3
fm \$10,\$5,\$5	6	2
fa \$4,\$9,\$13	6	3
fma \$8,\$3,\$8,\$12	6	3
fa \$2,\$10,\$9	6	3
fs \$5,\$10,\$9	6	3
fm \$9,\$8,\$8	6	3
fcgt \$2,\$2,\$15	2	3
andc \$2,\$14,\$2	2	1

TABLE 2: No Pipeline Stalls

INSTRUCTION	LATENCY	WASTED CYCLES
ma \$23,\$2,\$23,\$33	6	0
fa \$2,\$24,\$34	6	0
fa \$6,\$26,\$25	6	0
fma \$20,\$3,\$20,\$32	6	0
fa \$7,\$22,\$24	6	0
fs \$21,\$26,\$4	6	0
fm \$25,\$23,\$23	6	0
fs \$19,\$22,\$2	6	0
fcgt \$6,\$6,\$29	2	0
fm \$24,\$20,\$20	6	0
fcgt \$7,\$7,\$29	2	0





**FIGURE 2** This Mandelbrot set was plotted with the boundary check optimization.

The answer to this problem is to broaden the problem. The SPU on the Cell has lots of registers—128 of them, in fact. That means it can process very complex mathematical problems while keeping the entire problem space in registers. To broaden our Mandelbrot problem, we increase the level of parallelism by processing not four but eight pixels at once. Processing eight pixels at once effectively lets us fill in the wasted cycles by calculating other instructions that are not directly dependent on the previous instruction. We use more registers, but since they don't get in the way of each other, we actually increase the processing throughput. You can find the disassembled code after increasing to 8 pixels in Table 2. Listing 2 shows the C code demonstrating how the calculations are interleaved.

## OPTIMIZATION FIVE: LOOP UNROLLING

The final optimization is one that most programmers will be familiar with: unrolling the main iteration loop. Unrolling loops is a simple technique which reduces the “per loop” overheads of an algorithm. Counting up to 100 using an iterative loop is an example. A naive algorithm could go like this:

```
int num = 0;

do {
    num++;
} while( num < 100);
```

But this incurs the penalty of checking the condition every single time the number is incremented. A more efficient approach would be to batch the increments together and check less often, as such:

```
int num = 0;
do {
    num++;
    num++;
    num++;
    num++;
    num++;
} while( num < 100);
```

This version checks for the end condition only every five increments, thus saving instructions and speeding up execution of the algorithm. Of course, simply adding 5 to num each iteration would be quicker still, but we'll forget about that since this code is purely symbolic. My final code unrolled the loop eight times. I could have unrolled it more but the extra performance gain is reduced as the unroll count increases. It's the law of diminishing returns kicking in.

I am now at the end of my optimization journey, and I am happy to report that the final Mandelbrot generator does indeed run very quickly on the Cell. Navigating the set at a maximum iteration depth of 256 is a smooth experience which updates at 60Hz at a resolution of 1,280\*720. Quite an impressive demonstration for a console.

One thing that I would like to make clear here is that there are many other optimizations which could be done to the algorithm—results caching and use of the GPU could greatly accelerate and increase the fidelity of the rendering, but they are beyond the scope of this article.

## APPLICATION

During the brief time I spent exploring SPE optimization, I learned a great deal about how the Cell SPU works and how to make it perform very quickly.

It seems clear that the Cell processor is best suited to tasks that can be broken down into parallel computable pieces—but that's not necessarily the whole story. One thing to remember is that although the SPE processors are somewhat specialized, they can run normal C++ code very quickly, too—in fact, quicker than the main PPU units. This processing power can be used to augment the GPU and can perform tasks like LOD and clipping calculations without the GPU having to get involved. Audio processing can also be offloaded to the SPE units, meaning that the potential for very complex and rich audio in PlayStation 3 games is almost unlimited. In fact, once you realize that the SPE units are really just general purpose processing units with a limited amount of very fast memory, you start finding all sorts of uses for them.

There are of course trade-offs to this extra processing horsepower, namely some code re-architecture, but I am sure that as programmers become more experienced with the PlayStation 3, we'll start to see some truly astonishing technology. The trend of moving toward more middleware should reap rewards across a broad spectrum of game genres. Optimizations performed on middleware are felt by all software that uses that middleware. The Cell may well be seen as a non-traditional CPU architecture, but it's clear that the potential made available will be capitalized on by the best in the industry.

Whatever side of the next-gen performance battle you sit on, I hope this article has demonstrated that the Cell processor in the PlayStation 3 is indeed capable of very high computational throughput, and as programmers become more familiar with the architecture and write code to fit the hardware, we will see many more interesting and computationally impressive games. ❄

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## ADVENT OF ADVERGAMING

### BLITZ GAMES' BURGER KING GAMES

**THE BURGER KING PROJECT CAN TEACH US MANY THINGS. FOR A** start, working on these three games increased the development team's vocabulary—we aren't sure how often we'll need to use the word "meatnormous," but we'll never forget it.

There's another word we learned that no one is likely to forget in the near future, the mere whisper of which is guaranteed to provoke an extreme reaction from virtually anyone in the industry. That word is "advergaming."

Whether you're now rubbing your hands together with glee at the thought of enormous marketing budgets or praying desperately that you won't have to sit through a commercial every time you beat a boss, advergaming is here to stay.

Should we be as afraid of them as many people undoubtedly are? If our experience on the Burger King games—BIG BUMPIN', POCKETBIKE RACER, and the infamous SNEAK KING—is anything to go by, we don't think so.

#### WHERE DID IT BEGIN?

It all started when senior executives from Microsoft and Burger King Corporation met to accept an award in Cannes for their respective I LOVE BEES and Subservient Chicken campaigns. As talks continued, a plan emerged that focused on developing three Burger King-specific games for release over Xbox Live Arcade.

Importantly, it was Microsoft's desire from the very beginning that these games would not be forcing the Burger King brand down the throats of Xbox players. Instead, they wanted nothing more than to give players a great deal of fun and a lot of laughs. It would be pure coincidence that it all took place in a Burger King context.

Microsoft then turned to us at Blitz Games, as we'd developed the popular party game FUZION FRENZY. Talks began with us in fall of 2005. Thanks to our previous background working on licensed products, we could see the potential in what Xbox and Burger King were trying to achieve, and by February 2006 the development team was assembled and work on the project began.

#### COLLABORATIVE DEVELOPMENT PROCESS

It was obvious from the start that there would be not only a huge amount of organization required to make these games, but also a great deal of communication between the involved parties and team members. To this end, we decided to assign two full-time project managers to the team. Chris Swan and John Jarvis worked constantly to keep the flow of information as smooth as possible across continents and time zones, taking part in nightly conference calls with Microsoft's Xbox division and Burger King throughout the project and informing the team of the latest developments first thing each morning.

The first step was to decide what type of games would create the widest portfolio of genres for players to enjoy. A large list of

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**EDWARD LINLEY** is a senior designer at Blitz Games and was the design lead on SNEAK KING.

He is currently working on the first release from Blitz's new division Blitz Arcade. Email comments about this article to [editors@gdmag.com](mailto:editors@gdmag.com).







## GAME DATA



### PUBLISHER

King Games

### PLATFORM

Xbox, Xbox 360 (both on the same disc)

### RELEASE DATE

November 2006

### NUMBER OF DEVELOPERS (ACROSS ALL PROJECTS)

80

### DEVELOPMENT TIME

7 months

### LINES OF CODE

BIG BUMPIN'	85,000	comments	50,000
SNEAK KING	60,000	comments	43,000
POCKETBIKE RACER	60,000	comments	14,000

### DEVELOPMENT SOFTWARE USED/NOTABLE TECHNOLOGIES

The BlitzSDK  
Visual Studio .Net 2003  
Maya  
MotionBuilder  
Photoshop  
Subversion  
Perforce  
Cruise Control



# POSTMORTEM

possible party games was produced and sent to Burger King and Xbox for approval. The three they selected were a last-man standing bumper car game, an arcade racing game involving pocketbikes, and a sort of stealthy, actiony, food delivery kind of thing.

Burger King and its marketing agencies were keen to be actively involved in every stage of development, and we realized straight away that we'd have to change our usual approach. We decided to frame all our ideas and suggestions in a context that would be clear to non-game developers. For example, we knew that such savvy marketers are accustomed to seeing very high quality concepts. If we had shown them the very rough, blockout environment of SNEAK KING's test level, with its flat gray roads and boxy orange buildings, there would have been a risk of them thinking that we were presenting our final art benchmark.

Therefore, the project managers arranged a meeting in which the key Burger King contacts were guided through our development process using development images from a previous game: first the black and white sketches, then the color concepts, environment blockouts, texturing and lighting, and finally the results on screen.

This collaboration really inspired all parties involved and helped to smooth out the communication issues we would encounter over the following months. An incomplete understanding of our work methods could have crippled the project, since our approval chain was the longest we had ever encountered. All developers that work on licenses are familiar with seeking approval from both the publisher and the licensor, but in our case concepts needed to be passed not only by Xbox and Burger King but the fast food giant's various branding, advertising, and marketing agencies.

Often, ideas came the other way, too. Burger King and its agency representatives had a seemingly infinite pool of suggestions, often from deep left field. After all, the concept of a guy in a giant burger suit riding a tiny bike doesn't come to just anybody. As game developers, our instinctive reaction to

many of them was bewilderment; it often seemed there was no way these would work. However, we kept an open mind and when we put them in the games and tried them out, we realized something very important: these people know marketing; they know what will work and what won't. Ideas that, on the surface, were completely bizarre produced some of the best comedy moments in the games, and this input from a non-industry source was extremely refreshing.

## HOW MANY GAMES IN HOW MANY MONTHS?

One challenge was the notion of making original Xbox versions of each game at the same time as the 360 versions. We were faced with the concept of making a total of six SKUs in a mere seven months!

Fortunately, our in-house development tools are cross-platform. Aside from a couple of memory issues, converting the game to the Xbox was relatively straightforward.

The trouble with the Xbox versions came when the games changed from being downloadable to boxed products, with both versions on a single disc. Each console is capable of detecting and running the appropriate version, but having two SKUs on one disc was a first, requiring an unusual path through the submissions process.



## Case Study: Sneak King

### SNEAK KING WAS THE GAME THAT WAS

closest to the actual Burger King commercials that had been running in the U.S. for some time. All four environments in the game—the sawmill, suburban cul-de-sac, construction site, and urban downtown—come directly from the commercials, which we watched many times to get ideas for gameplay and character behaviors.

Believe it or not, SNEAK KING was originally a tile-based puzzle game. It rapidly evolved into an online SPY vs. SPY type of caper, with multiple kings trying to out-deliver one another while laying traps for their enemies. This was where the notion of hiding inside everyday objects

came from. It was also the point where we were given some rules that left us all scratching our heads.

*There is only one King.* Okay, no problem. The players can use their custom made avatars (shared with the other two games via the Character Customizer) to track down the crown. Whoever gets it becomes the King while the others try to take the crown.

*You cannot 'become' the King.* Oh, Well, one person plays the King, the others play the remaining Burger King personalities, laying traps to prevent his deliveries.

*The King is too savvy to find himself in danger of any kind.* Perhaps not then. Oddly, once such conventional gaming

staples such as enemies, hazards, and competition were lost, we were forced to come up with something completely original. Stealth, but without any throats to slit. Action, but with no opponents. A game, but with nothing that can go wrong.

Without human opponents, the NPCs had to become a larger part of the game. Taking stealth gameplay out of military zones and into suburban neighborhoods led to a widely varied list of bespoke motions for the NPCs that provided an unexpected change from the norm for our animation team. There can't be many games industry animators that have been called upon to create NPCs sawing logs, taking out the trash, cleaning swimming

pools, trimming hedges and cleaning cars.

SNEAK KING was the riskiest game concept in the project, the one that was completely unproven. It was all the more frightening because it is the appearance and antics of the King himself that give the game its humor and life; without him, the game simply wouldn't work. Until we had the finished King model and motion capture in the game, we couldn't be certain the concept would gel. Fortunately, the moment he went in, we knew we had created something truly unique.

Perhaps the gaming landscape could become a lot more interesting if more titles dared to ditch the conventions of previous generations.





## WHAT WENT RIGHT

**1 QUALITY OVER QUANTITY.** We purposefully set out to give a small slice of high quality gameplay rather than a large but average game. Most of our reviews confirm that, contrary to the expectations of a cheap game, the three Burger King games actually give surprising value for the money. We were never going to reach the visual heights of full-price games on Xbox 360, but the visuals of *BIG BUMPIN'* are streets ahead of similarly priced games on Xbox Live Arcade. This standard of quality is our launching point as we move into the future with our new division Blitz Arcade.

**2 PUTTING THE DETAIL IN THE CHARACTERS.** We concentrated the graphical detail on the Burger King characters, the stars of the show, with less detail in the sundry characters and environments. All three games are about the outrageousness of Burger King's personalities, and we wanted to ensure that the characters looked spot on.

To achieve the correct level of authenticity, we used motion capture as much as possible. That's right—the King himself made space in his busy schedule to fly over to the U.K. to spend some time hurling himself onto crash mats and dangling precariously from ladders! In all honesty, we were amazed by his professional attitude and apparently bottomless reserves of energy!

**3 IN-HOUSE TOOLS.** As mentioned previously, our in-house tools have been carefully designed to function across all platforms, and they had been next-gen ready for some time before the Burger King games got underway. Having a dedicated tech support team in-house and available at all times made completing these games on time feasible. Without that vital asset, there would have been no way for all of us to realize our ambitions for this project.

**4 AGILITY.** We were incredibly agile from a development point of view, able to implement ideas right up to the last minute, which is a huge benefit when working in the fast-moving world of advertising. Companies like Burger King are watching the world, seeing what's working and what's not, and jumping on the best opportunities at the right time, and that meant we would get updates and ideas right down to the wire.

With the long approval chain mentioned earlier, we knew from the outset that once a concept was approved we would have very little time to implement it. Keeping that in mind and expecting the unexpected, we managed to keep ahead and accommodate everything that was asked of us.

**5 STAKEHOLDER'S COMMITMENT.** Burger King's enthusiasm for these games meant a huge deal of support, both during and after production. Once the games were complete, a huge TV advertising campaign promoted the games and the

Burger King's online game *POCKETBIKE RACER* can support up to eight players.





# POSTMORTEM



Though a small game, SNEAK KING was developed using motion capture techniques to get the King's movement down just right.

BK Gamer.com web site ran tournaments with prizes for devoted players. It all goes to show what can happen when you get big buy-in from the license holder!

## WHAT WENT WRONG

**1 CHARACTER CUSTOMIZER.** The original concept for the games allowed players to create their own personal avatars and take them from game to game. In fact, the games were originally going to be connected within a single hub world so players of SNEAK KING might head to the fairground and take part in a quick game of BIG BUMPIN' while pocketbikes raced past in the distance.

However, it transpired that an obscure technical issue ruled out sharing of characters between Arcade titles, and as a result the Character Customizer lost much of its attraction and was slightly sidelined during development.

Both BIG BUMPIN' and POCKETBIKE RACER still include the feature, and it is fully functional. But without the ability to keep your character and use it elsewhere, it unfortunately became more of an afterthought than a full-fledged feature.

**2 CHANGE IN MEMORY FOOTPRINT.** The games were intended to first be released on discs in Burger Kings across the U.S., followed by a downloadable version on Xbox Live Arcade once the in-restaurant promotion finished. However, Microsoft requires that players be able to download the game at launch, which was not possible. This technical issue meant that the games would have to be on disc only.

Changing to disc-only, we suddenly had a lot more memory available to fill with bigger textures, more impressive shaders

and other enhancements such as shadow maps and improved audio quality. However, the change happened too late in the process to fully capitalize on our new-found freedom.

On the positive side, the move to disc allowed for the inclusion of the FMV menus that made the games fit very nicely with the style of the TV commercials.

**3 EVER-CHANGING PROFILE PRACTICES.** The details of how, when, and where player profiles could be saved became a major headache due to the relative youth of the profile concept at the time of development. We looked to existing games for reference, but best practices had yet to be proven, and we spent a lot of time modifying or scrapping our profile management system and starting from scratch. This hit us particularly hard on BIG BUMPIN'.

Microsoft's SDK documentation now includes a section on best profile practices that will prevent this problem from occurring in the future.

**4 ONLINE TESTING.** BIG BUMPIN' and POCKETBIKE RACER proved to be Blitz Games' first online multiplayer titles. We started work on the multiplayer support at the very beginning of the project but failed to truly test it until the last month before release. While Q/A on the other areas of the three games went very well, this crucial element went overlooked until the last minute. Nevertheless, we pulled it off and successfully managed to support four players online in BIG BUMPIN' and eight in POCKETBIKE RACER.

**5 INCOMPATIBILITY OF ASSETS.** The three games couldn't really share too many assets since the games were so very different and the demands of one weren't shared by the others. For a start, each game had very different environments, requiring each to be built individually.

In addition, SNEAK KING had more of an emphasis on character interaction and exploration, whereas the other two games were about multiplayer action. Each of the multiplayer games has a completely different viewpoint. One is a split-screen, third-person racer while the other is a top-down, screen-sharing arena game. These differences in viewpoint lead to different techniques when designing and building the visuals.

As a result, with the exception of some of the main characters, all three games feature completely unique content, all of which had to be created in seven months.

#### MEATNORMOUS

At the time of this writing, the games have together sold more than 3.2 million units since their release around Thanksgiving, with sales ongoing. In fact, Burger King recently announced that this promotion has directly contributed to the corporation's 40 percent increase in profits in the last quarter. Both the press

and the gaming public have been hugely impressed with the quality, playability and longevity of each title.

All parties involved with the project were extremely committed to doing the best job possible in the time available, and Blitz Games is very proud to have been a part of the process.

This project proved that the business model of advgaming is a viable one. By keeping the game in the foreground and the branding firmly in the background (note that none of the games feature a Burger King logo on any menu screens or HUD element), it also showed that advgames are not necessarily something to be feared. Indeed, they can be embraced by the press and public when handled with the correct attention to the balance between the sponsor branding and every game's primary purpose—to be fun! ❖



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# AUTODESK'S MAYA 8.5

BY TOM CARROLL

**MOST PEOPLE HAVE PHOBIAS:** FEAR OF technology (technophobia), fear of computers (cyberphobia), or even fear of being bald (peladophobia), which, had it struck me, would have killed me years ago.

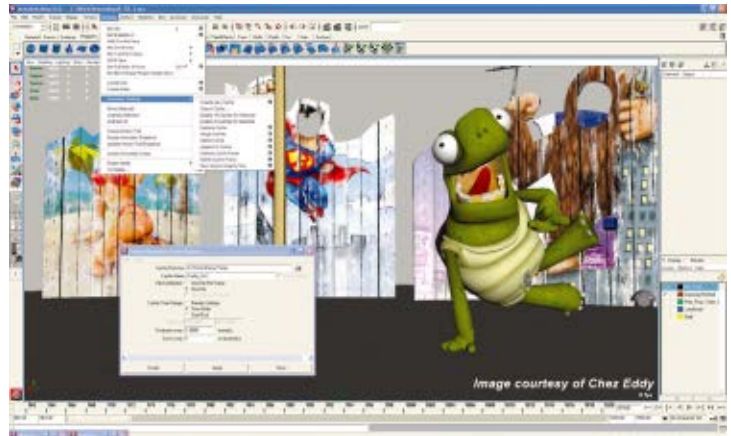
One such phobia that may be on the rise with software managers in the video game industry has to be one in which the email announcing a new 3D software upgrade pops into the inbox even as they're hitting the keystrokes to pay for and validate the current upgrades. Or perhaps that's just a recurring nightmare.

The files on my hard drive are pretty good testimony to this kind of upgrade mania. My hard drive's legacy files from approximately three years of employment begin at Maya 4.5, and the office is just now upgrading to Maya 8—and here I am concurrently reviewing 8.5! Whew!

By the way, because I believe in tireless research during the composing of product reviews, I searched online for "fear of software upgrades," and apparently it doesn't yet exist. An opportunity a-borning!

## GONZO FOR POLYS

Since I'm a poly and point pusher by profession, I am keenly receptive to



Autodesk Maya 8.5 features a geometry cache tool.

software upgrades that allow me to more easily poke and prod various primitive polygonal forms. Maya 8.5 is sort of all about that.

First of all, the Universal Manipulator, which sounds as if it were concocted by a mad scientist at Transformers HQ, is perhaps the best little upgrade, and it's new as of version 8. The handles allow the user to scale, move, or rotate without

changing tools, and there are numeric value boxes associated with each so that relative changes can be typed in for that little added precision that "real modelers" need. It's a smooth tool with real value.

Another tool that appeared in 8.0 and is just as good or better in 8.5 is the Select Shortest Path Edge Tool. Select it and a box appears that directs you to select two vertices, which instantly illuminates the shortest path between them.

## FLEXIBLE MAPS AND PYTHON SCRIPTS

The whiz kids at Autodesk have made UV mapping significantly more flexible and transportable. UV mapping is the system for applying textures to irregular polygonal objects, including the lifeblood of video games: character skins. One of the more useful upgrades is the ability to transfer attributes, including UV information, color per vertex, vertex translations, and normal maps from one surface to another. This means, for instance, that you can fit a character model inside the frame of an existing character and transfer the texture of the face of the existing character directly to the new character, something that was inordinately difficult to accomplish in past versions.

Maya 8.5 now supports the Python scripting language, which can be substituted anywhere you would normally

## AUTODESK

### STATS

**AUTODESK INC.**  
111 McInnis Pkwy.  
San Rafael, CA 94903  
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[www.autodesk.com](http://www.autodesk.com)

### PRICE

\$6,999 (Unlimited)—\$899  
(upgrade from version 8.0 only)

### SYSTEM REQUIREMENTS

#### Software

32-bit version is supported on the following 32-bit operating systems:

- Microsoft Windows XP Professional [SP2 or higher].
- Red Hat Enterprise Linux 4.0 WS [U4].
- SUSE Linux 10.1.

- Fedora Core 5.
  - Apple Mac OS X 10.4.8.
- 64-bit version is supported on the following 64-bit operating systems:
- Microsoft Windows XP x64 Edition [SP1 or higher].
  - Red Hat Enterprise Linux 4.0 WS [U4].
  - SUSE Linux 10.1.
  - Fedora Core 5.

#### Hardware

32-bit version minimum system requirements:

- Windows/Linux: Intel Pentium 4 or higher or AMD Opteron processor.
- Macintosh: Power Mac G5 or Intel-based Macintosh computers.

- 1GB RAM.
  - 2GB hard disk space.
  - Qualified hardware-accelerated OpenGL graphics card.
  - Three-button mouse with mouse driver software.
  - DVD-ROM drive.
- 64-bit version minimum system requirements:
- Windows/Linux: Intel EM64T, or AMD Opteron processor.
  - 1GB RAM.
  - 2GB hard disk space.
  - Qualified hardware-accelerated OpenGL graphics card.
  - Three-button mouse with mouse driver software.
  - DVD-ROM drive.
- See [www.autodesk.com/qual-charts](http://www.autodesk.com/qual-charts) for updates

regarding supported systems and software.

### PROS

1. Modeling tools improved and augmented; everything is speedier.
2. Mental Ray interface more intuitive.
3. The promise of future improvements is as heady as any perfume.

### CONS

1. Not enough new features to justify the cost for some game developers.
2. Time between revs seems shorter each time.
3. The dragon creature booting up artwork is scary, man [scary cool].

use Maya's MEL scripts. This news was less than thrilling to me, but after talking to a couple of technical artist friends, I began to see how Python might help make up for some of MEL's shortcomings. For example, depending on how well the function calls are done within Maya for Python, it will be more streamlined to use it for external error correction and testing. MEL is very poor at this because it's limited to print statements. A standard script language like Python will augment MEL with better error checking procedures. The ability to use API bindings also adds huge value here, as it allows cross-platform plug-in development with less overhead.

Among other things, a sub-surface scattering shader has been added to Mental Ray, and the interface has been made more intuitive—not hard to imagine if you ever used the old one, since it previously required a degree in check box-ology to operate.

#### DON YOURSELF IN GAY APPAREL

Regardless of whether you're in movies, TV, games, Flash animation, or perhaps

even sidewalk chalk drawing (known as "scribblers" back in Mary Poppins' day), what you want is easy cloth from your CD modeling package. So what module within Maya's new Nucleus architecture would be better to push out the door first than a cloth module called the nCloth dynamics system?

One downside of nCloth is that it is available only in the Maya Unlimited \$6,999 version. At that price, you had better need that cloth.

#### THE 8.5 MESSAGE IS ...

Maya 8.5 seems to be an upgrade that has one foot in the past and the other in the future, assuming of course that software upgrades come with two feet. Many features of the half point release, including Python scripting and the old-school cloth module, seem to be part of the past. Other modules will no doubt be affected by new Nucleus modules as they roll out in future releases.

To paraphrase a saying that has nearly become a part of pop culture, "Autodesk didn't make Maya 8.5 new, they just made 8.0 better."

And for game developers, that might not justify the cost of an upgrade.

But out of chaos inevitably comes order. Autodesk and its Maya engineers (and marketers) hope that there are enough cool new bits in Maya 8.5 that you'll want to order it for yourself—or that you'll buy into the new direction for Maya strongly enough to follow along, lock, stock, and two smoking upgrades.

Regardless of your position, think about dropping off a little something nice for your software manager next time you pass by. While a phobic term may not have been invented for the march from Maya 8.0 to 8.5 to 9.0 and beyond, they have to be feeling it, brother ... yup, they're feeling it.

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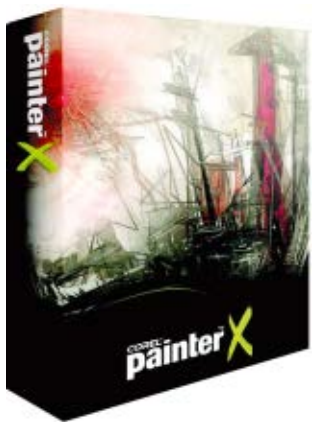
**TOM CARROLL** is a video game artist and freelance writer who strives to understand only enough of his corner of the universe to be able to sleep at night. Email him at [tcarroll@gdmag.com](mailto:tcarroll@gdmag.com).

## product news .....

### MAPLE-NAG CONNECTOR

#### MAPLESOFT

In partnership with the Numerical Algorithms Group (NAG), Maplesoft, a provider of high-performance software tools for engineering, science, and mathematics recently



announced the launch of Maple-NAG Connector. The product is a toolbox, which works with Maplesoft's flagship product (Maple) to deliver faster and more reliable models and applications in a shorter length of time. In short, the Maple-NAG Connector creates an integrated environment to make code development easier, but enhancing it with the power of NAG numeric routines as well as easy access to the NAG C Library. Single user licenses for the Maple-NAG Connector are \$295.

[www.maplesoft.com](http://www.maplesoft.com)

### COREL PAINTER X CURRICULUM

#### COREL

Corel, the company that makes the Painter software for digital painting and illustration, has developed a new curriculum for educators, which is being distributed for free. Titled

"Digital Painting and Sketching Using Corel Painter X," the material coincides with the company's release of Painter X and promotes its adoption among high school art and photography students. Consisting of one image file and two PDFs, there is enough material for five 45-minute lesson plans, including suggestions for grading.

[www.corel.com/paintercourseware](http://www.corel.com/paintercourseware)

### AMD 690 SERIES CHIPSET WITH ATI GRAPHICS

#### AMD

AMD recently released its AMD 690 series chipset for socket AM2 processors. The new chipset series combines multimedia capabilities and game compatibility with flexible connectivity options. The series uses the ATI Radeon X1250 GPU to deliver an improved Windows Vista experience.

It also supports ATI Avivo technology, producing smooth video playback and true-to-life images for multimedia, including those in high definition.

[www.amd.com](http://www.amd.com)

### NVIDIA CUDA SDK

#### NVIDIA

Graphics card maker Nvidia has announced the release of the Nvidia Cuda SDK and GPU C-compiler public beta. Nvidia Cuda, which was first announced in November 2006, is an architecture for computing on Nvidia GPUs, as well as the industry's first GPU C-compiler development environment.

The beta versions of the Cuda SDK and C-compiler for Windows XP and Linux (RedHat Release 4 Update 3) are available from the Nvidia Developer web site; Cuda is available on the new GeForce 8800 graphics

card and future Nvidia Quadro Professional Graphics solutions.  
[www.nvidia.com](http://www.nvidia.com)

### MAYA TECHNIQUES: ADVANCED PARTICLE INSTANCING

#### ALIAS LEARNING TOOLS

Because video games now require cheap, efficient crowd scenes almost as much as feature films and television, video game developers are asking more of Maya to deliver them. And technical artists need fast information.

The Maya Advanced Particle Instancing DVD is a definitive snapshot of the state of the art in complex crowd simulation and ordered assembly. While this is no beginner's training video, there is plenty of information to satisfy anyone conversant with the Maya software Particle Instancer and Adrian Graham, a master Maya maven, has the knowledge and teaching skills to make it happen.

[www.alias.com](http://www.alias.com)

### PHOTOSHOP CS3 BETA ONE-ON-ONE PREVIEW WITH DEKE McCLELLAND

#### LYNDA.COM

The march through new versions of Photoshop is as inexorable as the tides, though not nearly as fluid. Well, since December '06 Adobe has offered Photoshop CS3 in beta form and Lynda.com has now released a one-on-one training session that takes you through all the software's new bells and whistles. Some of this material is provided without charge on the site, some only to subscribers; "The New Interface" is extremely valuable since there are significant changes in CS3 (even from CS2... go figure).

<http://movielibrary.lynda.com>

### DRAWING DINOSAURS: ANATOMY AND SKETCHING WITH DAVID KRENTZ

#### THE GNOMON WORKSHOP

David Krentz's Drawing Dinosaurs: Anatomy and Sketching is a must have for anyone who has ever aspired to draw dinosaurs in motion. Without question it is simply the best DVD in existence for this. What Krentz doesn't know about dinosaurs isn't worth knowing and he has honed his craft by participating in digs with actual paleontologists. He has then created sculptures for them based

on the latest fossils. He is so close to the topic that he must dream about the orbit of the eye, the temporal fenestra, the anterior fenestra, the nares (nostrils), and the jugal, all important to the dinosaur sketcher. Krentz's passion for the subject is matched only by his ability to demonstrate how all of the anatomy factors into the viewer making a killer-diller dino sketch.

[www.thegnomonworkshop.com](http://www.thegnomonworkshop.com)

### IMAGINATIVE ILLUSTRATION WITH J.P. TARGETE, VOLUME 1: THUMBNAILING AND FINAL COLOR SKETCH

#### THE GNOMON WORKSHOP

In this, the first in a series of three DVDs, J.P. Targete lays the groundwork for creating a fantasy painting called "Dark Riders." He uses markers to create three quick sketches, emphasizing large blocks of form that are easy to compose on the page.

Before adding color, Targete explores how to design unique and interesting characters that take the basic sketch even further. He then selects one of his sketches, adds character details to it and turns that drawing into a finished color sketch using oil paints.

[www.thegnomonworkshop.com](http://www.thegnomonworkshop.com)

### IMAGINATIVE ILLUSTRATION WITH J.P. TARGETE, VOLUME 2: TONAL UNDERPAINTING AND DETAILING

#### THE GNOMON WORKSHOP

In the second DVD of the series, Targete goes digital with "Dark Riders." He begins by importing his sketches from his first lesson into Photoshop and creates a new digital composition using pieces of each. He then demonstrates how to render the sketch as in shades of grey tones, adding important details to focus the viewer's attention on various parts of the painting. The underpainting work will become the basis for what Targete accomplishes in his third, and final, DVD.

[www.thegnomonworkshop.com](http://www.thegnomonworkshop.com)

### IMAGINATIVE ILLUSTRATION WITH J.P. TARGETE, VOLUME 3: FINAL COLOR ILLUSTRATION

#### THE GNOMON WORKSHOP

The third and final DVD in the series is like the cherry on top of the sundae. Targete begins with the tonal underpainting he finished for "Dark Riders" in the second DVD and then demonstrates various techniques for adding quick, evocative color to the whole painting. He then demonstrates how it is possible to add color and detail to the painting without sacrificing the foundation work from the two earlier DVDs. The finished "Dark Riders" painting is a masterpiece on its own, but even more so because the viewer saw every brush stroke and pixel push from start to finish.

[www.thegnomonworkshop.com](http://www.thegnomonworkshop.com)

—Jill Duffy and Tom Carroll

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MICK WEST

## » THE INNER PRODUCT

# PRACTICAL FLUID DYNAMICS: PART II

**IN LAST MONTH'S ARTICLE, I GAVE AN** overview of the nuts and bolts behind simple two-dimensional fluid dynamics using a grid system. This month, I explain how programmers can achieve a reasonable level of realism with fluid dynamics without too much expensive iteration. I'll also continue with my goal of explaining how everything works by using nothing more complex than basic algebra.

To recap last month's column: we have a velocity field, which is an array of cells, each of which stores the velocity at a particular point. Remember this is a continuous field, and we can get the velocity at any point on the field surface (or in the field volume for 3D), by interpolating between the nearest points on the field.

We also have a matching field of density. The density field represents how much of the fluid or gas is in a particular grid cell. Again, we're dealing with a continuous field, and you can get a density value for any point in the simulated space by interpolating.

I then described the process of advection, which is the moving of values in one field (for example, the density field), over the velocity field. I described both forward advection and reverse advection, where the quantities in the field are respectively pushed out of a cell or pulled into a cell by the velocity at that cell. The advection process worked well if you performed forward advection and then follow it with reverse advection.

### INCOMPRESSIBLE FIELDS

Reverse advection in particular only works if the velocity field is in a state termed incompressible. But what does that mean?

You may have heard that "water is incompressible," meaning you can't squeeze water into a smaller volume than it already occupies. Compare this with gasses such as air, which can clearly be compressed. Picture, for example, a diver's air tank. The tank contains a lot more air than the volume occupied by the tank. But if you were to take that tank and fill it with water, and then somehow push in another pint of water, the tank would explode.

Actually, water is in fact compressible, very slightly, since it's physically impossible to have a truly incompressible form of matter. The incompressibility of a material is measured by a metric called a "bulk modulus." Air's bulk modulus is about 142,000, whereas for water, it's 2,200,000,000 or approximately 15,000 times as much. By comparison, the least compressible substance known to humankind, aggregated diamond nanorods, are just 500 times more incompressible than water. So for most practical purposes, you can imagine water as being incompressible.

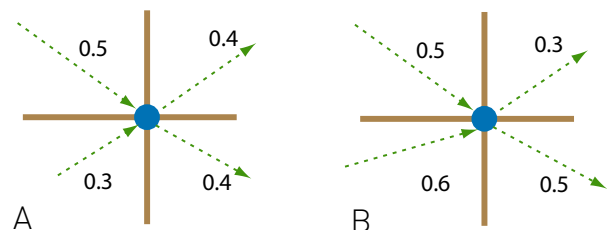
Because water is considered incompressible, there cannot be more water in one cell than in another when

considering a solid volume of water. If we start out with an equal amount of water in each cell, then after moving the water along the velocity field (advecting), we can't increase or decrease the amount of water in each cell. If this happens, then the velocity field is incompressible or mass conserving.

### PRESSURE

You can think of the pressure at a particular node as being the difference in density between a cell and its neighbors. The pressure of water will be the same throughout the density field since it's incompressible. If we think of a node as having a series of inputs and outputs during the advection process, then in an incompressible field, the sum of input is equal to the sum of outputs (see Figure 1A). When we move the water along its incompressible velocity field, the density at each node remains constant, and hence the pressure remains constant.

On the other hand, if the velocity field happens to be structured in such a way that for some cells more is going into them than is coming out, the velocity field is compressible (see Figure 1B). When the density of the fluid is advected across a compressible velocity field, the density in individual cells will increase or decrease. If we simply keep advecting the density, all the matter will eventually be



**FIGURE 1** A simplified view of the inputs and output of a node in the velocity field. A is balanced, but in B the density will continually accumulate in this node.

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compressed into the cells of the velocity field that have a net gain of input over output. If we were not performing accounting in our advection step (as explained last month), then there would be a net loss in density (the field is not mass conserving).

Let's step back from our abstraction for a second and consider what prevents this situation from happening in real life? If more of a fluid flows into a cell than flows out, then the density of that cell increases relative to its neighbors, and hence the pressure in that cell increases. High pressure in a cell creates an acceleration force on the neighboring cells, increasing their velocity away from that cell, thereby increasing the outflow rate from the cell and evening out the imbalance. As with the atmosphere, fluid flows from an area of high pressure to an area of low pressure.

## APPLYING PRESSURE

Listing 1 shows the code for applying pressure. Here `mp_p0` is the array that stores the density (which is equivalent to the pressure, so I actually refer to it as pressure in the code). The arrays `mp_xv1` and `mp_yv1` store the x and y components of the velocity field. The function `Cell(x,y)` returns a cell index for a given set of x and y coordinates. The loop simply iterates over all horizontal and vertical pairs of cells, finds the difference in pressure, scales it by a constant (also scaled by time), and adds it to both cells.

The logic here is slightly unintuitive, since physics programmers are used to the Newtonian principle that every action has an equal and opposite reaction—yet here when we add a force, there's no opposing force, and we don't subtract a force from anywhere else.

The reason is clear if you consider what's actually happening. We're not dealing with Newtonian mechanics. The force comes from the kinetic energy of the molecules of the fluid, which are randomly traveling in all directions (assuming the fluid is above absolute zero), and the change to the velocity field actually happens evenly across the gradient between the two points. In effect, we're applying the resultant force

from a pressure gradient to the area it covers (which is two cells here), and we divide it between them.

Here's an example: Just looking in the x direction, we have a flat pressure field, with one cell denser than the rest. The cell densities are 4, 4, 5, 4, 4. The gradients between the four pairs of cells is 0, -1, 1, and 0. Adding this to each cell (ignoring scaling), we get: 0, -1, 0, 1, and 0 (see Figure 2).

The cells on either side of the high-pressure cell end up with a velocity pointing away from that cell. Consider now what will happen with the advection step. The reverse advection combined with forward advection will move the high-pressure cell outward, reducing the pressure and force. The fluid moves from an area of high pressure to low pressure.

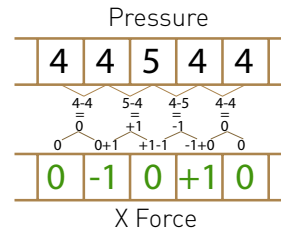
Effectively, this makes the velocity field tend toward being incompressible and mass conserving. If there's a region that's increasing in density, then the resultant increase in pressure will turn the velocity field away from that area, decreasing the density in that area. Eventually, the velocity field will either become mass conserving (mass just circulating without density change) or it will stop (become zero). See Listing 1.

## INK AND SMOKE

What we're modeling here is motion within a fluid, such as air swirling around inside a room, and not the overall motion of a volume of water, such as water sloshing around in a cup. This method as it stands does not simulate the surface of the fluid. Visualizing the fluid itself is not very interesting, since a room full of air looks pretty much the same regardless of how the air moves.

What's more visually interesting is the situation in which some substance is suspended by that fluid, carried around by the fluid. With water, we might have silt, sand, ink, or bubbles. In air, we could see dust, steam, or smoke. You can even use the velocity field techniques outlined here to move larger object, like leaves or paper in a highly realistic manner.

It's important that what we're talking about is a suspension of one substance in another. We are generally not so



**FIGURE 2** Pressure generates a directional force in the x direction, which is then scaled and applied to the x velocity field. When done to the y velocity field as well, this gives a reasonable representation of reality.

interested in simulating two fluids that do not mix (like oil and water). Games typically feature burning and exploding things, so smoke is a common graphical effect. Smoke is not a gas, but a suspension of tiny particles in the air. These tiny particles are carried around by the air, and they comprise a very small percent of the volume occupied by the air. So we do not need to be concerned about smoke displacing air.

In order to simulate smoke, we simply add another advected density field, where the value at each cell represents the density of smoke in that region. In the code, I refer to this as "ink." It's similar to the density of air, except the density of smoke or ink is more of a purely visual thing and does not affect the velocity field.

## LISTING 1 pressure differential

```
for (int x = 0; x < m_w-1; x++)
  for (int y = 0; y < m_h-1; y++) {
    int cell = Cell(x,y);
    float force_x = mp_p0[cell] - mp_p0[cell+1];
    float force_y = mp_p0[cell] - mp_p0[cell+m_w];
    mp_xv1[cell] += a * force_x;
    mp_xv1[cell+1] += a * force_x;
    mp_yv1[cell] += a * force_y;
    mp_yv1[cell+m_w] += a * force_y;
  }
```

The pressure differential between two cells creates an identical force on both cells.

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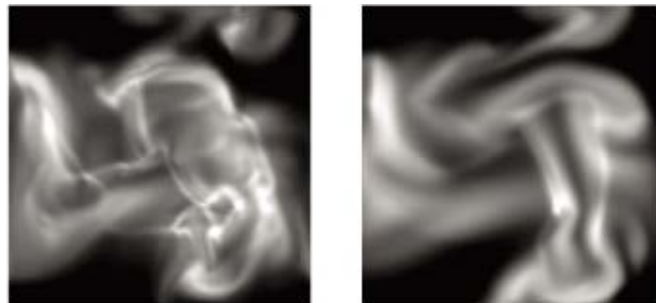
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**FIGURE 3** The image on the left has no diffusion filtering, while the image on the right has a single pass of diffusion filtering applied every update. This A-B comparison allows the effect of the variable to become apparent.

### HEATING UP

One final ingredient that often goes along with a fluid system like this one is the heat of the fluid or gas at each location. Sources of smoke are usually hot, which heats up the air the smoke initially occupies, causing the smoke to rise because higher temperatures mean more energy, which means the fluid molecules are moving faster, which means higher pressure, which means lower density (remember density is only proportional to pressure at constant temperature), which makes the hot air rise. Now, that's a complex sequence of events, but it's initially simpler to just model the result "hot air rises" and have the relative temperature of a cell create a proportionate upward force on the velocity field at that cell. We can do this trivially by adding a scaled copy of the heat field to the Y velocity field.

Similarly, rather than attempt to model the effects of heat in the initial phases of a simulation, I found it easier to simply model the expected results. So, although a flame creates heat which makes the smoke rise, more pleasing results were found by "manually" giving the volume of air around the flame an initial upward velocity and letting the heat take it from there. With more complex systems, such as an explosion, the fiddly physics happen in the first tenth of a second, so you can just skip over that and set up something that looks visually pleasing with our simplified physics.

### FILTERING OUT ARTIFACTS

The simplistic application of forces we perform for acceleration due to pressure (Figure 2) has the tendency to introduce artifacts into the system. These typically appear as unnatural looking ripples. The way to deal with them is to smooth out the velocity and pressure fields by applying a simple diffusion filter.

If you use the Stam-style reverse advection with projection, you have to use a computationally

intensive filter, iterating several times. But with the inherent diffusion of forward advection, in cooperation with the accuracy of the combined forward and backward accounted advection, we can get away with a single iteration.

It's often difficult to see exactly what effect a change can have on a fluid system. The fluid is very complex looking, and small changes to parameters often have an outcome that's not immediately obvious. The ideal way to solve this problem is to set up your system so you can run two copies of the same system in parallel, with one using the modified parameters. The difference becomes obvious. Figure 3 shows such a comparison.

### FLUID IDEAS

I've glossed over a few other important aspects here, but details of these aspects can be found in the accompanying code, available on [www.gdmag.com](http://www.gdmag.com).

Be sure to pay particular attention to how you handle the cells that are at the edge of the system, as the differing number of neighbors has a significant effect. At the edges of a system you have the option of reflecting, wrapping, or zeroing values, depending on what you want. By wrapping in one direction, you essentially get a tiling animated texture in that direction, which could be used as a diffusion or displacement map for the surface of a moving stream of fluid.

There's also the issue of friction. Motion in a fluid is generally quite viscous, which can be implemented as a simple friction force that applies to the velocity field. If there's no friction in the fluid it will slosh around forever, which is generally not the desired effect. Different viscosity settings give very different visual results.

There is a large number of variables that you can tweak to give radically different visual results, even in my rather simple implementation. Spend some time playing with these values just to see what happens. ❖





STEVE THEODORE

## PIXEL PUSHER

# NEITHER FISH NOR FOWL

## The legendary 'technical artist'

### IN THE DARK AGES, CHRONICLERS

populated the vast unknown spaces of the world with fantastic hybrid creatures. Snakes with wings, fish with legs, and human-headed lions helped explain the impossible diversity of the natural world in terms that were at least partly familiar to an audience that rarely traveled more than 30 miles from home. In the vast unknown that is the game industry, we've come up with a few chimeras of our own, mythical beasts such as the "senior game programmer" (the title of a fully grown person attached to the body of a video store clerk) and the "beta tester" (the head of a hammer on the body of a frat boy).

Of all these monstrosities, though, none is as rare and elusive as the eerie crossbreed known as the *technical artist*. With the head of a programmer, the heart of an artist, and the thick skin of a rhinoceros, the technical artist is a formidable beast, hardy, adaptable, and cunning. Here we chronicle the origins, care, and feeding of this mythical monstrosity.

### (UN)NATURAL HISTORY

This fantastic creature has evolved in a harsh and unforgiving landscape. Games have grown and their hardware platforms have exploded in power, but the tools we use to make them have not kept pace. 3ds Max debuted 11 years ago in 1996. One of the original reviews gushed with admiration at the software's ability to display a model

with 40,000 polygons "effortlessly" and with "almost no slowdown." Maya arrived very early in 1998, when hardly anyone in the U.S. had even seen a PlayStation 2 dev kit. Though both programs have been upgraded and tweaked over the ensuing decade, the basics of content creation haven't changed radically, even though games have seen mind-boggling advances in graphics complexity.

Compare a *QUAKE III* screenshot to a current shot from *METAL GEAR SOLID 4* or *GEARS OF WAR*. The differences in polycount and texture budget may be glaring, but the gulf between the PlayStation era and today is even deeper. A modern character model might be "merely" 20,000 triangles instead of 500, but it also has to be built as a million poly original to generate normal maps and shader masks. In addition to geometry and textures, we're also creating shaders. Instead of using a handful of canned animations, we now need to create many blending animation cycles.

The starkest measure of the changes in game creation is the explosion in team size. A decade ago you could make a triple-A title with a team of 30 people in less than two years. Nowadays, teams of 150 and dev cycles of three years scarcely garner a mention, except perhaps from publishers' accountants or harried HR managers. Overall, we've seen about an eightfold increase in the amount of work that goes into the box.

This is the harsh environment in which the technical artist thrives. This strange creature supplies from its own ingenuity and will power tools that help to bridge that deadly eightfold gap. Here's a scary statistic: In a 50-person content team, saving every artist eight minutes a day is the equivalent of hiring a 51st artist. Eight minutes is hardly an impossible goal, when plenty of game companies tolerate 15-minute load times when opening a level file or multi-hour lighting compiles. As teams get larger, technical

artists are no longer a luxury or a rarity—they are an absolutely necessity. Whether they're providing efficient character rigs, squeezing the last drop of resolution out of a lightmap, or making sure precious assets move smoothly through the pipeline, a good technical artist provides extra leverage to everybody on the production team.

### GENUS AND SPECIES

Of course, some naturalists are skeptical that the technical artist is really an "artist" at all. Surely, the argument goes, anyone who has written their own model exporter and uses the word "algorithm" in ordinary conversation must be a coder, not a real artist. The true tech artist, however, is a genuine hybrid worthy of the title. The job requires not only technical savvy but also real veteran stripes from the art production frontline.

If you poke through a good tech artist's bag of tricks you'll find that clever shortcuts outweigh technical *tour de forces* by a long shot. You can only know the pain of Maya's endless texture swatch loading time, or how unreliable Max's vertex annotations are, or how long it takes to dig up the right normal map out of a big Perforce tree by actually working on a game—not by meditating deeply on the mysteries of mathematics. These are the kinds of liabilities that don't show up in the typical cube-and-teapot test scene, and even the best intentioned tools coder will have a hard time knowing what the art team really needs to make them go away.

We've been a long time coming to recognize the value of technical artists. The tech artist lives in the no-man's land of the game industry's most significant cultural trench line: the divide between engineers and artists. One veteran pipeline wrangler I spoke to complained that programmers regarded him as "uppity" because he knew enough to question some of their dictates, but at the same time other artists regarded him

**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](mailto:stheodore@gdmag.com).

with suspicion because he seemed too analytical and insufficiently “artsy.”

Technical artists also struggle with the legacy of the bad old days when simply knowing how to operate a 3D application or a painting program made one an “artist.” If you know a piece of software too well, you may be suspected of being nothing but jumped-up IT tech rather than a real artist. Good tech artists, however, need more than technical skills.

Doing the job right requires the critical eye and aesthetic vocabulary that have forever been vital to creative types. The tech artist will be the one who mocks up the parallax-mapped cobblestones that complete the city scene, or who hacks a way to get squash-and-stretch animation into a character without completely rewriting the animation engine. All the technical skills in the book won’t help without the restless ambition and knack for telling detail that comes from the imaginative side.

## BREEDING

Now that you’ve heard how great tech artists can be, maybe you’re thinking of rearing a few of your very own. Here are a few of the traits to look for if you want a real thoroughbred.

*Stubbornness.* Stubbornness is a critical component of the tech artist’s psyche. Most are self taught. They learned by virtue of refusing to accept busted tools and lousy results. Far, far too much of the game artist’s life is circumscribed by strange taboos and inexplicable prohibitions: “You can only do that if the model has just one set of UVs,” or “You can’t use that shader with a light that casts shadows,” or “Yes, that’s what it says in the documentation, but it never actually works.”

Most of us learn to just roll our eyes and move on to a new problem. The tech artist is the one person on the team who won’t put up with these kinds of setbacks. If it ought to work, it’s gonna work, even if the way forward requires a

bleary eyed night of pawing through the undocumented scripts in the Maya “other” folder or a mind-bending Max workaround. Having a stubborn disposition makes technical artists a bit exasperating to work with, but in the end, it’s why we need them.

*Cunning.* Like a jujitsu master, the tech artist redirects the power of existing tools to new and interesting ends. It may take a genius to efficiently compress the spherical harmonics in your lightmaps, but only a tech artist can write the script that makes sure every one of the hundreds of lights in the scene is correctly configured to work with the new tech. Writing a particle system from scratch may be the province of “real” programmers, but using a particle system and a joystick to mock up a fully controllable player model inside of Maya, like one artist I know did, is a classic example of tech artist wiles.

*Bilingualism.* An amphibious creature, the technical artist has to live simultaneously in two very different environments, operating with two varying systems of communication. To the engineers, tech artists can articulate the ways in which new engine features or tools will support the key visual needs of the game (beyond just looking “cooler”). To artists, a tech artist must be able to translate esoteric concepts into understandable metaphors (beyond just “push this button, and we’ll take care of it”).

This can be a tough role. Neither artists nor engineers are famous for their communication skills, but helping them to speak to one another clearly is fundamental to the whole effort. However, this ability is only possible for tech artists because of their next trait:

*Thick skin.* Like other creatures that live in a harsh environment, the tech artist has evolved important protective measures. The most notable is a very thick hide, useful for dealing with flanking attacks from both sides. Like

diplomats, tech artists often have to broker compromises, which leave no party feeling completely satisfied, so a positive attitude and the ability to look on the bright side are important traits.

Being a tech artist is, in the end, almost like a service business. The value in the job comes from what it does for others. Any service job has its share of frustrations, so tech artists may sometimes be heard grumbling about their “clients” on both the creative and engineering sides. The frustrations are very real, but the value in working past them is even greater. Which brings us to the last, most important mark of the breed:

*Pack behavior.* The last distinguishing trait of the breed is the most important of all. Tech artists rarely get to own individual assets or characters or levels. Underneath it, though, they are artists, with all the bravado and egotism that goes with that proud title.

To keep up their artistic spirits they must learn how to take pride and pleasure from collective accomplishments as well as their own wizardly tricks. The best tech artists are cheerleaders for the whole team, encouraging teammates to keep learning and improving, sharing information, and helping to bring the content and code sides of the business closer. A tech artist who really fulfills this side of the role makes a priceless addition to any team.

## A HERD ON THE MOVE

So that’s a brief guide to the care and feeding of the technical artist. They’re still hard to find—don’t expect to trot down to your local pet store and find a MaxScript guru or a shader whiz in an afternoon.

Yet the species is growing every day. As teams continue to swell and engines become incomprehensibly more complex, the need for people who can boost the output of an art team is only going to get stronger. Every studio will have its own philosophy about how best to use the strange powers of the technical artist, but any outfit that doesn’t believe in the existence of these fabulous creatures will have a tough time in the years to come. ❖



# SOFTWARE TOYS

**A GOOD WAY TO START AN ARGUMENT** among game designers is to ask for their definition of the qualities and origins of a specific gameplay style. Their responses will likely draw on the fields of psychology, education, and mathematics, as well as a myriad of examples from within the game industry itself. It should be no surprise then that a similar diversity of opinions exists about a subset of games: software toys.

## WRIGHT THINKING

It seems likely that Will Wright helped coin the term “software toys”—he undoubtedly is the prominent leader in the field. He has said that one can build a game from toys, but a toy itself is less goal-directed and more freeform. Most of Wright’s published titles are software toys, with the ultimate goals left to the user to determine. *SIM CITY* and *THE SIMS* were wildly successful just for that reason.

On the other hand, *SIM EARTH* and *SIM LIFE* failed to find as large an audience, which I contend was because *SIM CITY* and *THE SIMS* are firmly rooted in everyday life. People bring their own goals into play, while the other games required more esoteric and abstract understanding of processes that are beyond the experience of most players. Some people I’ve spoken to have suggested that the difference in appeal lies in whether and how the game uses people. Games that involve humans directly are the more popular ones, and for that reason Wright’s new game *SPÖRE* isn’t likely to be a big success.

My stance on *SPÖRE* is this: I think its survival theme is more than sufficiently

familiar and compelling enough to appeal to millions of potential players.

There’s no doubt that a game with user-defined goals can be a big hit. And you don’t have to be Will Wright to make one. He’s not the first to try.

## SANDBOX, GOD, OR RPG

The success of the *GRAND THEFT AUTO* series popularized the term “sandbox play.” The concept of sandbox play is closely linked to software toys, but it’s not exactly the same. There’s no formal definition of what sandbox games are, but people seem to generally agree that unlike a pure software toy, they have a narrative thread you can follow, an ultimate goal that is often accomplished through a series of stages or missions.

Critically, they also give players the ability to use those same gameplay mechanisms to explore and generally experiment in the game world, finding enjoyment without seeking a goal. Another distinction is that the player controls an actual character or entity in a sandbox game. If the player does nothing more than move a cursor around and change the world, the game will more likely be classified as a god game.

Another fuzzy boundary lies between sandbox games and role-playing games, which are marked by lots of open quests that aren’t linked to some eventual story goal. Most MMORPGs are sandbox-like in this extent, hosting play for thousands of players who ignore the story goals and just do whatever they enjoy. The *ZELDA* games have many interesting side-quests that give them a sandbox-like feel, too.

## IN THE BEGINNING

With such a fuzzy definition, it’s not surprising that the origins of sandbox play also go back a long way—at least to the early 1980s. *ELITE*, a popular space exploration game, had many of these



Some designers theorize that the difference in appeal between *SPÖRE* (top) and *THE SIMS* (lower) is humans.

elements. An even earlier release called *SUNDOG: FROZEN LEGACY* let the player roam around space, trading, fighting, and generally ignoring the game’s storyline—but it still offered a fun experience.

I’ve even heard someone make the case that *COLOSSAL CAVE ADVENTURE*, the late 1970s title that was the first text adventure, was a sort of sandbox game. Players could traverse the game world in whatever order they liked, and the text parser interface at least gave the illusion of being able to do a wide range of things, even though the game was really quite constrained.

## SOMETHING LIKE THAT

Perhaps the best lesson to draw from this is that our industry has a lot of work to do in creating clear definitions of gameplay varieties. It’s been said that our industry has no true genres—just hit games and their imitators. I contend that there are underlying patterns of play that transcend individual games. But until we can agree on some common definitions, we may well be left to point to specific games and say, “Like that, only different.” ❖

**NOAH FALSTEIN** has been a professional game developer since 1980. His web site, [www.theinspiarcy.com](http://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](mailto:nfalstein@gdmag.com).





ROB BRIDGETT

## » AURAL FIXATION

# INTERACTIVE AMBIENCE

### AMBIENCE IS AN OFTEN UNDERVALUED

area of video game sound. It's the canvas upon which all the spot effects, dialogue, and music sit, but it also has a much more powerful interactive potential.

Ambience typically tends to be loops of one or two minutes in duration, which is generally inactive and doesn't draw any attention to itself. This makes good sense in games that have very predictable set-pieces in terms of gameplay and have minimal dynamics to their play narrative.

However, as we enter a new era in video games, particularly in cinematic console-based games, where action sequences are balanced with periods of relative calm and exploration and where interactivity with more or less any object or character in a game is possible, there's a clear opportunity to make ambience more detailed and involved.

### ART OF IMMERSION

Ambience generally hints at a world just outside what can be seen and experienced on screen. It performs the functional task of making a scene feel real and continuous, no matter what other effects are layered on top of it. Everything should seem to belong to the same scene. It doesn't have the in-sync immediacy of sounds that are coming from within the on-screen diegesis. This is not to say that it cannot represent and reflect events that are occurring as a result of gameplay actions the player has undertaken.

The sound of distant sirens in a large urban setting, for example, may indicate that tension has slowly been raised, either because of actions taken by the player (for example, shooting) or because something has happened in the game

world that will soon become apparent.

These sounds are not merely there to add flavor or a mood to the game, although they can clearly do that very well.

What differentiates ambience in interactive entertainment from ambience in film is that it's reactive to events. I tend to think of interactive ambience as musical score. It has a powerful subliminal effect on the player and raises or diffuses tension in a very subtle way. When it reflects events that the player is inaugurating, the effect is very powerful.

This works especially well when orchestrated along with all the other elements of an interactive soundtrack such as music and spot effects. The idea that interactive events are being triggered by a kind of ripple effect in the distance is indispensable for immersing the player further into an interactive world. It gives a great impression of life beyond what's happening directly on screen and helps to fill the player's head with notions of an unseen and reactive world that isn't being rendered by the game engine, but by the player's imagination.

The crowd ambience in sports games has long been interactive to events that take place at run-time within the gameplay narrative. Here, various crowd reactions are reacting directly to what occurs—they're not simply a continuous crowd loop that occasionally feels right. It's this use of ambience that can be extended greatly into other genres, such as open world crime and first-person shooters. Rather than having a bed of sounds that accidentally works every now and then, there's a membrane of interactive ambience that feels organic and responds to user actions telling a more subtle and subliminal version of the story as it unfolds.

### RECORD ON LOCATION

It can be highly beneficial to a project's audio if, as a sound designer on a project set in a real world location, such as Miami or Cuba, you have the opportunity to travel to those areas and make location

recordings of the ambience. Unlike film productions, video games have no equivalent to being on location and collecting location sound. A visit to the location will give you not only the opportunity to collect real sounds, but also a genuine feel for the environment.

In sci-fi or fantasy projects, ambience still functions to create the feel of the world, perhaps more so than a real location. And although it's impossible to collect "authentic" sci-fi ambient sounds, it is possible to find locations that have a similar feel as what you're trying to create. For example, the sounds in a stark abandoned building may provide lots of inspiration and source material that can be processed and adapted toward a forlorn alien planet game world.

### CAN IT BE CAPTURED?

When you return to the studio, you may find that the sounds you collected really don't give the same impression as when you were there. Bear in mind that sound is not only heard, but also physically felt (especially in very loud locations, such as New York City) and influenced perceptually by everything else in the environment, from temperature to heat to smells and visual cues. All these factors greatly affect what how the brain processes sound, which is why it's very important to capture the whole feeling of a place and not just the sounds being emitted.

Taking photographs at each location will help you catalogue and recapture the feeling back in the studio. You might choose to sweeten the recordings with additional sounds in order to better replicate the whole feel.

There are many factors that affect the noises of a particular location; these sounds are quite different from what most of us hear in our every day environments. To create authentic sounds for a game, it's essential to visit real locations that reflect the game environment to capture and reproduce these local quirks. ❖

**ROB BRIDGETT** was sound director on *SCARFACE: THE WORLD IS YOURS* from Radical Entertainment. Previously, he was an in-house sound designer at Climax in the U.K. Email him at [rbridgett@gdmag.com](mailto:rbridgett@gdmag.com).

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MAKOTO IWAI

## » BUSINESS LEVEL

# MARRIAGE LICENSE

### IN 2005, NAMCO AND BANDAI'S GAME

divisions merged to form Namco Bandai Games. Namco is primarily known for its video games while Bandai is known more for its toy and media publishing and vast array of licenses and intellectual property. Since these two companies came together we've been figuring out how to utilize one of our greatest strengths: owned licenses. With the integration of two companies as large as these, it will take some time before the results of the merger come to fruition, before we fully understand how to work in tandem toward maximizing the profits of our shared original IP.

### INVEST IF YOU BELIEVE

It has long been common practice to invest just enough money in the development of a licensed game to get it

out the door and shipped before the end of a quarter. Fortunately, this practice is starting to become a thing of the past. Now when creating a title, it's important to ensure an more appropriate budget is in place that can uphold high quality. Maintaining the quality of a product is the first step in protecting its license; the owner of the license must make

sure the product reflects the same standards that consumers have come to expect from that brand. This strategy is critical when considering the long-term life span of a license.

Once a suitable budget has been set aside for a new project, we make sure we have a clear understanding of who we are

developing for so we can aim at that market. For example, with a game like TAMAGOTCHI DS, we had to be sure the game was youth-, casual-, and female-friendly, since those three segments reflected our target market. We wanted the product to not only reflect the characteristics of the Tamagotchi license, but also offer gameplay that we felt appealed to this specific audience.

### BORDER COMMUNICATION

With Namco Bandai Games having so many shared licenses across different mediums, it has become critical to have an open exchange of communication across all divisions, such as games, toys, and anime. One lesson we learned right after the two companies integrated was how important it is for different divisions to communicate, coordinate, and work together to create plans that combine all their knowledge bases.

Realistically, the integration of Bandai and Namco is still fairly new, therefore from one division to the next, our product cycles do not always match up. And it's important to keep some borders in place so that the two divisions don't interfere with each other unnecessarily. But at the same time, we are opening up the lines of communication for more fluid plans in the future.

As our companies become more fully intertwined, our product cycles will begin to sync up, opening a number of possibilities, including coordinated product launches and shared shelf space for multiple media products at retailers. Namco Bandai will inevitably become a machine in which all the cogs work together. At least, that's what we're shooting for.

### THE DOWNSIDE

The sheer amount of coordination that's required for an owned license across different mediums is very challenging. It requires a huge investment of time, cooperation, and motivation from a number of people in order to be successful. Even when all these factors operate correctly,

a single product slip can throw the entire strategy off, leaving us to face a mad dash to get all the necessary aspects back on track. The process is huge and difficult and takes a long time to execute.

Worse, even when the execution of the strategy is flawless, we still run the risk of having our license perform better in one area than the other. For example, we weren't sure how many consumers of our Tamagotchi brand, which consists mainly of small toys, would also be interested in the DS game.

Before undertaking a license transition, it's important to understand that even when both products present a strong representation of the license, failure can happen. TAMAGOTCHI DS could have caused a whirlwind of problems if the overall product wasn't appealing to those who had already adopted the Tamagotchi toy. We all know consumer backlash is very difficult to mend, and if the new product didn't resonate, we could have turned off some of the old consumers forever. Fortunately, this didn't happen in this instance, but it's always a risk.

### THE UPSIDE

One benefit of having a license perform successfully across mediums is that it proves the company has a heightened awareness of the consumer base since it is able to capture them in a new space. This scenario opens the door for a number of future possibilities in that new market. For example, now that we know Tamagotchi consumers also have a Nintendo DS in their pockets, we can start looking at other licenses that appeal to a similar demographic to determine whether it makes sense to bring them to the DS as well.

The greatest benefit of successfully carrying a license into a new medium is that it increases the longevity of that license. It allows the company to bring new products to the consumers, and in Namco Bandai's case, possibly deepen their interest in video games in general. Playing is believing! ❖



TAMAGOTCHI DS is an example of a toy to game transition that went smoothly.

MAKOTO IWAI is executive vice president and COO of Namco Bandai Games America. He previously served as a board member and senior executive at Sony Computer Entertainment Korea. Email him at [miwai@gdmag.com](mailto:miwai@gdmag.com).

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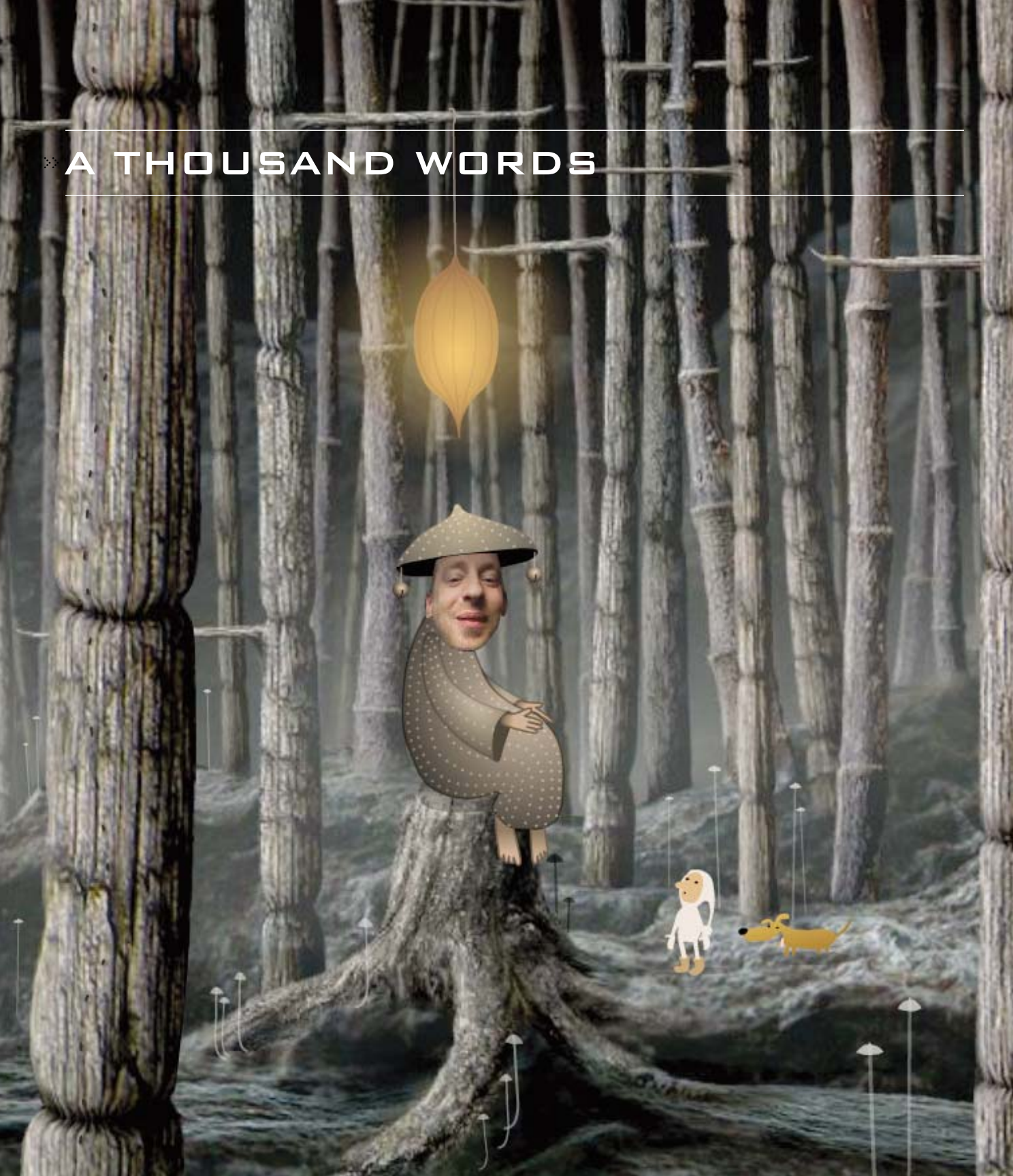
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for game design, artwork, and production. Vaclav Blin contributed to game design and animation, while sound and music were provided by two people, both named Tomas Dvorak.



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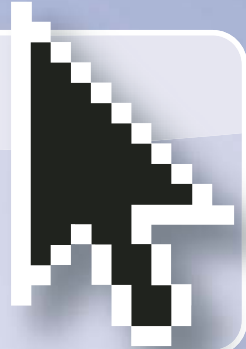




**Bink** is the best video codec for games! It provides amazing quality, super fast performance, and a great audio codec all in a simple, clean API. It is available for all platforms, including Windows, Xbox 360, Sony PSP and PS3, and Nintendo Wii.



**Granny** is a powerful toolkit for building all kinds of interactive 3D applications. It features the most efficient and flexible content exporters, data manipulation, normal mapping and run-time dynamic 3D animation system you'll find anywhere.



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