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POSTMORTEM

32 MIDWAY GAMES' STRANGLEHOLD

STRANGLEHOLD was an attempt to take the best elements of John Woo's famous films, and translate them into the video game world. Between project scope changes and difficulties with unfinished tools, the team managed to create a title that's nothing if not an interactive John Woo movie—here's how.

By Brian Eddy

DEPARTMENTS

2 GAME PLAN *By Brandon Sheffield*
New Year's Fears

4 HEADS UP DISPLAY
Activision/Vivendi merger, new ESA appointment, and ESRB rating statistics by console

40 TOOL BOX *By Tom Carroll, Thomas Grové, and Amir Ebrahimi*
Unity Technologies' Unity 2.1

COVER ART: MOBY FRANCKE AND THE PORTAL TEAM

FEATURES

7 THINKING WITH PORTALS

From the game's university-created roots through to its ORANGE BOX-ed release, PORTAL was an exercise in creativity. Here, three members of the eight-person team come together to discuss Valve's iterative playtesting process, the power of simple storytelling, and clever ways to present new ideas to a mass-market audience.

By Kim Swift, Erik Wolpaw, and Jeep Barnett



15 GDC 2008 EDITORS' PREVIEW

Want to know what we really think about this year's GDC? Of course you do! This is your chance to scoop up our hot knowledge and insights into the rapidly-approaching conference. Editors from our multiple publications come together to weigh in on what's hot and what's not.

By Brandon Sheffield, Jeffrey Fleming, Christian Nutt, Jill Duffy, and Leigh Alexander



23 2007 FRONT LINE AWARDS

It's been a year of consolidation for some, and growth for others, but nothing changes the importance of tools in game development. Here, we honor the best and brightest tools of 2007, and enter one indispensable tool into the Hall of Fame.

By Jeffrey Fleming



COLUMNS

44 THE INNER PRODUCT *By Mick West*
Relational Databases

[PROGRAMMING]

72 BUSINESS LEVEL *By Scott D. Nelson*
Going Independent

[BUSINESS]

48 PIXEL PUSHER *By Steve Theodore*
Custom Tools

[ART]

52 AURAL FIXATION *By Rob Bridgett*
Post-Production Audio

[SOUND]

51 GAME SHUI *By Noah Falstein*
Orange Box, Gold Star

[DESIGN]



NEW YEAR'S FEARS

CONSOLIDATION SCARES THE CRAP OUT OF ME, but it's running rampant through our industry. Some of these companies seem to be getting so bloated that I wonder how they even operate. It's funny how it's often the execs at large publishers who talk the most about making games more like movies, or at least more successful than them—and yet these are the very entities that are moving further and further away from the Hollywood studio system, which is composed mostly of freelance agents, production houses, and funding groups, and moving more toward a factory-style production model. It's a wonder to me that original or innovative games ever get through this system—at times it seems like it must have been some sort of grievous error of judgement on the part of somebody in the upper echelons, allowing a team to get paid to make what they want. After all, that's how Ralph Baer wound up creating the first modern videogames while researching for the military.

But of course, publishers fund big-budget games, and as the medium discovers itself, it strives to tackle more—more hours of gameplay, more sandbox options, more user-generated content, more graphical flourish and physics interaction. These are certainly good things to an extent, but at this stage are incredibly reliant on the money of large corporate entities, the largest of which are absorbing creative studios left and right (though on enlightened occasions, leaving the studios themselves alone, just taking a bit of the money and risk, as seen in the Blizzard deal).

There are talented people in these publishers, but as we all know, being talented and being in charge don't always go hand in hand. And when these structures get larger and more labyrinthine, it makes me wonder how long before we're submitting game concepts to representative committees, like government entities, who will then relay this information, complete with riders, to persons who consult with the people who have the money, who in turn speak with the people that “push the button,” as we represent our “constituents” whose tastes we barely even know. Or are we there already? Or alternately, am I being too pessimistic?

The fact is, you can make a good movie for \$100,000 that can be shown in theatres—it's rare, but it's possible. Could you make a game for the same price that would make it onto store shelves? You might be able to consider

downloadable games as a corollary to direct-to-DVD movies. With movies of lower-budget, it's the luck of the draw and who you know that gets you in theatres or simply on a disc. But in games, if you've got a small budget it's pretty unlikely that you're going to get any kind of traditional marketing or retail treatment. But DVD sales have overtaken box office sales, and so too will downloadable sales overtake retail. So perhaps the era of the indie is at hand?

POSTMORTEMS: THE BEST POLICY

And I've also been thinking—can there ever be such a thing as a truly honest public postmortem? I had a conversation with a designer friend recently, and we came to the conclusion that unless the game was made entirely by one person, probably not. While you can say “we changed scope too quickly,” you can't say “So-and-so screwed everything up and lost us lots of time because he's a terrible manager.” The latter is likely a truer statement, but you'd never hear anyone say it outside of the office. And in the case where the people giving you the money are the problem, well what can you do?

At a certain point, one has to wonder—are we continually repeating the same mistakes, or are we just keeping it close to the vest? (And I use “we” merely for the sake of convenience—I've never written a postmortem myself.) Certainly there can be interesting elements in these articles, such as information about genre or platform shifts, or innovative ways to deal with budgetary or time constraints. But in general, it seems these articles frequently tread over old ground, as the skeletons of the past come back to haunt us. There's still plenty to glean if you're a fan of reading between the lines—most authors, like poker players, have a “tell,” which at the very least informs you of when they clearly have a lot more they could say on a certain subject.

I don't mean to say postmortems are useless—after all, we feature them on the cover of almost every issue of our magazine, and in fact our STRANGLEHOLD postmortem has a few rather honest confessions this month. But there might be better ways to structure this information, might there not? I don't have any solutions but I do think it's worth thinking about how we can do more to actually inform and share with each other, hand-holding Kumbaya-style.

—Brandon Sheffield

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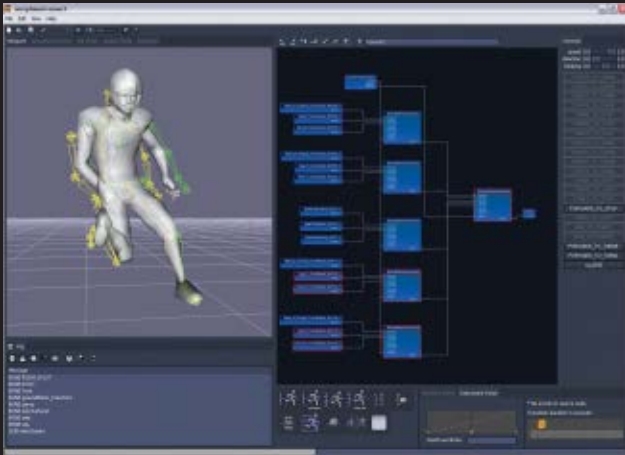
advanced animation system

morpheme is the industry's first graphically authorable animation engine. morpheme consists of morpheme:runtime: an advanced runtime animation engine for PLAYSTATION®3, Xbox 360™, Wii™ and PC. morpheme:connect: a highly-customizable 3D authoring application.

morpheme gives animators and developers unprecedented control over the look and feel of their animations in-game: blends, transitions, compression, etc. can all be previewed and modified graphically in morpheme:connect and live on the target platform.

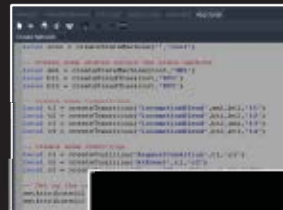
morpheme:runtime ships with full source code and integrates seamlessly with euphoria, NaturalMotion's Dynamic Motion Synthesis technology.

For more information, visit www.naturalmotion.com



scripting

Full Lua scripting for automating tasks, adding AI logic or polling game pads for real-time input



timeline

Graphical mark up of animation data to add one-shot and duration events, for highlighting footfalls, sound effects, etc.



node palette

Advanced blend notes for dragging and dropping into transition network. Fully customizable node types through C++ and scripting



animation browser

Easy browsing and selection (drag & drop) of source animation. Animation list is automatically updated to reflect changed source files



transition requests

Exposure of custom transition messages. In-tool emulation of interaction between morpheme:runtime and game AI system



blend tree

Advanced graphical tools for building complex blend trees. Real-time visualization of animation source contribution through node highlighting



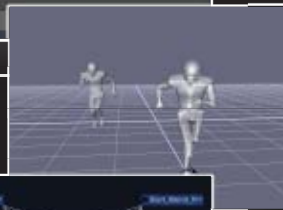
blending

Graphical control of transition blending between states in the transition graph



multiple characters

Visualization of multiple runtime characters in morpheme:connect for easy authoring and analysis of character interaction



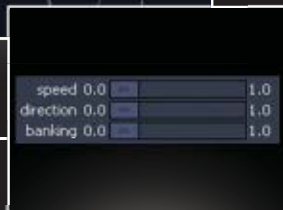
network

Advanced graphical tools for creating and visualizing transition networks through drag-and-drop



control parameters

Exposure of custom high-level controls for entire animation system. Real-time manipulation through sliders or game pad controller



THE ACTIVISION/ VIVENDI MERGER 5 KEY POINTS

BY NOW, BUZZ HAS SUBSIDED AROUND THE FACT THAT ACTIVISION AND VIVENDI GAMES ARE MERGING, in a complex deal that will end (providing regulators and Activision shareholders agree) with a 52% majority Vivendi-owned 'Activision Blizzard' entity trading on NASDAQ.

What are the major points and lessons we should derive from this mammoth deal? Here are some of the elements we think you should take from the Activision and Vivendi Games press release.

1 ACTIVISION IS THE DOMINANT PARTNER

You can read this multiple ways, but in general, the company whose chief exec becomes CEO in a "merger" such as this is in the driving seat, business-wise. One good, if more extreme example of this was the GameStop/EB "merger", which concluded with the EB executives and name largely removed from positions of power in the company.

In this case, Activision boss Robert Kotick will be President and Chief Executive Officer of Activision Blizzard, and Vivendi Games' Bruce Hack will be COO of the combined company. Vivendi is still majority shareholder, but as for who's actively running the business—you do the math.

2 BLIZZARD—NEW BILLING, SAME INDEPENDENCE

One of the intriguing things about the old Vivendi structure was that, even when Martin Tremblay joined to run Vivendi's publishing, it was specified: "WORLD OF WARCRAFT creator Blizzard Entertainment has been designated a stand-alone division reporting to VU Games' CEO, and is not part of Tremblay's product development mandate."

And it's the same deal, more or less, in the new system—Mike Morhaime will continue to serve as President and Chief Executive Officer of Blizzard

Entertainment, and no explicit reporting structure is even discussed in the release. Blizzard will continue to plough its own furrow, then.

3 WORLD OF WARCRAFT'S REVENUES: ABSOLUTELY STAGGERING

And there's a reason why Blizzard has been and will be left well alone—the clout that comes with this mindblowing statistic: "Blizzard Entertainment [which has "over 9.3 million subscribers" to WORLD OF WARCRAFT] has projected calendar 2007 revenues of \$1.1 billion, operating margins of over 40% and approximately \$520 million of operating profit."

This disclosure separates out Blizzard's revenue from Vivendi Games and Vivendi very explicitly, and shows why the division has been key to holding Vivendi Games together in recent years.

4 VIVENDI'S NON-BLIZZARD ASSETS DOWNPLAYED

One of the things that came up repeatedly in developer responses to *Game Developer's* Top 20 Publishers Report was that Vivendi's non-Blizzard assets, which includes multiple development studios (Radical Entertainment, High Moon, Swordfish, Massive Entertainment) and publishing labels (Sierra, Sierra Online, Vivendi Mobile) have a relatively low profile, with

confused brand messaging for the latter—and their relative unimportance (for now) is shown in this announcement.

In fact, all that is commented regarding those elements of the business is: "Mike Griffith will serve as President and Chief Executive Officer of Activision Publishing, which after closing will include the Sierra Entertainment, Sierra Online and Vivendi Games Mobile divisions in addition to the Activision business." Sure, it's also noted: "Vivendi Games also owns popular franchises, including CRASH BANDICOOT and SPYRO"—but those franchises are past their prime, and minus their original creators.

5 ELECTRONIC ARTS: STILL BIG, PROBABLY WORRIED

While the merger release notes that the merger will be "creating the world's largest pure-play online and console game publisher", with the "highest operating margins of any major third-party video game publisher", Electronic Arts may still be the largest—predicting net revenue of between \$3.8 and \$4.0 billion for its 2008 financial year, as opposed to \$3.8 billion for Activision's (not concurrent) 2007 calendar year. It's worth noting that this Electronic Arts revenue figure is excluding the impact of an account change on EA's part, thus confusing the whole matter.

EA's BioWare/Pandemic and Mythic (WARHAMMER ONLINE) acquisitions were partly to plug a gap in the MMO and RPG genres—one in which Blizzard is already a master. It's perhaps not a worry for EA CEO John Riccitiello just yet, but is most certainly a pause for thought.

—Simon Carless

ESA APPOINTS NEW EXECUTIVE

THE ENTERTAINMENT SOFTWARE ASSOCIATION has announced the hiring of Rich Taylor—a former senior executive with the Motion Picture Association of America (MPAA) and aide to Congressman Jim Chapman (D-TX)—as senior vice president for communications and research.

The ESA represents U.S. computer and video game publishers, and including its most recent inductees, Codemasters and Epic Games, now has 29 member companies.

As Senior Vice President for the MPAA (a global advocate for the American motion picture,

home video and television industries), Taylor was the overall head of the organization's communications department under former MPAA President Jack Valenti.

In that capacity, he was responsible for overseeing all aspects of the Motion Picture Association of America's press and communications efforts, while serving as the primary spokesman and senior strategist for the American motion picture industry.

ESA CEO Michael D. Gallagher commented, "The ESA and the video game industry are very

lucky to have Rich aboard. Rich's expertise and extensive experience in communications are a perfect match for the investment, innovation, and creativity of the video game industry."

The MPAA has been quite successful not only in terms of working with government agencies, but also in communicating its rating systems and values to parents, which is a key concern for the ESA going forward. With any luck Taylor will spur additional movement in this direction.

—Leigh Alexander

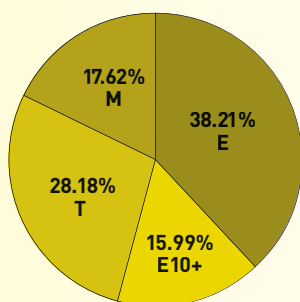
ESRB RATING DISTRIBUTIONS PER PLATFORM

The ESRB has long provided a variety of means for searching its database of rated games. Here, we've taken the data and made charts of the ratings distributions for the three contemporary home consoles; the Xbox 360, PlayStation 3, and Nintendo's Wii. These graphs reveal manufacturer-specific ratings distributions, and possibly even some evidence of different strategies from platform to platform.

For instance, while it's clear that Nintendo has the largest distribution of E and E10+ games, it's also plain to see that Microsoft is making a significant bid for that market with the 360. Sony, on the other hand, has the highest percentage of M-rated games on any major console so far, perhaps indicating another strategic shift for the company.

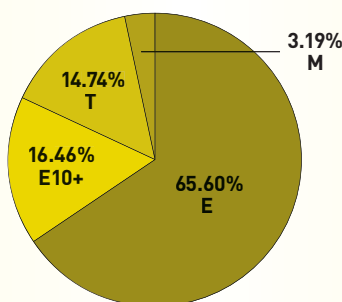
XBOX 360, NINTENDO WII, AND PLAYSTATION 3

While we are only a year into the current generation of console hardware, the ratings of their games already reveal some interesting characteristics. Here are the graphs for each of the three systems.



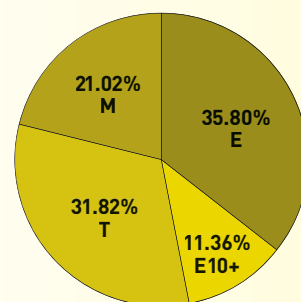
XBOX 360

MICROSOFT HAS ANNOUNCED ITS GOAL TO COURT more casual gamers with games like *VIVA PIÑATA* and *SCENE IT!* The distribution of ESRB ratings on the 360 is suggestive of just such a shift. At this point in its life, over 54 percent of the Xbox 360 library is rated E or E10+. Compare this with less than 42 percent for those same categories of games on the original Xbox. It is possible that some games that might have been rated T prior to 2005 are now being given the new E10+ rating. M-rated games accounts for over 17 percent of the Xbox 360 library—similar to the 19-plus percent of M-rated games on the original Xbox.



NINTENDO WII

THE NINTENDO PLATFORM STANDS OUT FOR its selection of games appropriate for nearly all gamers. From the beginning Nintendo has wanted to attract non-traditional gamers with its Wii hardware and software. Perhaps as a result of the manufacturer's strategy, many Wii games have been designed to appeal to—and therefore are rated for—a general audience. Over 82 percent of the Wii catalog is either rated E or E10+. Only three percent are rated M, less than half the rate on Nintendo's previous console, GameCube.



PLAYSTATION 3

OVER 47 PERCENT OF PLAYSTATION 3 GAMES ARE rated E or E10+. Games rated T account for nearly 32 percent of the PlayStation 3 library compared to 38 percent on the PlayStation 2. The M rated games are a significant portion of the software on the PlayStation 3, currently 21 percent, up from almost 15 percent on the PlayStation 2. No other platform of the last two hardware generations has as high a ratio of M-rated games. The two platforms with comparable numbers of M-rated games are the Xbox (over 19 percent) and Xbox 360 (over 17 percent).

CAVEATS

A GAME SUBMITTED TO THE ESRB FOR review is typically assigned a rating irrespective of whether that game reaches the market or not. Moreover, the ESRB database contains some games that have received ratings and will be released in the near future—but not necessarily all of them.

For these reasons the ESRB database is not a perfect reflection of reality. However, the defects in the data are small relative to the total number of games. The PlayStation 3 has 176 games in the database, so a single game represents around six tenths of a percentage point. Nearly

every feature of the distribution graphs discussed above represents 3 percentage points or more. Therefore what errors exist in the ESRB database will not greatly affect the contours of the graphs above.

Another thing to keep in mind is that after 2005, T-rated games were

broken up into T and E10+ rated games, which makes distribution from the last generation to this one somewhat confusing. That said, the statistics of the current consoles, which were all released after that period, still tell an interesting tale.

—Matt Matthews

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» kim swift,
erik wolpaw,
and jeep barnett

THINKING WITH PORTALS

CREATING
VALVE'S NEW IP

» TO OUR GENUINE DELIGHT, PORTAL HAS BECOME ONE OF THE most notable games of 2007. Though PORTAL's development path was by no means perfect, during the two years we spent creating the game, we refined what we think is a terrific process. A rigorous playtesting schedule, iterative story design, and a marketing strategy that helped mitigate some of the game's riskier elements all contributed to a fresh, enjoyable experience for players—one which remained accessible despite its unconventional narrative and gameplay mechanics.

GETTING STARTED

Perhaps the most unconventional element of PORTAL's development was the way in which the project arrived at Valve. All of us on the PORTAL team (with the exception of our writer, Erik Wolpaw) were students at DigiPen Institute of Technology, a university focused on video game development. As a part of the curriculum each year we had to form teams and create a game from scratch using our own code and artwork. The requirements for the games range from a text-based game for our freshman year to a fully 3D game with simulated physics for our senior year. For our final game project, seven of us got together and created a game called NARBACULAR DROP.

We knew that we were going to be graduating soon, and we needed a great project to put on our resumes. When trying to come up with the game design for our project we focused on creating a game that was simple and unique. Simple, because from our previous school projects we learned that there are never enough hours in a day to do what you'd like. Unique, because we figured we could get more attention for a new idea, and since we were in school there was no risk in trying out an original concept. After throwing around a few ideas we were able to come up with the game design for NARBACULAR DROP, the

KIM SWIFT graduated from DigiPen in 2005, and subsequently became a level designer and team lead for PORTAL.

ERIK WOLPAW co-wrote PSYCHONAUTS' story and dialog. For his current employer, Valve, he has contributed dialog to HALF LIFE 2: EPISODES ONE & TWO and TEAM FORTRESS 2, and was the lead writer for PORTAL.

JEEP BARNETT started programming for Sandlot Games, for which he shipped INCREDIBALL: THE SEVEN SAPPHIRES. After that he focused his efforts on ensuring that the Source Engine is thinking with portals. Contact them at valve@gdmag.com.

THINKING WITH PORTALS

predecessor of PORTAL. In that game, you were able to create two interconnected portals, a red and a blue, and place them dynamically around the level; using them to solve challenges and traverse the various maps in the game.

Every year, DigiPen holds a job fair for graduating seniors, during which they bring in developers from across the country to take a look at students' projects—and hopefully offer them interviews. During our job fair, Valve sent over a couple of representatives who took a look at NARBACULAR DROP, and they subsequently invited us to come to their offices and demonstrate the game for Valve founder and managing director Gabe Newell. We ecstatically accepted and the following week we found ourselves in one of the conference rooms at Valve, with Gabe Newell sitting with rapt attention on a couch. About fifteen minutes into our demo, Gabe stopped us and

asked what we planned on doing after we graduate. After we answered, Gabe offered us a job on the spot to make the game in full using the Source engine.

Needless to say, we all accepted the offer and started working on PORTAL in July 2005. Working at Valve straight out of school certainly required some adjustment. One of the wonderful things about Valve is how intelligent and helpful everyone is. We've learned many things that have helped us to become better game developers.



GAME DATA

PORTAL

PUBLISHER:

Valve

NUMBER OF FULL-TIME DEVELOPERS:

8

NUMBER OF CONTRACTORS:

0

LENGTH OF DEVELOPMENT:

26 months

RELEASE DATE:

October 10, 2007

PLATFORMS:

PC Windows

Xbox 360

PlayStation 3 (Developed in conjunction with EA)

DEVELOPMENT HARDWARE:

AMD and Intel CPUs

DirectX 8-9

ATI and Nvidia GPUs

256-4GB RAM

DEVELOPMENT SOFTWARE:

Softimage XSI

Visual Studio 2005

Adobe Photoshop and Illustrator

Perforce

ZBrush

Sound Forge

Havok

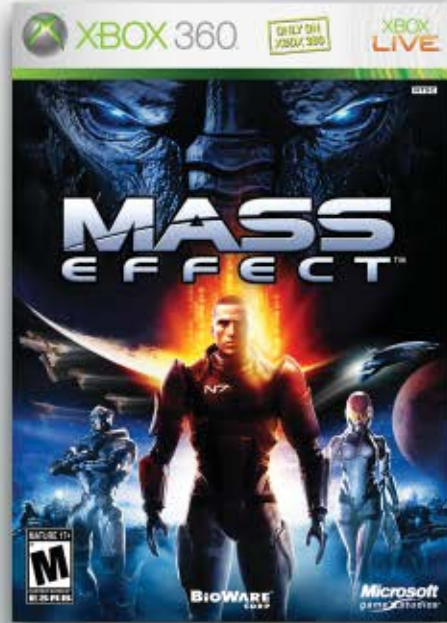
PLAYTESTING IS EVERYTHING

We were introduced very quickly to the cornerstones of Valve's development process: Playtesting and application of playtest observations to game design. While creating NARBACULAR DROP, we didn't playtest the game until the last month of its development. Our playtests revealed several problems and bugs, but it was far too late to actually fix most of them. When developing PORTAL, on the other hand, we started playtesting our game almost immediately. We had a very rough version of the first room of the game up and running the first week we started at Valve.

There wasn't much to that first room, and in fact, it didn't even really have a puzzle (other than waiting for a portal to appear and then walking through it). Even so, we began having other people playtest it. Testing this early let us start making



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THINKING WITH PORTALS



efficient, playtest-driven changes to the level from the very beginning of development.

Every week (or any time we created a significant new piece of content), we would bring in someone that hadn't played the game before. We'd sit them down, tell them to play the game just as they would at home, and then watch them play from beginning to end. Actually observing someone play your game gives you much more information than simply having them fill in a questionnaire after they've finished playing. You can clearly see when a player is having fun, is confused, happy, sad—everything. Watching them lets you monitor their moment-to-moment experience. This instant feedback was invaluable for tuning the game in addition to uncovering plenty of code bugs.

This particular testing method was beneficial in a number of ways. It allowed us to be objective about new content and often gave us ideas of how to fix problems. It even provided the inspiration for new puzzles, as we witnessed playtesters solving puzzles in ways that we hadn't previously considered. After watching a playtest, we would begin working on improving our levels and gameplay based on what we had observed during the playtest.

This rapid iteration on our maps helped us create a very smooth difficulty ramp. If more than one playtester had problems in a

certain area we would break out problem-solving concepts into separate sections. For instance, in one of our maps there is a section where you have to reorient an energy ball through a portal twice to direct it into an energy ball socket to activate a sliding platform. Originally, this was our first introduction to puzzles that involved redirecting energy balls. Several of our playtesters would get stuck in this section for a very long time and get really frustrated. So we broke this concept out into another two sections which involved redirecting an energy ball only once. We tested this progression of three sections, and by the time the players got to the final section they managed to grasp the concept much quicker than early playtesters were able to.

A PUZZLE GAME WITH A STORY?

One of the many things that we discovered during our playtests was that, fifteen to thirty minutes into the game, the experience started to get a little dry. We decided that the game needed some flavor and an entertaining narrative, so we turned to Valve staff writer Erik Wolpaw to help us.

Before the writing started, we met with Erik and discussed our list of narrative constraints. Since at the time we were using some HALF-LIFE art assets, and because we wanted to leave ourselves the option of someday using the portal gun



in a HALF-LIFE game, we decided that the story should in some way connect to the HALF-LIFE universe. Practically speaking, we didn't have sufficient time or staffing to add any human characters, which would have required an impressive amount of animation work and scene choreography. That meant the story had to be expressed without the benefit of any visible extra characters.

A week after the meeting, Erik came back with some sample dialog he'd recorded using a text-to-speech program. It was a series of announcements that played over the newly-christened "relaxation vault" that appears in PORTAL's first room. Everyone on the team liked the funny, sinister tone of the writing, and so Erik continued to write and record announcements for other chambers, while still searching for the story proper. At some point, however, it became apparent that these announcements were providing playtesters with the incentive to keep playing that we'd been looking for all along. Better yet, in the sterile, empty test chamber environment, players were actually becoming *attached* to the alternately soothing and menacing computer guide. We'd found the narrative voice of PORTAL.

After this insight, the rest of PORTAL's story fell into place quickly. The facility would be owned by Aperture Science, the scrappy, unethical scientific rival of HALF-LIFE's Black Mesa. The guide, now named GLaDOS, would simply talk to players throughout their experience—praising them, taunting them, and, whenever possible, trying to make them feel guilty for the nonstop acts of defiance and mayhem that game players are conditioned to commit routinely in game environments. Our hope was that by the end of the PORTAL, players would know GLaDOS better than any boss monster in the history of gaming. Though we knew at some point the player would have to meet and destroy her, we thought it would be even more satisfying if players got a chance to cause her some emotional pain along the way. Even though you literally break her to pieces at the end, the entire game is a long process of tearing her down; she becomes increasingly more vitriolic and desperate as the player progresses.

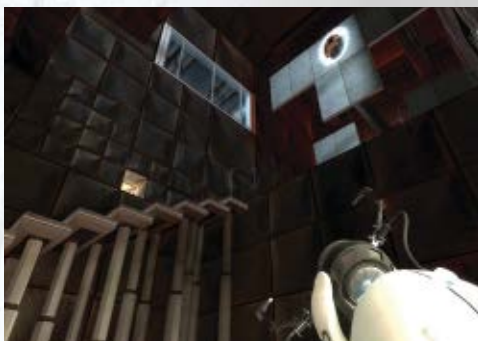
What started out as a seemingly burdensome constraint—a total lack of human NPCs—eventually turned into one of the strongest parts of the game. Navigating the environment is PORTAL's primary

gameplay challenge; In effect, the environment *is* your enemy. GLaDOS's disembodied omnipresence gives that enemy a voice and personality.

PORTING PORTALS

These successes are not to say that the game was a cakewalk. The first challenge we faced was to take the portal technology we'd developed for NARBACULAR DROP and make it work in Valve's Source engine. Source is a huge code base, and while it offers a lot more functionality than our homespun NARBACULAR DROP engine, it required that we undertake a massive redesign. When we first started working on PORTAL, we tried to get a hacked version of portals up and running as quickly as possible so we could begin testing our maps. This system basically involved a teleport and the camera/monitor system that already existed in Source. Quickly, we realized that we needed a more robust method for rendering the portals and allowing the player and other objects to move seamlessly between them. This required us to dig a little deeper into the Source engine's rendering and physics code, and we had to program our own portal system.

Basically, we had to tell the Source physics system to make a temporary hole on only one side of a wall, and that everything behind the portal is connected



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THINKING WITH PORTALS



Source engine like HDR blooming. Since we have to render our scenes an additional two times for our portals we poured a lot of our effort into making portals render as fast as possible, such as special view frustum culling based on the portal's edges, and render list optimizations for portal drawing.

THE ORANGE BOX

When we started working on PORTAL, we didn't know that it was going to be packaged inside THE ORANGE BOX with HALF-LIFE 2, the HALF-LIFE episodes, and TEAM FORTRESS 2. In the end, though, we're certainly glad it was. We took plenty of risks with PORTAL; the game is short; it features a new gameplay concept, and it's a puzzle-based game with a story. Under normal circumstances, it would be extremely challenging to market an experimental project like PORTAL. Placing the game in THE ORANGE BOX alongside a well-known franchise allowed us to present a new concept to a wider base of players than we could have if it were only sold as a standalone game. In retrospect, packaging a new franchise as a smaller game amongst two well-known IPs is a low-risk way of testing its potential.

Though two years is a short development cycle in comparison to some other games, it was definitely plenty of hard work. Now that we're at the end of the Cinderella story of PORTAL's creation, it's just incredibly gratifying to hear how many people have enjoyed the game, and that all of our efforts have paid off. Despite the common wisdom that gamers simply want to play the same basic concepts over and over again, PORTAL is happy proof that, when approached in the right way, original gameplay and narrative elements can produce fun, memorable, and most importantly for everyone's ongoing employment, successful games. The medium still has a lot of unexplored territory, and we're certainly looking forward to striking out into the unknown. ❖

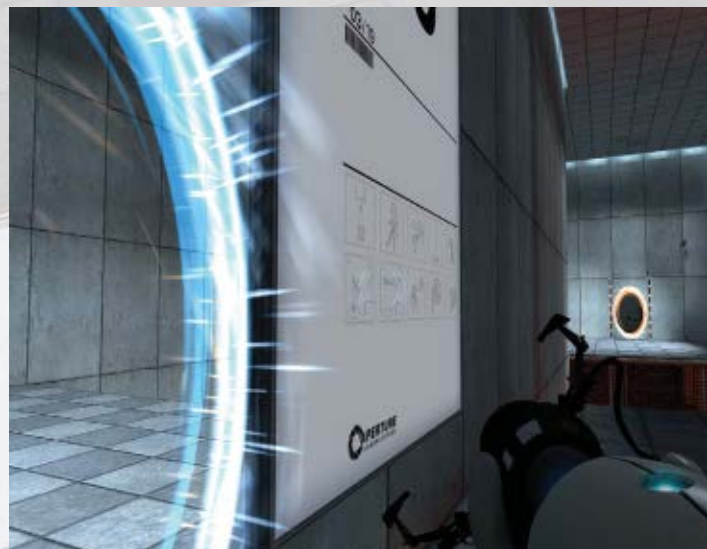
to geometry in another part of the map. Getting this to work and optimizing the solutions to run in real-time was a major challenge.

After we implemented the bare bones of getting a working portal system we had to figure out how to tackle some of the more complicated problems. For instance, how do you deal with one of our weighted cubes sitting halfway in a portal? The player and other objects needed to be able to interact with both sides of the weighted cube and have that interaction be convincing. This also comes with interesting edge cases such as an object being able to actually collide with itself.

LOD RUNNER

Another problem we ran across was the need to change distance-based systems such as level of detail (LOD) for models, because with our game, distance is relative to the portal locations. This means that the distance calculations became a choice of three lines connecting two points, rather than just one line. Also, line of sight can pass through a single portal more than once to reach its target. The Source Engine does many pre-computed visibility optimizations for culling. Allowing users to bridge visibility leaves with portals added another level of complexity.

For better rendering, we implemented a stencil buffer drawing method for portal views, which gave us a lot of flexibility for handling the portal recursion depth. This allowed us to render an infinitely deep number of portals (limited only by performance), which made our "infinite" hallways look pretty neat. Stencil drawing also helped us solve the problem of integrating properly with other technology in the





Unreal Technology News

by Mark Rein, Epic Games, Inc.

Canadian-born Mark Rein is vice president and co-founder of Epic Games based in Cary, North Carolina. Epic's Unreal Engine 3 has won Game Developer Magazine's Front Line Award for Best Game Engine for the past three years, and Epic was awarded Best Studio at the 2006 Spike TV Video Game Awards. Epic's "Gears of War" won GameSpot's overall Game of the Year and sold over 4,000,000 units on Xbox 360. Epic recently shipped the PC version of "Gears of War" for publisher Microsoft Game Studios, as well as "Unreal Tournament 3" for PC and PlayStation 3 for publisher Midway.

Upcoming Epic Attended Events:

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Please email:
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UNREAL TOURNAMENT 3 UTILIZES GAMESPY AND SPEEDTREE TECHNOLOGIES

Epic has licensed IGN GameSpy's multiplayer technology and Interactive Data Visualization's SpeedTree middleware for use in *Unreal Tournament 3*. IGN GameSpy and IDV are members of Epic's Integrated Partners Program, which means their technologies have been integrated into Unreal Engine 3 and are immediately available to engine licensees.

GameSpy's multiplayer technology, which includes multiplayer matchmaking, in-game and out-of-game messaging, deep player statistics, Voice over IP (VoIP) communication and a robust leaderboard and ranking system, has been incorporated into the PLAYSTATION³ and PC versions of *Unreal Tournament 3*.

"GameSpy is excited to expand our existing relationship with Epic Games and align ourselves with *Unreal Tournament 3*," said Jamie Berger, IGN Entertainment's senior vice president of consumer products and technology. "As our technology continues to expand and evolve with next-generation consoles, we will continue to work with developers to provide an ease and expertise when it comes to online gaming technology."



Unreal Tournament 3 for PC and PlayStation 3 uses GameSpy multiplayer technology and SpeedTree foliage software.

Unreal Tournament 3 is the first game to give the mod-making community access to professional SpeedTree tools. The game industry's leading foliage technology is set to enhance the game's virtual worlds as well as offer unprecedented tree-editing features to players creating their own game versions.

"SpeedTree is the undisputed leader in virtual foliage, and its superb presentation in *Unreal Tournament 3* will set a new standard in the way games should look and feel," said IDV CEO Chris King. "*Unreal Tournament 3* is going to be an incredible experience, and we are unbelievably proud to get to be part of it."

NORTH CAROLINA TECHNOLOGY ASSOCIATION NAMES EPIC 'LARGE COMPANY OF THE YEAR'

Epic has been recognized as the Large Company of the Year by the North Carolina Technology Association (NCTA). The NCTA 21 Awards are North Carolina's oldest and most prestigious awards devoted to promoting excellence, innovation and leadership in technology.

The NCTA 21 awards are grouped in five categories:

Technology Industry Awards, Stage of Development Awards, Functional Awards, Leadership Awards and Excellence Awards. Even though it has fewer than 100 employees, Epic received the large company Stage of Development award for its massive success following the record-breaking launch of *Gears of War*, as well as the continued prosperity of its *Unreal* series and Unreal Engine 3. Other finalists in the Large Company of the Year category included Accenture, Cisco, Red Hat and Microsoft Charlotte.

ACROGAMES LICENSES UE3 FOR NEW GAME

AcroGames, a new Seoul-based developer, announced that it has licensed Unreal Engine 3 to develop its first title. AcroGames' team members have helped create best-selling titles in Korea such as NCsoft's *Lineage II* and Softmax's *Magna Carta* series.

"We are very satisfied to be working with Unreal Engine 3," said HyunTae Jeong, chief executive officer and game director of AcroGames. "We have had positive experiences making games with previous releases of Epic's engine and are finding that Unreal Engine 3 is extremely flexible and quite capable of meeting our development needs."

EPIC JOINS THE ENTERTAINMENT SOFTWARE ASSOCIATION (ESA)

Epic Games has joined the Entertainment Software Association (ESA), which represents U.S. computer and video game publishers. As a member, Epic will have access to and influence the ESA's work in meeting the challenges currently facing the entertainment software industry. Initiatives include business and consumer research, a global anti-piracy program, government relations and intellectual property protection efforts.

"As an independent game developer and pioneer in enabling game mods and user-created content with the Unreal Engine, we look forward to bringing our unique views on balancing intellectual property rights and user freedoms to the ESA," said Tim Sweeney, chairman and chief executive officer of Epic.



For UE3 licensing inquiries email:
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2008 GAME DEVELOPERS CONFERENCE PREVIEW

IT'S GDC TIME AGAIN (DOESN'T IT SEEM TO BE HAPPENING MORE FREQUENTLY these days?), and the giant, pulsating overmind at CMP, which also owns *Game Developer*, has instructed us to inform you of the various goings on in this year's iteration. Well, it's not actually quite like that. In fact, we as the editors of the magazine truly do look forward to GDC every year, not only because it's the best place to speak with and interact with game developers, but also because it's still a great place to learn things, even as it's growing. After all, your teams have all gotten bigger too!

The GDC is continuing its tradition of high-level speakers mixed with some more entry level fare for those just breaking in, but is seeing more compartmentalization in terms of summits. A new addition this year is the Worlds in Motion summit, discussing virtual worlds and the sticky points involved in their creation. There's even a Game Outsourcing Summit. Who says we can't keep up with the times? Outsourcing is still frightening to a lot of people, and this is a good place to discuss the ups and downs.

This year in the main conference you'll find a number of talks devoted to learning to plot out the development process better, including some nice postmortems, such as *PORTAL* (you might read more about that on page 7), *CRYSIS*, *GOD OF WAR PSP*, *SPIDER-MAN 3 DS*, Raph Koster's *METAPLACE*, *ROCK BAND*, and *UNCHARTED: DRAKE'S FORTUNE*. If hearing "we didn't manage our schedule well enough" for the hundredth time isn't your cup of tea, there are separate talks on agile development from Rich Vogel (BioWare), Peter

Paul Gadi (Anino Mobile), and Clinton Keith (High Moon) respectively. This development technique has taken the industry by storm—but is it right for everyone? Perhaps not, but there is also a more general talk on crunch-less development by David Amor (Relentless Software).

Of course there are also tons of excellent [sounding] art talks from Bungie, Crytek, and a host of others, tackling issues of lighting, normal (and variant) maps, and all the things consumers have come to expect with the current generation of high-end consoles. Programming discussions are tending toward AI and pathfinding, as they will no doubt do for some time, since with greater visual reality, unexpected behaviors in characters become even more pronounced.

And if you'd really just like to spectate, we've also got Magnavox Odyssey creator Ralph Baer in the house this year, lauded by many as the creator of video games as we know them. If you read our interview with him in the March, 2007 issue, you'll know that he's not afraid to speak his mind, and what he says is generally food for thought.

With that, after a few more detailed previews, I leave you to our 'best of show' picks, chosen by editors of *Game Developer*, Gamasutra, and GameCareerGuide.com. And if we're wrong with our suggestions, you can berate us at length on the show floor—if you can catch us!

—Brandon Sheffield

Worlds In Motion Summit

Thanks to the success of **WorldsInMotion.biz** as a web site, we've been looking for new ways to bring our readers more information and insight about online worlds. In that vein, we'll be hosting the first-ever Worlds in Motion Summit on February 18–19. The summit will focus on the intersection of online worlds and games, tailored for the growing number of industry professionals and Fortune 500 companies developing interactive online spaces for both entertainment and commercial purposes.

Discussion will delve into online worlds, social gaming and media and player-created activity. This will provide insight for developers of all backgrounds into how the game industry is collectively building socialization into games and integrating personalization and player-generated content into gameplay, while widely accessible Web and networking tools are looking to the game industry for their way forward.

Among the speakers, Multiverse's Corey Bridges and Raphael Cedeno will be discussing their world-building platform specifically with a new era of end user in mind—those looking for social engagement and low barrier to entry in their gaming experience. Turbine's Jeffrey Steefel will discuss how the advent of participatory content is enriching the experience for LORD OF THE RINGS ONLINE users, and Relic Labs studio head Adrian Crook will be discussing the meteoric rise of the free-to-play

business model and the advantages it holds for users and game companies alike.

Other speakers include Areae's Raph Koster, who will highlight the ways virtual worlds are increasingly relevant to the way we play; web entrepreneur Nabeel Hyatt will discuss the marriage of gaming and social networking with games for Facebook; and author and developer Erik Bethke will share lessons on user engagement he learned while growing his GOPETS online community.

Above all, the Worlds in Motion Summit's goal is to provide a grounded, hype-free collaborative environment to identify and discuss the new ideas that have surfaced from an era of virtual worlds, and what they have to teach us about the evolution of gaming, with insight and experience from revolutionary trailblazers in the field.



Summits

Since the GDC has grown to be rather large, individual summits serve to fit the needs of specific markets, and these two-day sessions allow a more intimate environment within the larger scope of GDC. While the worlds in Motion conference is discussed on a larger scale due to this year being its debut, the rest are no less important.

GDC Mobile hosts more than 50 sessions, panels, and lectures, continuing to push the “we’re the future, really!” angle (nobody’s buying it, folks! Kidding!). Major issues this year include porting difficulties and solutions, creativity in design (why can’t we make a game that’s better than TETRIS?), and mobile-specific 3D programming.

The **Casual Game Summit** is in its fifth year now, and ever-more important as “casual games” bleed into all other categories—mobile, downloadable console games, and PC portals. With everyone going after the mass market nowadays, it might be a good time to listen to the folks who have been aiming for it all along. The speaker lineup really is a who’s who in the industry.

The **Game Outsourcing Summit** looks at the issues surrounding ... well, it’s rather self-explanatory, isn’t it? As frightening as the idea of outsourcing is, from both control and job security standpoints, large-scale games aren’t getting any cheaper to make. There are ways to outsource bits of your game and wind up having more time to actually create, and this summit should help you find the sweet spot.

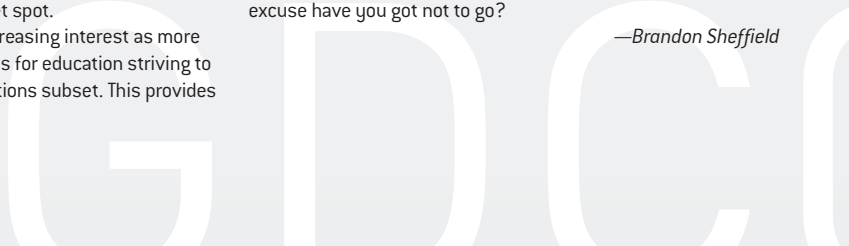
The **Serious Games Summit** is of increasing interest as more academics enter the space, with games for education striving to match the already established simulations subset. This provides

the potential to combat the negativity games are often painted with by the mainstream media. As serious games evolve, so too does our ability to parlay with government entities. But with the number of games funded by the U.S. government, developers’ reliance on them may increase as well.

The **IGDA** has two summits—one on education, and one on governments and associations. There’s a slight amount of crossover here with serious games, but both summits are very much from the developer advocacy side, in terms of setting up structures to deal with government, and support networks for game developers looking to transition into, or at least consult with academia.

The **Independent Game Summit** had its successful start last year, and is rolling on into the future of shiny happy small-company bliss. The summit helps indies, new and old, come to grips with the downloadable world, and how to ground one’s idealism in the horrors of reality. All the Summits run from February 18-19, before the main conference starts, so what excuse have you got not to go?

—Brandon Sheffield



Senior Editor Brandon Sheffield's Picks

Streaming Open World Pathfinding (lecture)

Quinn Dunki (Pandemic)

As the concept of the “level” has fallen way to the idea of an open world, certain elements, such as pathfinding and AI for NPCs, and physics for environments, have to be “on” at all times. Pandemic wrote an article for this very magazine about streaming AI in DESTROY ALL HUMANS 2's open world in December 2006, so if all goes well this talk will expand on what they've learned as it applies to the upcoming SABOTEUR.

Brainstorming in Public: 52 Game Ideas in 52 Weeks (20-minute lecture)

Patrick Curry (Midway Games)

Patrick Curry, in a fit of contrarianism, decided to create a new game idea every week for a year, in a pitch to say that original IP shouldn't be the exception, it should be the rule. Hopefully I haven't botched his message, but the exercise is interesting regardless, and in this talk, which is unfortunately relegated to 20 minutes (don't be late!), he gives a postmortem of the entire process, and whether he bit off more than he could chew.

Storytelling in BioSHOCK: Empowering Players to Care about Your Stupid Story (lecture)

Kenneth Levine (2K Boston)

Empowering is the right word here, as BioSHOCK rarely forced players into a story scenario for more than a few seconds at a time, but most frequently encouraged them to uncover the story—and indeed the game's universe—all on their own. To me, some of the more gripping moments were in the scripted

events, when the lights turn off, and you can hear voices all around you—effectively involving you as the player in the telling of the tale. This is one of my favorite games of the year, so it's not like I'm biased or anything.

Creating a Character in DRAKE'S FORTUNE (lecture)

Christian Gyrling (Naughty Dog)

UNCHARTED: DRAKE'S FORTUNE is quite impressive, not only in terms of its game design, but also its character animation and AI. Unfortunately, it's also an exclusive on the currently least-selling console, so not everyone will get to experience it. Christian is an AI and animation programmer on the Naughty Dog team, so this talk will be technically oriented, discussing how to integrate his two specialties without making them interdependent.

How to Break All Rules and yet Make a 90+ Game (lecture)

Petter Sydow (Massive Entertainment)

This rather smugly-titled talk discusses the benefits of agile development as applied to Massive Entertainment's new title, WORLD IN CONFLICT, which did get some mighty review scores. Here, he'll pitch iteration, agile teams, and the ability to change scope on a dime—or at least a quarter—and how the lessons they learned can help any developer.

Senior Contributing Editor Jill Duffy's Picks

Game Studies Download 3.0 (lecture)

Jane McGonigal (Avant Game), Mia Consalvo (Ohio University), and Ian Bogost (Persuasive games)

Every year, hundreds of research projects uncover new information about players, gameplay, electronic media, cognition, and the like that could better inform game developers. But who has time to research the research out there? Thankfully, GDC attendees have Jane McGonigal (lead designer at Avant Game), Mia Consalvo (associate professor at Ohio University), and Ian Bogost (founding partner of Persuasive Games and assistant professor at Georgia Institute of Technology) to do the legwork for us. This affable academic trio boils down the good bits to present relevant and applicable information to developers about some of the academic findings of the past year.

Python for Technical Artists (lecture)

Adam Pletcher (Volition)

Adam Pletcher, a technical art director of core tools and technology at Volition/THQ, has worked his way through the ranks of game development for the last 14 years. His Python talk promises to get down to the nitty-gritty for why all technical artists should be working with the language. His game plan is to give attendees an overview of the language's strengths, then give some game development examples and recipes to jump start all this newfound knowledge. Any technical artist or aspiring TA will want to attend for the working examples, code listings, and online resources. No worries if you have no experience with Python—beginners are welcome!

Learn Better Game Writing in a Day (full-day tutorial)

Evan Skolnick (Vicarious Visions)

Evan Skolnick knows his way around a story. A former journalist and Marvel Comics editor, he has written for *Spider-Man*, *The Incredible Hulk*, *X-Men*, and other properties; and as editorial director for Vicarious Visions, he has written (or rewritten) storylines for games, including CRASH BANDICOOT, SPIDER-MAN 2 and 3, ULTIMATE SPIDER-MAN, and X-MEN LEGENDS 2. In this full-day workshop, based on last year's popular presentation on the fundamentals of good game

writing, Skolnick teaches novice and intermediate writers the basics of good story structure, character development, and dialogue.

10 Tips for a Successful Wiki (60-minute poster session)

James Everett (Say Design)

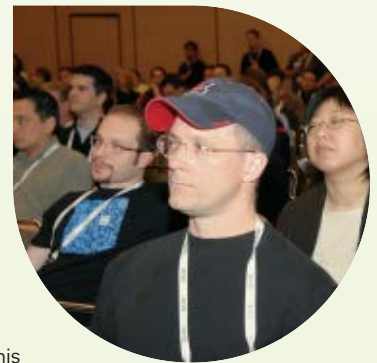
As much as I love theory, there comes a point in every conference when you ask yourself, “How am I ever supposed to do anything with these ideas?” What attracted me to this session is how it is clearly aimed at giving GDC attendees of all levels actionable information.

The session promises bullet point takeaway ideas that developers of all levels—but especially smaller studios, student game dev teams, and perpetual online games (such as MMOs)—will be able to implement immediately. The tips will all be platform agnostic, concrete, and based on someone else's tried and true experience. Who doesn't love functional fundamentals?

Breaking in to Academia (Roundtable)

Ian Schreiber (designer-at-large), Evan Robinson (Threewave Software); moderators

Educational institutions with game development programs are in need of sophisticated professionals who can teach, or at least are interested in learning how. Developers who are burning out on late nights at the office working on the same old rehashed game plots, but still have a true appreciation for theory and technique, might want to listen in on this GDC roundtable. Come to these two separate talks ready to ask questions and learn what it means to be a game professor.



Gamasutra.com Features Editor Christian Nutt's Picks

FABLE 2: The Big Three Features Revealed

Peter Molyneux (Lionhead Studios)
Peter Molyneux's ambition in game design is perhaps only outstripped only by his ability to talk about it. Here, he'll delineate the three most important innovations Lionhead has in store for FABLE 2, and illustrate through his presentation—including video and a live demonstration—exactly how he intends to push the medium forward this time around. The original FABLE may not have quite lived up to the massive pre-release hype, but I can't help but get a charge out of Peter's constant pursuit of pure inspiration.

10 in 20: Ten Keys to Designing for New IPs (20-minute lecture)

Timothy Longo (Crystal Dynamics)
Seeing Longo's impassioned and creative presentation at the IGDA Leadership Forum, in which he called for more (and more fruitful) preproduction in games, ensured I'd be interested in this talk. This one has the Crystal Dynamics creative director presenting his key concepts for developing new game design techniques for existing properties. Given that his studio rescued Lara Croft from the tailspin of the TOMB RAIDER franchise, and Longo's strong belief in following your creative impulses, this talk should deliver some useful takeaways.

WiiWare Project Lifecycle—FINAL FANTASY CRYSTAL CHRONICLES: THE LITTLE KING (lecture)

Fumiaki Shiraishi and Toshiro Tsuchida (Square Enix)
Xbox Live Arcade and PlayStation Network are known quantities. Less so Wii

Ware, which launches in March in Japan. As the makers of the first high-profile title announced for the new service, Square Enix's Shiraishi (programmer, designer) and Tsuchida (producer) will outline how the company had to change its tactics to tackle the download service—including being forced to abandon the company's trademarked lengthy cutscenes. Scheduling is also on the agenda. Tsuchida is responsible for some of Square Enix's best game design, so I'd listen to him talk about making lunch.

Nuances of Design (2-hour panel)

Jonathan Blow (Number None, Inc.)
Jonathan Blow's BRAID is a highly anticipated Xbox Live Arcade Game and winner of last year's IGF Innovation in Game Design award. This year, he returns to GDC to deliver a talk that challenges the very nature of GDC presentations. Most speakers offer non-interactive demos of their games to illustrate points, but Blow rejects that format, citing the fact that it's just "not effective" enough, making it "difficult to communicate ... subtlety and nuance." The remedy? He intends to offer a "visceral" take on your usual session by offering up interactive play sessions. This one will be worth attending to see just how he pulls it off.

Developers in the Crosshairs: Mature Content, Censorship, and Design Choices

Daniel Greenberg
Recent research has shown that Mature-rated titles sell and score the best. Here, Greenberg, who worked on CRYISIS and LORD OF THE RINGS ONLINE, will spend two sessions delving into the maelstrom of complicated issues that surround the production of the M-rated game. He will tackle questions such as the fine line between Mature and the dreaded Adults Online rating, how and why developers make the design decisions they do—including how the current social and political climate, as well as the brisk sales of violent titles, affect that.

Jeffrey Fleming's GDC Picks

Game Development Deals 2008 - Critical And Emerging Issues In Every Negotiation (full-day tutorial)

Jim Charne (Lawyer, Law Offices James I Charne), Dan O'Connell Offner (Founder, Offner & Anderson), David S Rosenbaum (Attorney, Law Offices of David S Rosenbaum), Joshua Meyer (Legal Counsel, Ubisoft), Mike Arkin (General Manager, MumboJumbo LA), Marty O'Donnell (Bungie), Steve Taylor (President, Wahoo Studios / NinjaBee), Robert Walsh (CEO, Krome Studios)
It's been said before that the game development deal is essentially a development studio's business plan. Understanding the specifics of the deal and its implications over the long-term are essential for a development studio's success. Unfortunately, because deals with publishers are almost always shrouded in confidentiality it can be hard for start-up studios to learn from the experiences of those who went before. This all-day session will pull back the veil on development deals, examining every aspect from rights and ownership, technology, licensing, financing, and even the complexities of default/breach provisions. If you want to form your own development studio, start here.

Playing to Lose: AI and CIVILIZATION (lecture)

Soren Johnson (EA Maxis)
Despite the incredible growth of MMOs and social gaming, the single-player experience is still the heart of video games. In the subtle interaction between neurons and silicon that provides the central mystery of video games, Artificial Intelligence seems like a bit of a misnomer. The best game designers understand that we don't need a computer opponent that can pass the Turing Test. Instead, we want algorithms that push and pull, like children holding hands as they spin around each other.

Designing Conflict Resolution without Combat (roundtable)

Gordon Walton (BioWare)
From the beginning, video games have almost always revolved around conflict. This conflict is rarely expressed in the "win/lose" outcome of traditional board and card games from which video games evolved, but rather specifically in terms of "kill/die." How many more times must we kill the enemy? Perhaps it is time to move conflict resolution in video games beyond the primate urge to destroy.

Virtual Greenspans - Running an MMOG Economy (lecture)

Eyjolfur Gudmundsson (CCP)
WORLD OF WARCRAFT seems to get most of the attention but I have always been intrigued by CCP's ambitious EVE ONLINE. Here is an online game that aspires to the dream of MMOs in its efforts to thoroughly simulate reality (or perhaps more accurately a reality). Hard physics govern the behavior of its star ships and the cold dictates of scarcity drive its economy. How do they manage the immutable clockwork of their single-shard world and still make it fun? Do they "game" the system?

Living with MADDEN: The Drive for Consistent Excellence (lecture)

Phillip Holt (EA Tiburon)
The MADDEN series is a silent giant (in America, that is). It's a game that doesn't get talked about much by critics but those on the ground level know that MADDEN drives hardware sales. I think it's fair to say that a not-insignificant portion of the video game audience is made up of people whose entire experience comes solely from MADDEN. In 1985 MADDEN first appeared on home computers and 23 years later it is still at the forefront of sports games. How is it possible after all this time for it not to grow senescent? The kid's got motor.

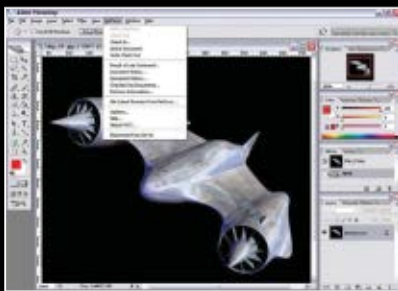


Introducing P4GT, a productivity feature of Perforce SCM.

The Perforce Plug-in for Graphical Tools, P4GT, makes version control painless by seamlessly integrating Perforce with leading graphical tools. Drop-down menus allow access to Perforce from within 3ds Max, Maya, Softimage XSI, and Adobe Photoshop.

Art and development teams can standardize on Perforce to version and manage both source code and digital assets. Enhanced collaboration during the design process helps teams to work together in real time to release small patches or create whole new worlds.

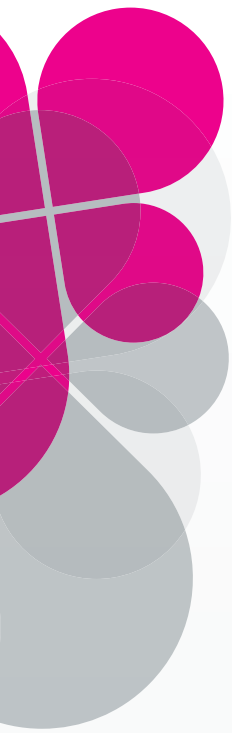
P4GT is just one of the many productivity tools that comes with the Perforce SCM System.



P4GT

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Week in Review. What to do on...

Tuesday: IGDA Party

This members-only event has become one of the biggest parties at GDC (last year, the queue to get in went halfway down the block). It will be held in '08 on Tuesday night from 8:00PM to midnight at the Westin San Francisco on Market Street (also known as The Argent). Of all the GDC parties, it's the one that I personally feel most comfortable at because there are no pretenses and no product promos. It's also the place where I'm most likely to run into people I actually want to see! Check your ego at the door, drop the shoptalk, and just come hang out.

Wednesday: Choice Awards

An older industry friend of mine once told me that in the days of yore, the Game Developers Choice Awards (which I've only been attending for about three or four years now) were once like a black tie gala. Though tickets were expensive for non-honorees, you were treated to a sit-down dinner with full service during the show. Everyone rented tuxedos and donned evening wear. Last year, to revive that proud peacock experience, I actually encouraged some co-workers to go in ball gown attire. Tasteful as all that may have seemed, I think the dress code got in the way of the spirit of the awards, which have evolved over time into a more joyful celebration.

Go, if for no other reason, to hear the Lifetime Achievement Award winner speak, and take away a renewed sense of inspiration about why you do what you do for a living. The Choice Awards are the most respectable video game awards among professionals, and though the venue is more crowded than it was ten years ago, I'm proud that we can now revel together sans three-inch heels.

Wednesday: Independent Games Festival

Back-to-back with the Choice Awards is the Independent Games Festival, not only a recognition program but also a fountain of true innovation, experimentation, and boundary-pushing for the game industry. The finalists and winners are usually somewhat new to the industry or are self-employed, often with not only their reputation on the line, but their home equity, too. Winning an IGF award is an honest to goodness chance to make it in the industry, and it's truly a moving experience to see it happen to developers again and again. Check out work by the finalists before the show at www.igf.com.

Wednesday: Expo and Booth Crawl

Tools become toys in the GDC Expo hall. The show floor is a bumping and hopping little event all its own, where developers wander, play, noodle, and doodle. But if you're a hyper organized producer-type who needs to carve out a specific timeslot for the floor, jot down Wednesday, February 20, 4:30PM in your GDC Excel sheet for the annual Booth Crawl. The Booth Crawl is like a quickie tour of the show floor where you can catch the highlights, usually while drinking domestic beer from the bottle.

Wednesday through Friday: Career Networking Bar

One tequila, two tequila, three tequila—"interview"? New to the Career Pavilion this year is a Career Networking Bar. Call me kooky, but this just seems like a bad idea waiting to happen. From the description, however, the Networking Bar sounds like it's up for an airport bar vibe, with couches and tables providing a miniature oasis from interview-mode stress of the Pavilion. See the West Hall Expo hours for times.

Thursday: Suite Night

Suite Night, an annual tradition at GDC, is something like hotel party hopping, only it all takes place in one hotel. Different rooms host different parties, sponsored by various companies (mostly tools vendors) in the game industry. This year's Suite Night is slated for the W Hotel, which has a pretty nice bar if you grow weary of networking.

Friday: Video Games Live Concert

Returning to the Nob Hill Masonic Center on Friday, the last night of GDC, is the Video Games Live concert. The show features a live orchestra playing montages of video game music as well as a giant monitor playing montages of video game footage. It's funny, it's quirky, it's a little bit geeky ... but this is your week to geek out if you want. Plus, when do you get the chance to hear a live orchestra actually play music you know?

—Jill Duffy

WEST HALL EXPO HOURS

Wednesday, Feb. 20
10 a.m. to 6 p.m.

Thursday, Feb. 21
10 a.m. to 6 p.m.

Friday, Feb. 22
10 a.m. to 3 p.m.



Week in Review Calendar

GAME DEVELOPERS CHOICE AWARDS AND IGF AWARDS	WED., FEBRUARY 20	6:30-8:30PM
GAME CONNECTION	TUE.-THURS., FEBRUARY 19-21	9AM-7PM
GDC EXPO BOOTH CRAWL	WED., FEBRUARY 20	4:30-6PM
SUITE NIGHT @ GDC	THUR., FEBRUARY 21	8-10PM
GDC MOBILE RECEPTION	MON., FEBRUARY 18	6-8PM
GAME CAREER SEMINAR	FRI., FEBRUARY 22	10AM-4PM
VIDEO GAMES LIVE	FRI., FEBRUARY 22	8-10PM



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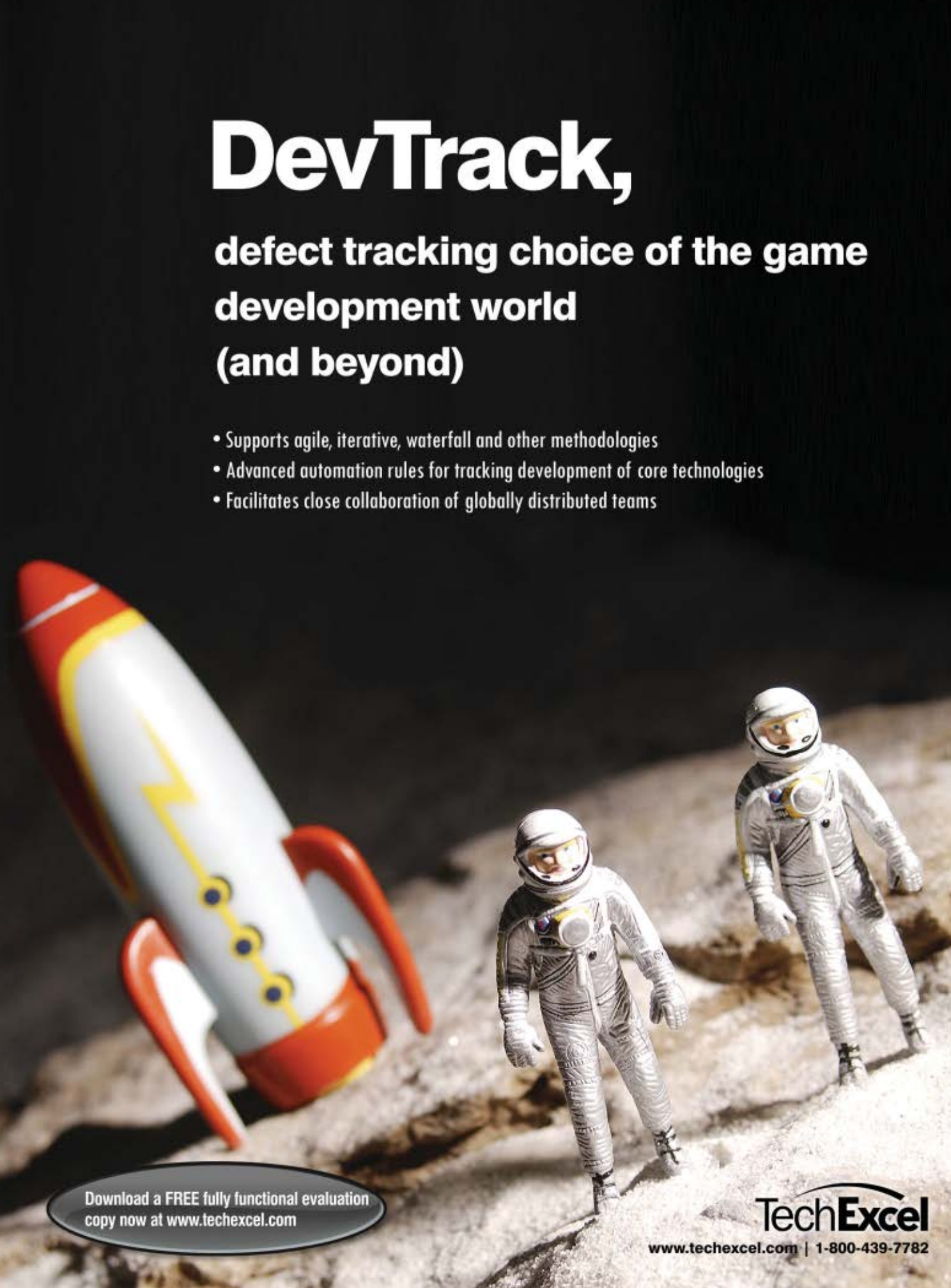
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A photograph of a white toy rocket with red and yellow accents, and two silver astronaut figurines standing on a rocky, grey surface. The rocket is on the left, angled upwards. The two astronauts are on the right, one slightly behind the other, both facing forward. The background is dark and out of focus.

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THE GAME DEVELOPER

2007

FRONT LINE AWARDS

▶ **GAME DEVELOPMENT HAS ALWAYS BEEN A COMPLICATED BUSINESS. WITH EACH NEW WAVE OF** technology comes new challenges, and of course new opportunities for developers to express themselves. The latest tide of game consoles to wash over us was greeted initially with gloomy warnings about the exponential jump in complexity that developers would need to manage. It could have been highly disruptive to the game business, marginalizing smaller code shops and leaving the market in the hands of trans-national combines who, because of exorbitant production costs, would have little incentive to create anything but carefully focus-tested crowd pleasers.

Fortunately, this gray prophecy did not come to pass and the game industry is still the home for cutting edge innovation, thanks in no small part to the variety of development tools honored by *Game Developer's* 2007 Front Line Awards. These tools have helped reduce the complexity of next generation development, allowing artists, musicians, and designers to bring their visions to life while coders push at the edges of the possible and producers keep all the plates spinning at once.

The Front Line Awards recognize excellence in game making software and pays respect to these tools. Five finalists were chosen over six categories, and one product per category is given the award. Each year we also induct one special product into our Hall of Fame, honoring a tool of lasting utility and influence that has been integral to developer's work for five years or more.

Nominations for the Front Line Awards were open to all new products and new versions of products related to game development released between September 1, 2006 and August 31, 2007. Front Line Award finalists were selected by the editors and our decisions were influenced by previous reviews of products, comments from tool customers, and the opinions of the Front Line Award judges. A panel of judges comprised of professional game developers selected the winners. The following criteria were used in the evaluation process: relevancy to game creation, innovation, ease of use, responsiveness, value, and quality. Because some products can only be evaluated in the context of day-to-day game development, feedback from users, licensees, and published reviews also informed the selection of winners. Congratulations to the finalists and the winners.

The Front Line Awards would not be possible without our panel of judges, whom we sincerely thank.

JUDGES

Shekhar Dhupelia
Amir Ebrahimi
Bijan Forutanpour
Fred Galpern
Doug Gesler
Jay Koottarappallil
Justin Lloyd
Nicholas Olsen
Bradley Meyer
Robert Morgan
Greg Snook
Jennifer Sparks
Sharan Volin

Game Developer also thanks users and licensees of many of the product submitted comments, which were integrated into the judging process.

Hall of Fame



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NAME THE SOFTWARE THAT HAS WON

more Oscar statuettes than Donald Sutherland, Peter O'Toole, Marilyn Monroe, Christian Bale, Johnny Depp, Jeff Daniels, and Steve Martin—combined. Maya is the answer.

The Maya high-end 3D modeling, graphics, and animation package won the Scientific and Technical Achievement Academy Award in 2003 citing, in part, its use "on nearly every feature using 3D computer-generated images."

Maya is top dog in the 3D animation market, having staked out the high ground as the leader in character animation for feature films and television. Aggressive pricing has recently helped Maya make inroads into video game development as well, but competition is much stronger there, primarily from 3DS Max and XSI.

Currently part of Autodesk's Media and Entertainment Division, Maya's origins have a distinctly international



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flavor. Three unique lines of research—Wavefront's The Advanced Visualizer (California), Thomson Digital Image (TDI) Explore (France), and Alias' Power Animator (Canada)—came together via a sweeping set of corporate mergers and software acquisitions in the early 90s. The resulting company was named Alias/Wavefront and the code name for the new company's product was "Maya", the Sanskrit term for "illusion." Legend has it that the first scene ever animated with the new Maya software suite was the cave-mouth set from Disney's feature film *Aladdin*. Within a year the developing software supplied the tech muscle for such blockbuster films as *Jurassic Park*, *The Abyss*, and *Terminator 2: Judgment Day*. Roughly two years later, in 1998, Alias/Wavefront rolled out the first version of Maya, streamlined and optimized for a phalanx of eager commercial users.

Later Alias/Wavefront was renamed

Alias. In 2005 Alias was sold by the cash-strapped SGI to the Teachers' pension fund of Ontario and the private equity investment firm Accel-KKR. In October 2005, Alias was sold again, this time to Autodesk, and on January 10, 2006, Autodesk completed the acquisition and Alias Maya is now known as Autodesk Maya.

Today's Maya has a flexible modeler, dominant character animation tools, and robust visual effects capabilities. While Maya can appear complex and often seems overwhelming at first, it has a fully customizable interface that smoothes out initial yips while accommodating any subsequent workflow issues. Dynamic simulation of rigid objects, soft-bodies, fluids, cloth, and hair, combined with a powerful scripting language, make Maya a great visual effects tool. Maya comes complete with its own renderer, but also includes a license for Mental Ray, a more flexible, powerful, and stable renderer.

From its auspicious beginnings, rubbing shoulders with Spielberg and Cameron, Maya has continued a run behind the scenes in major motion pictures, including *Pan's Labyrinth*, *Spider-Man 3*, *Grindhouse*, *The Host*, *Pirates of the Caribbean: At World's End*, and *Transformers*. The software has also been used to animate popular television shows. For instance, it is used in combination with CorelDRAW to animate the cartoon *South Park*, has been used to make 3D segments on *Futurama*, and every episode of *VeggieTales* after *Larry-Boy* and *the Rumor Weed* used Maya.

Of course, such games as HALO 2, CALL OF DUTY, XENOSAGA, RESIDENT EVIL, and character models in F.E.A.R are a testament to Maya's ongoing importance to the game industry and for this we honor it with the Hall of Fame award.

—Tom Carroll

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THE 2007 FRONT LINE AWARDS



Engine

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Engine Finalists

Hero Engine, Simutronics
Gamebryo 2.3, Emergent
CryENGINE 2, Crytek
Vison Game Engine, Trinigy GmbH



FOR THE THIRD YEAR RUNNING Epic Games' Unreal Engine 3 takes the lead and it's not hard to see why. Some of the most talked-about games of the next-generation have been built on Unreal technology. From the shattered, lead-etched landscapes of *GEARS OF WAR* to the groaning death rattle of *Rapture* in *BIO SHOCK*, Unreal Engine 3 gives developers the visual fidelity and the design flexibility they need to realize these diverse experiences.

While the engine offers all of the graphical amenities that artists demand, such as per-pixel lighting and rendering, dynamic shadowing, and post processing effects, it may be Epic's Integrated Partners Program

that makes Unreal Engine 3 the tool of choice. Although earlier versions of the tool arguably may have lacked the level of support developers needed to fully realize the engine's potential, Epic has since been working closely with third party providers to ensure that Unreal technology combines with a wide variety of middleware solutions. Rather than treating licensing as a side business, Epic wants Unreal Engine 3 to become the cross-platform development tool for next-generation systems. Even Electronic Arts chose to use Unreal Engine 3 over its own Renderware in the production of *MEDAL OF HONOR: AIRBORNE*.

Although born out of the run-and-gun frenzy of first-person shooters, Unreal

Engine 3 is proving itself to be highly adaptable to a variety of genres. Sega of America and Sega Europe recently licensed the engine for a number of upcoming games and BioWare's *MASS EFFECT* was built on the technology. The nascent serious games industry is beginning to invest in cutting-edge technology and Virtual Heroes plans to use the Unreal Engine 3 in the development of its simulation learning products. Epic has also been making progress with Japanese developers as well. Both Square Enix's *LAST REMNANT* and Mistwalker's *LOST ODYSSEY* are utilizing Unreal Engine 3 to realize their lush, fantasy worlds.

—Editors

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IN AN INDUSTRY WHERE FASTER GAMING platforms bring higher user expectations, the pressure for producing higher quality art in turn raises the bar for art tools. There may be many 3D modeling and animation systems available, but only a very few deliver packages that are powerful, comprehensive, and provide an efficient workflow as well. Softimage XSI excels in these areas, and is our choice for the 2007 Front Line Award.

One of XSI's great features is its gigapolygon core architecture, which allows for pushing millions of polygons interactively. For organic models such as creatures and humans, modeling feels less like traditional 3D modeling and more like sculpting. Built on top of the gigapolygon engine lies a fast

subdivision surface modeler, which works using texture coordinates as well. After your character modeling is complete, Softimage has a great hair and fur system to add the finishing touches. The hair engine is Joe Alter's renowned Shave and Haircut, used in films such as *300* and *Charlotte's Web*.

As an animation package, XSI has a nonlinear animation system with a clip-based interface, making character animation simpler than other systems. The Animation Mixer provides both high-level and low-level control for editing animations.

XSI includes the Mental Ray renderer as one of its rendering options. While other 3D packages may claim the same, none are as tightly integrated and easy to use. Additionally, with the gigapolygon core

at the heart of it all, one is able to render more detail and geometry than other systems. Finally, when the rendering tasks are completed, XSI includes a node-based 2D compositing system. In fact, XSI is the only 3D package to provide a built-in compositor.

As a significant departure from other 3D systems, Softimage allows almost any programming or scripting language to be used for plug-in and tools development. Industry standards C++, Python, Jscript and C# are supported.

The list of areas in which Softimage excels makes it a formidable system that can handle heavy loads and produce fantastic results with an efficient workflow. Definitely a winner!

—Bijan Forutanpour



Audio Tools Finalists

Fmod
Miles Sound System
Voice-O-Matic
Wwise 2007.2



Audio Tools

VIVOX PRECISION STUDIO SDK

VIVOX WWW.VIVOX.COM



BECAUSE PLAYING MMOS IS MORE THAN ANYTHING

else a social experience, voice over IP communication between players is fast becoming a mandatory feature. Recognizing that MMO developers need all the help they can get in staying ahead of the technology curve, Vivox has stepped up with their Vivox Precision Studio SDK, enabling full voice chat for massive online worlds. Going further, Vivox provides developers with a VoIP carrier infrastructure and hosting that can handle thousands of chats at once, freeing game servers from the additional voice load.

Vivox is also fostering a climate of genuine role-playing in MMOs through their unique Voice Fonts technology that allows users to alter their voices to match the appearance of their onscreen avatar. In addition, the technology enables designers to add environmental effects to player's voices, helping to maintain immersion in the game experience. With games like Linden Labs' SECOND LIFE and CCP's EVE ONLINE signing on to Vivox, online gaming may have found its voice.

—Editors

Programming Tools Finalists

Hansoft 5.0
NVIDIA PerfHUD 5
ReplayDIRECTOR
XNA Game Studio Express



Programming Tool

PERFORCE 2007.2

PERFORCE SOFTWARE WWW.PERFORCE.COM

PERENNIAL FAVORITE PERFORCE ONCE again takes honors as the leader in source control software. Unsurprisingly, it delivers strong implementations all the expected core features including revision management, and branching and merging. As an enterprise-class system, Perforce capably handles modern game industry demands of supporting hundreds of users working with hundreds of gigabytes of source and data. Plenty of configurability allows for operation within a wide array of workflows and team structures.

As a mature product line, Perforce includes many niceties. It runs on a wide variety of platforms [BeOS anybody?] and has integration features for several

key game development products: Maya, 3D Studio Max, PhotoShop, Softimage, and Windows Explorer. For custom integration purposes, both APIs and script-helpful modes exist. Recent versions have expanded Perforce's repertoire of adjunct tools with graphical viewers of branching revision history, time lapse (newer text is highlighted), and an administration tool.

Then things get powerful. From an administration angle, Perforce allows management of user and group permissions as well as the implementation of triggers on certain actions—e.g. validating a submission before accepting it into the repository.

One key difference between Perforce and other source control systems is the use of a server-based central database to manage the system. This allows for some interesting functions, such as figuring out who is running a particular version of data, or determining what somebody actually has on their system.

Some users may find Perforce a bit daunting at first, and some of the terminology only a programmer could love [ClientSpec]. Nevertheless, Perforce makes an excellent foundation piece for a game development team.

—Robert Morgan



Middleware

PATHENGINE SDK

PATHENGINE

WWW.PATHENGINE.COM

Middleware Finalists

Havok Complete, Havok
Kynapse, Kynogon
Gameface 4.0, Anark
Euphoria, Natural Motion



PATHENGINE TAKES HOME THE award for middleware because it enables complex path-finding that is easy for game designers to implement. Employing a points-of-visibility model for intelligent agent movement across 3D surfaces, PathEngine produces dependable behaviors [no more getting caught on trees!] that can reliably operate

even in the most densely populated game world. Artists like PathEngine because its continuous space movement model and overlapping ground meshes allow scenery to be placed naturally, removing the need for tile-based environments that are aesthetically constrained by AI limitations.

—Editors

Books

GPU GEMS 3

HUBERT NGUYEN (ED.), NVIDIA/ADDISON-WESLEY, JULY 2007

HTTP://DEVELOPER.NVIDIA.COM WWW.AWPROFESSIONAL.COM

Books Finalists

XNA Unleashed, by Chad Carter, Sams, August 2007
Second Person: Role-Playing and Story in Games and Playable Media, edited by Pat Harrigan and Noah Wardrip-Fruin, MIT Press, February 2007
Game Design: From Blue Sky to Green Light, by Deborah Todd, A K Peters, March 2007
Game Writing Handbook, by Rafael Chandler, Charles River Media, March 2007

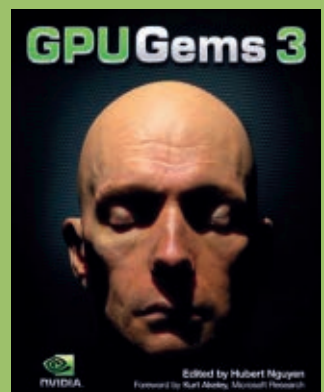
WITH THIS THIRD INSTALLMENT OF the GPU Gems series, NVIDIA cuts to the core and provides roughly 40 case studies of GPU-based approaches to solving various problems in computer graphics, physics, image processing, and general computation. What makes NVIDIA's *GPU Gems 3* the clear winner is its laser-sharp focus on demonstrating solutions that use only the latest developments in graphics hardware technology. The new generation of graphics cards such as the GeForce 8800 Ultra contain over 100 processors and are capable of performing over 400 billion floating-point operations per second, outperforming the fastest supercomputers of just a

decade ago. With no end in sight to GPU processing power through parallelism, its important to learn how to harness and solve interesting problems, which is where *GPU Gems 3* and its sequels lead the way.

As with its predecessors, *GPU Gems 3* is written for professional graphics software engineers, and assumes a strong background in C programming, mathematics, physics, graphics APIs DirectX, OpenGL, and their related shading languages, such as HLSL, GLSL, or Cg. A healthy understanding of NVIDIA's CUDA (Compute Unified Device Architecture) is also helpful in understanding some of the chapters. Needless to say, without the proper background, this book

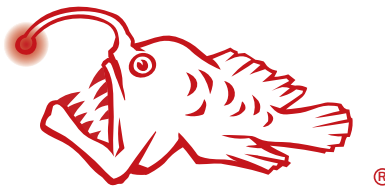
may not be rewarding to all. But for graphics engineers, it is nothing less than an important university-level textbook to take one's knowledge and skill to the next level.

While *GPU Gems 3* does not focus solely on graphics for video games, most of it is in fact extremely relevant to game development. The book is organized in five parts, including animated geometry, lighting, rendering, image effects, physics simulation, and general GPU computing. The chapters are illustrated well, many with code samples, and an accompanying DVD that includes some code and sample videos. Because of the focus on the latest hardware developments, most examples rely on DirectX 10 to run,



which means a PC running Windows Vista is required. We proudly select *GPU Gems 3* as the winner of the 2007 Front Line Award.

—Bijan Forutanpour



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Programmers
Database Administrator

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Motion Graphics/Flash Animators
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POSTMORTEM POSTMORTEM

STRANGLEHOLD

FROM THE VERY BEGINNING, OUR GOAL FOR

STRANGLEHOLD was to recreate the authentic John Woo experience in game form. We wanted players to feel like they were smack in the middle of a Hong Kong action movie, but one where they were in control of the action—"directing" the action if you will. If the player walked away from the game feeling like a bad-ass, like Chow Yun-Fat in John Woo's classic film *Hard Boiled*, we would have done our job.

As if that weren't ambitious enough, STRANGLEHOLD was also slated to be Midway's first foray into next-gen, shipping on PlayStation 3, Xbox 360 and PC. When we began, the new hardware was either at an alpha stage or non-existent, depending on which. To get a jump-start on development we licensed Epic's Unreal Engine 3, which was still very much in development itself, and we knew would need heavy modifications to create the game we envisioned. A large part of Midway's next-gen strategy is to create a shared technology base, leveraging these modifications

and new engine features across all of its studios with unified tools and art pipelines. STRANGLEHOLD was the tip of the spear in this sharing initiative, as the first internal UE3 game to ship.

STRANGLEHOLD was also a new intellectual property and brand for Midway. Even though the main character and themes were from John Woo's *Hard Boiled*, the story was written as a follow-up to the film, and Midway gave STRANGLEHOLD the full new IP treatment, trying hard to not treat it as "just another licensed game." A new IP, a new engine, and new platforms meant that STRANGLEHOLD needed to be something special and unique. We built the game from the ground up, which necessitated tons of creativity and R&D in art, engineering, and design.

We knew we had some pretty lofty goals. There's nothing like tackling everything at once. While the task was daunting, we love a challenge and couldn't wait to jump in. I could fill a book on the development of STRANGLEHOLD, but I'm going to concentrate on the core game development lessons in this postmortem.

BRIAN EDDY has been at Midway for nearly 17 years. He originally started at Midway programming pinball machines and then moved on to spearheading development on arcade titles such as *HYPHER DRIVE* and *ARCTIC THUNDER*. Eddy was the lead designer on *PSI-OPS: THE MINDGATE CONSPIRACY* and was most recently creative director on *JOHN WOO PRESENTS STRANGLEHOLD*. Email him at beddy@gmag.com.



GAME DATA



TEAM SIZE:
Ranged from 20-150 depending on phase of development.
5 art outsource companies.
3 music composers.

COST:
In the tens of millions.

LENGTH:
34 months.

RELEASE:
Sept 5th, 2007 (Xbox 360)
Sept 30th (PC)
October 28th (PlayStation 3)

PLATFORM:
Xbox 360, PS3, PC

WORKSTATION:
Custom built Dual and Quad core PC's, 3-4 GB ram, 200-400+ GB HD, ATI X1900 or Nvidia 8800, Xbox 360 and PS3 dev and debug system.

SOFTWARE:
Unreal Engine 3, Havok, Ai Implant, Bink, Devtrack, MS Studio, Perforce, Maya, Max, Motion builder, Zbrush, Photoshop, Unreal Tournament 2004.

STRANGLEHOLD



WHAT WENT RIGHT:

1 RECREATING THE JOHN WOO EXPERIENCE. Since our primary goal was to make the player feel like a bad-ass, I think it's here that we had our largest victory. Many important elements of Woo's films made it into the game in a fun, interactive form. There are dual-wielded pistols, highly cinematic action and slow-motion sequences, stunts and interactions with the world, and of course massive amounts of destruction. It's not any one of these elements that make for the fun over-the-top action we were going for, but it's the combination of all of them working together. No detail was too small to get just right when it came to capturing the Woo feel. We iterated like crazy on blood squibs, dust impacts, and death animations to get them bigger and bigger until they filled the screen like Woo's films. It wasn't realistic, but it sure looked incredible. At times we took control of the camera to create mini-movie moments and get that highly cinematic feel.

2 PROTOTYPING GAMEPLAY. Since we were creating a completely new franchise, we knew we needed to nail the core gameplay. We wanted to tackle the hard, unknown issues up front, letting us concentrate on content at the end of the project. When we started, UE3 was mostly a renderer and toolset, without the systems we needed to create the game (AI, robust physics, animation control, etc). As a result, we prototyped our core gameplay mechanics using the completed Xbox engine from our previous title, PSI-OPS. This was invaluable as we could quickly iterate on ideas with a working engine that our team was already familiar with. This really paid off, as we got the core gameplay fully functional in a flat-shaded version of our Teahouse level with

almost all of the abilities the player has in the final game. The only down side to this was it took much longer than we expected to convert this prototype code over to our Unreal codebase.

3 ART AND LEVEL DESIGN PIPELINES. While we prototyped the player mechanics in the PSI-OPS engine, we needed to get our level design team up to speed on the Unreal Editor. We began by blocking out all of our environments using UNREAL TOURNAMENT 2004, since it was a completed, fully functional game and engine. This allowed for quick iteration, and had the nice side-benefit of letting us test the maps in a multiplayer environment, discussing the maps over voice chat as we battled in them. On the art side, we started with strong concept "mood paintings," and then once the levels were blocked out in UT 2004, the concept team painted over screenshots of the levels. These "paint-overs" gave our environment artists a great vision of what to shoot for when they began creating the level in the engine. We kept the concept department involved throughout the game's development to give feedback and work with our 3D artists.

4 STRIKE TEAMS. For the second half of the project we extensively used "strike teams." Each level in the game was created by a strike team made up of around 10-12 people, with usually one or two individuals from each discipline. Each strike team had a lead who was ultimately responsible for getting the level completed. The strike teams met weekly to show off current progress, give team members feedback, and resolve any issues. These weekly meetings kept the problems visible and helped hold everyone accountable for getting their portion

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of the level completed. We also used strike teams for various features in the game like the “Tequila Bomb” special moves, boss fights, AI features, and gameplay tuning. We found that you really need strong leads and sub-leads for strike teams to work well, and we fortunately had enough good people to lead them.

5 OUTSOURCING. Outsource went better than we expected. Roughly 40% of the art and 90% of the music was done by groups outside of Midway. I attribute this to good planning. We picked assets that were lower risk and easy to send out of house. When we identified a new potential vendor, we extensively tested them first to make sure they could hit our quality bar. On the art side, we provided specifications and concept images for all objects. We also had a full-time art producer for outsourcing who gave prompt, weekly feedback to the vendors. We also did some “internal outsourcing” where we drew on the talents of our fellow Midway studios.

One big surprise was effects. Most of the effects work in STRANGLEHOLD was created by a team in our Seattle office. We realized they had some extra bandwidth, so we decided we would try “insourcing” all our effects to them. This decision was met with some skepticism, since effects are so tweaky. But this ended up working out really well, partly because the group is really talented, and partly because we had a full-time effects artist managing it all locally, and providing constant feedback. Outsourcing the music also went exceptionally well. We found some very enthusiastic musicians to work with and provided them with plenty of direction, and they in turn provided us with an exceptional soundtrack. It was a lot of work to manage the outsourcing, and the secret seems to be having internal “owners” managing the work from within your own team.



WHAT WENT WRONG:

1 OVERESTIMATING THE CAPABILITIES OF NEXT-GEN. When we started we were trying to figure out “what is next-gen?” What did it look like? How did it play? All the hardware manufacturers showed off shiny tech demos touting the unlimited power of their consoles—and the bottom line is that we bought into that a little too much. We did spend a good amount of time doing art R&D, but not enough time doing tech R&D, as most of our tech team was just trying to get the engine and game systems fully functional. So we ended up spending time on features and overly high-end art that we ultimately had to cut once we found out what the hardware could actually handle.

We also didn’t spend time on good metric tools up-front, which hampered this process further and caused more

Midway used the Psi-Ops engine to prototype player mechanics early in STRANGLEHOLD’s development. Before and after shots of the game running on the Psi-Ops engine and Unreal Engine 3 are shown.





rework. We should have been tougher in terms of setting and holding ourselves to metrics earlier on, but we really wanted to squeeze as much as we could out of the systems and maintain a high quality bar. So we pushed the envelope until we had to pull it back a bit to get STRANGLEHOLD to fit and run on the new consoles.

2 UNREAL ENGINE 3. As mentioned, Midway decided to license Unreal Engine 3 as a company-wide strategy to get every team on the same base engine. This was both a blessing and a curse. The engine gave us a big jump-start, but it was still in development during our project, and the stock engine didn't meet all of our needs, so we also brought in other middleware we had worked with before, like Havok and Ai Implant. Working with an incomplete engine was difficult and far from optimal, but it was unavoidable since we didn't have an alternate engine or toolset for next-gen.

Unreal worked really well in giving art a big head start, but keeping up with the code drops from Epic took up lots of time. We did a big merge of all Epic's new changes into our code base about once

every three months. This was a difficult and error-prone task, and at times it took the whole team down for weeks while we worked out all the issues. We lost probably two months of time on the project due to completing these merges. In the end using Unreal Engine 3 was still a win, but we should have done merges less often, and found ways to insulate our content creation teams from the downtime.

3 SCHEDULING. We knew STRANGLEHOLD was a high-risk project. With a series of unknowns, an incomplete engine, and totally new console hardware, our completion date was always in flux. As such, it was nearly impossible to schedule out the entire project. There were lots of factors. This was Midway's first next-gen game, a new IP with an extensive feature list, it was using a brand new engine and toolset on next-gen hardware that didn't exist yet and we were simultaneously starting a company-wide sharing initiative. All of this made scheduling challenging. Management allowed our completion date to move in order to fit as much as we could into the game and make it the best we could, but this was also a blessing and a curse, scheduling-wise. We kept an overview schedule showing everything needing to get done, and then we scheduled the next three months in detail. This worked well, and we made good

progress, but without a realistic hard ship date it was difficult to close out the project.

The company wanted STRANGLEHOLD to be a great game and have an extensive feature list, but we also needed to make money. Eventually management decided to set a hard end date. This allowed us to adjust the scope and schedule out the project until the end with hard deadlines. In hindsight a hard end date with a realistic feature set should have been laid out earlier in the development.

4 SCOPE NOT REINED IN SOON ENOUGH. Believe it or not, STRANGLEHOLD began its life as a free-roaming GTA-style game. But after about six months of development we convinced management that this would take far too long to develop, and was too risky to be Midway's first next-gen game on top of everything else we were tackling. We were then allowed to cut the game back to a more linear sandbox experience. But it still had an extensive feature



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list: the single player game, world interactions, four special moves, massive destruction, drivable vehicles with combat, and extensive multiplayer. We aggressively cut down the scope of each of these features as we progressed, but we kept them all in the game. After about a year of development it was clear we could not complete all these features at AAA quality, but we still kept trying. At the two year mark management set the hard end date. This let us cut drivable vehicles so we could concentrate on getting the rest of the features done at a high quality level. Ultimately cutting vehicles helped get the game shipped, but if we had made that decision a year earlier we could have put more time into mission variety and overall polish.

5 INABILITY TO AVOID CRUNCH. Quality of life is really important to us, and when we started we really tried to limit crunch but in the end we still failed miserably. We had executive reviews every three months, where we showed our progress to the management team. So we decided to try working normal hours and then for the one or two weeks before a review we would do a mini-crunch to pull it all together. This worked fine and we showed well at the reviews until management picked a final ship date. We then had to scramble to finish up the game while trying to keep the quality high. A number of features were too far along to cut, and we still wanted to have a competitive feature set, so the only way to accomplish that was to crunch the last six months of the project. Reducing scope

sooner would have allowed us a better chance of maintaining our mini-crunch method to the end. Our goal for next time is to reduce crunch as much as possible by reining in scope from the very beginning. But as long as there are deadlines and the desire to make AAA games, there will always be some amount of overtime.

CONCLUSION:

STRANGLEHOLD was a game of firsts. Not only was it Midway's first next-gen game, but it was also everyone on the team's first next-gen game. It was the first John Woo game to be released. It was the first game for us on Unreal. We knew it was a huge project, and everyone on the team put in a tremendous effort to make a AAA action game we're all extremely proud of. ❖





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UNITY PRO 2.1

Perspectives from Art, Design, and Code

UNITY: AN ARTIST'S PERSPECTIVE

By Tom Carroll

WHEN I FIRST BROKE INTO VIDEO GAMES in 1984 the argument about whether you needed an artist to make a video game was very much in vogue. That was mostly because vector-based blockbusters like *ASTEROIDS* and *STAR CASTLE* had set earnings records at the arcades, and creation of the "art" in such early raster



Unity's terrain engine.

hits as *PACMAN* and *SPACE INVADERS* certainly didn't require a degree from Art Center. Well, now thanks to the good folks at Unity Technologies that argument is kept alive, but in reverse. Via the company's Unity video game engine it's now possible for a software savvy artist to produce a game without requiring the services of a programmer.

From an artist's standpoint the Unity engine is a very flexible and relatively

easy to use venue for creating a game out of various 2D and 3D assets, and it passed my "20 Minute Test" with flying colors. I usually apply the 20 Minute Test to video games, but in Unity's case I was able to work with the software for 20 minutes without wanting to tear out my already patchy hair or lobotomize myself because of confusion, errors, or simple tedium. In fact, at the end of the first twenty, I was quite happy to spend more time playing with terrain, importing assets from Maya, and delving into deeper aspects of the package. And really, at the end of the day, isn't that what it's all about?

Unfortunately for me, before I could begin the 20 Minute Test, I had to borrow a PowerMac from a friend. It doesn't yet work on Windows, my OS of choice, though there are plans to bring Unity to Windows. My first exercises were to emulate Unity's video tutorials, wherein you create, resize and reposition various native primitive objects. The interface is clean and easy to understand. Tools are very 3D-friendly, so the learning curve was short. One of the most valuable tutorials involved Unity's Inspectors, which are hierarchical, visual methods of keeping track of your assets. One big plus for Inspectors: double click on one and it opens the file in the appropriate application, such as Maya or Photoshop.

This is a real time saver because you're always hopping from app to app and then back into Unity.

THE MEAT

After finishing the tutorials, I quickly graduated to importing assets I modeled and textured using Maya into Unity, and that's where things began to really get fun.

Terrain. Terrain is essential to nearly every game. Unity comes with a sample model already made up, so I played with that for a while using the in-game deformation tools to raise and lower the lay of the land. Later I created and textured my own terrain in Maya and imported it into Unity. Really, it was that easy. Rather than using Unity's tools to make changes, I bounced back over to Maya until I had the terrain piece the way I wanted it. Any changes I made using Maya were instantly reflected in Unity when I reopened the file.

Physics. Unity contains the full capabilities of the Ageia PhysX next-gen Physics Engine, which, in plain English, means that it supports all the physics you can shake a stick at—more than enough to satisfy the casual gamer. For me, with limited evaluation time, that meant creating a cube, designating it as a rigidbody object (which meant it would collide with other objects, including my newly imported terrain piece). It's

UNITY TECHNOLOGIES

★★★★

STATS

Unity Technologies
Esromgade 15
2200 Copenhagen
Denmark
<http://unity3d.com>

PRICE

Unity Indie: \$199.00
Unity Pro: \$1499.00
Asset Server client license: \$499.00

SYSTEM REQUIREMENTS:

Mac OS X "Panther" 10.3.9 or later
Radeon or GeForce graphics card with 32 MB of RAM
Games will run on Windows 2000/XP and Mac OS X "Jaguar" 10.2
Rage 128 graphics card or better, depending on complexity.

PROS:

1. Asset Server was easy to set up, and integrated seamlessly with Unity [Pro Feature].

2. Powerful multi-language scripting engine built on .NET with a straight-forward API exposed.
3. Real-time, in-game updates for art assets and design data.

CONS:

1. Development environment is currently OS X only, which could be a deal breaker for some developers.
2. Shadows are a Pro-only feature.
3. Not able to undo all changes made in the editor.

OUR RATING SYSTEM :

★★★★ EXCEPTIONAL

★★★★ GREAT

★★★ FAIR

★★ POOR

★ UNFORTUNATE

amazing how little it takes to amuse me, but Unity's physics capabilities are nothing to sneeze at and they are very easy to create and modify.

Prefabs. A lot of what I created in my 3D game world was purely for play, and one area that was insanely fun to play with was what Unity calls "prefabs." Simply put, a prefab is an object that is created once and then used again and again in your game world. The prefab can contain any number of attributes, such as animation and particle systems. Once created, all of the prefabs can be modified uniformly with a few simple commands. Likewise, changes can be introduced to various prefabs so they don't all look identical. My first prefab was an Easter Island head with water splurting out of the top. Once I designated the head as a prefab, I quite happily populated my terrain with it. Later, seeking to obtain a more mature rating for my game, I changed the color of the water particles from blue to red to make it look like the heads were pumping blood. With prefabs—no biggie.

While there is a lot more that I could describe about Unity from an artist's point of view, trust me when I say that it is at least as artist friendly as the Maya, Max, or Modo that you struggled to master. And since it passed my 20 Minute Test, you should investigate, innovate, and create. The one thing you shouldn't do? Procrastinate.

TOM CARROLL is a video game artist currently with Rockstar San Diego. He is also a contributor to *Twinks* and *Plonkers*, an online comic gallery. Email him at tcarroll@gdmag.com

UNITY: A DESIGNER'S PERSPECTIVE

By Thomas Grové

UNITY'S SLEEK INTERFACE AND

architecture seem fitting for a product designed in Copenhagen by Mac enthusiasts. Anyone familiar with a major 3D package such as Max or Maya should feel right at home as many of Unity's scene navigation shortcuts and commands are shared with those applications. Anyone new to professional 3D applications can find Unity's interface clearly described in the "introduction to the Unity interface tutorial". Unity is something of an all-in-one development environment for coders, level designers, artists, and systems designers. With so much crammed into a unified editor,

can be made on the fly while the game is running. This kind of instant gratification is empowering; iteration becomes fast and fun when you don't have to wait for files to cook or compile, or for the game to load.

Scripts can be added to an object simply by dragging and dropping the script from the project asset folder onto the object in the 3D scene or in the scene hierarchy. Clicking on an object displays its properties in the inspector. All of the public variables from that script that you just dragged onto the object are exposed and can be edited either by typing in a new value or by using the right mouse button to slide the value. Need to edit more than just the script's variables? Double click on the script and it pops up in Unity's syntax color-coded text editor.

Also useful were the Prefabs, mentioned in Tom Carroll's portion. These instantiated objects can be useful not only in terms of populating an environment, but can also be given to others for use in their scenes. What's really nice about Prefabs is that all of the relevant assets and code for a character can be

associated in one place instead of being defined in disparate locations throughout your project.

UNIFIED DESIGN

Unity should appeal to even code-shy designers. Prototyping ideas is very quick and the architecture is general enough for everything from 2D casual games to next-gen first person shooters. I have evaluated several engines and would put Unity at the top of my list for any budget minded company or individual. Companies with deep pockets may also want to add Unity to their lists of engines



Serious Games Interactive's GLOBAL CONFLICTS: PALESTINE was built with Unity.

I initially found myself frustrated by my laptop's 1440 x 900 display—until I discovered the space key. Every pane, such as the various 3D scene views, the scene hierarchy, the project asset folder, and the object inspector, can be maximized by hitting the space key with the mouse over the desired pane. Each pane is also dynamically resizable and configurable. Once I had my bearings, working in Unity became easy and I was quickly able to experiment with its functionality.

This is my first time working with an engine where nearly any adjustment

to evaluate; they may be surprised that good technology doesn't have to cost a million dollars.

THOMAS GROVÉ works on IP development and moment to moment gameplay. He is currently wrapping up *THE SPIDERWICK CHRONICLES* at Stormfront Studios. Email him at tgrove@gdmag.com

UNITY: A PROGRAMMER'S PERSPECTIVE

By Amir Ebrahimi

AS PART OF THE TRIUMVIRATE REVIEWING

Unity 2.1, I have taken on the task of evaluating the product from a programmer's point of view. Unity Technologies claims that over 50+ new features have been added to Unity since its last release. For many of us, a claim to having 150+ new features is more appropriate, considering this is the first time Unity has shown up as a blip on our collective radar. Why now? Well,



Unity's integrated editor.

simply enough: the feature-set is there, the performance is there, and the price is hard to ignore for the budding indie developer.

Space constraints bar me from writing in-depth about features such as .NET DLL extensibility, cooperative multi-threading from script, or the dynamic rendering adjustments employed by the engine to give you the best performance on almost any machine. But what this review can do is point out the salient features, and

answer the burning question: "Will this game engine last the lifetime of my development cycle?" The short answer is yes.

Unity 2.1 Pro, which includes the Asset Server, was used for the purposes of this review. Notably, the Asset Server, along with real-time dynamic shadows, streaming video-playback that can be used in-game on 3D models, and a pro asset library are among the new features in version 2 that you will see only with a Pro license. Dynamic shadows are a must-have for me, which makes me wonder why it is a Pro-only feature. However, the needs of your game may allow you to forgo this feature to save a few greenbacks.

You would be hard-pressed nowadays to find a game developer with a sizable project who doesn't utilize a revision control system (RCS). Lucky for you, the Asset Server is incredibly easy to set up, administrate, and begin using. If you have never worked with a RCS and don't have an IT department at your disposal, then adding Asset Server might be your best bet. Otherwise, you can choose from a variety of other RCS software packages. Perforce still reigns as the champion and unfortunately comes with a hefty price tag. The features of the Asset Server don't come close to the latest edition of Perforce, but what does these days? If you absolutely have no budget for revision control, then at the very least you should use Subversion (SVN), which can be had for a bit of blood, sweat, and tears. Even if you were a single programmer working solo, it would be remiss of you to skip out on revision control considering that you may want to roll back to previous versions of code on a whim. To avoid the entropy that creeps into any project, take this one step to delay the onset.

The biggest question on any programmer's mind when evaluating an engine is its extensibility. Short of having the source for Unity available, rest assured that Unity Technologies has provided the necessary hooks to give you the control that your artists and

designers will demand from you. The first order of business is the scripting engine, or rather scripting engines. Built on .NET, you have C#, JavaScript, and Boo (Python variant) to choose from. Naturally, the engine API is exposed to these scripting engines and all future scripting engines because .NET is being used. Not only do you have access to runtime classes such as the Camera or the MeshRenderer or a Texture, but you also get access to the editor classes to allow for additional extensibility. Need a new gizmo for your artists? Code one.

The best part of the editor is that you can expose variables from your scripts that show up as customizable hooks to your designers. What this means is that you can write an array of small scripts that your designers can mix and match in ways that you would prefer to not concern yourself with. Even better is that you can enforce type-safety with those scripts by declaring the type of the object you expect to be assigned to a variable. Respect your authority!

From a graphics standpoint, you will not be disappointed. You get over 40 built-in shaders, full screen post-processing effects, and water shaders. Tweak away on your shaders by using Unity's ShaderLab language, which encompasses Cg/GLSL. If you are in a bind and need a new shader yesterday, then you can hop over to the thriving Unity community's wiki to browse a list of contributed full-source shaders.

If you are developing a game for simultaneous release on Mac, PC, and the web, then Unity should be at the top of your list for engines to review. With any game engine you always hit a wall when you push beyond what was envisioned by the product's developer. Luckily, the wall for Unity is still off in the distance and rendering as a single pixel. ❖

AMIR EBRAHIMI is a graphics programmer at Flagship Studios, which recently shipped *HELLGATE: LONDON*. He is also an instructor at the Art Institute of California-San Francisco. Email him at aebrahimi@gdmag.com



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MICK WEST

» THE INNER PRODUCT

RELATIONAL DATABASES

RELATIONAL DATABASES ARE SOMETIMES viewed as being in the domain of business applications and web development. You would use a relational database for boring applications such as inventory, accounting, or implementing a shopping cart system for a commercial web site. Game programmers sometimes view databases as old fashioned, large, slow, and replete with imponderable terminology such as “inner joins,” “foreign key,” and “tuple.” However, modern databases are actually fast, easy to use, and often useful in various stages of game development.

While relational databases can be immensely complex and powerful, their robustness and ubiquity means they can also be useful for relatively simple tasks. In this article, I'll attempt to demystify databases a little and show how they can easily be incorporated into development code, discussing a few potential uses.

WHAT IS A RELATIONAL DATABASE?

A relational database is simply a set of tables with named columns where each row is an individual record. Game programmers essentially use many forms of relational databases at run-time to store and organize things like game objects and various resources. Those databases are generally rather ad hoc. They're usually tuned for a specific purpose and operating environment and are implemented using custom code. While technically this is a database, a programmer would probably not refer to it as such.

The uses of relational databases as presented in this article are not intended to replace these custom in-game “databases,” but rather to add new functionality to be used during the development process. While the examples I give are all for Windows-based development, the nature of communication with a database server is basically text-based, so a minimum amount of work would be required to implement similar functionality on console platforms.

SETUP

Databases are run by a server, so the first thing you need to do is set up a server. The server can be local, in that it's part of your code and you access it directly via a relatively low-level API. Alternately, the server can be remote, and you access it via a network connection. This distinction can be blurred a little as you can have a server on your local machine, accessed via the network (using localhost), but that's still essentially a remote server, just somewhat quicker. Here we'll be discussing remote servers.

There are several ways of setting up a database, and what you settle on will vary with your needs and situation. If you have developers in various locations, then you might benefit from having your database hosted by a third party, as this should ensure everyone has sufficiently fast access. If your developers are all on the same network, then you'd more typically have the databases hosted on the network server. If you are a lone developer, then you'd be more likely to have the database on your local machine to take advantage of the additional speed.

Setting up a database is very easy. If you have remote hosting, you are often supplied with a web interface such as phpMyAdmin that allows you to create databases and users. On a local network, your network server will often already have some database server software installed, and you can just add

a database to that. Lacking this, you can very simply install a database by downloading and installing the MySQL software, which takes only a few minutes to get up and running.

Once you have a database up and running, it's very important that you have some way of testing your connection and the database, so you can more easily debug problems with your code. A useful tool here is HeidiSQL, a free program that lets you connect to your database server and setup, examine, and modify databases in a visual manner. There is also more fully featured software, such as PremiumSoft's Navicat, which performs similar functions.

In the examples below, I give the SQL query definitions for the database tables. While it's quite possible to set these up using a command line tool or web interface, it's generally easier to use a tool like Navicat, as it allows you to more easily adjust individual parameters in your tables.

A database server can have various users. If you are just doing some initial experimentation, then you can log in as the “root” user that you set up when you installed the server. However, as you expand the usage of the databases, then

LISTING 1 Code to Connect to a Database

```
#define SERVER_NAME "localhost"
#define DB_USER "user_name"
#define DB_USERPASS "password"
#define DB_NAME "db1"

MYSQL *handle=NULL;

handle = mysql_init(NULL);
mysql_real_connect(handle,SERVER_NAME,
DB_USER,DB_USERPASS,DB_NAME,0,NULL,0);
```

MICK WEST was a co-founder of Neversoft Entertainment. He's been in the game industry for 17 years and currently works as a technical consultant. Email him at mwest@dmag.com.

you will want to add additional users with fewer privileges to prevent inadvertent modifications to the database.

Once this is set up, you can now connect to your database from your code. The simplest way (from game code) is to use the C API. The code to connect is shown in Listing 1. The `SERVER_NAME` would be the URL or IP address of your server, or "localhost" if it's on your local machine. This setup need only be done once when your program runs. The other examples assume this has already been done, and there is a valid value in the "handle" variable. Error checking is omitted for clarity, but is something you will need to add, especially if connecting over the internet.

UNIQUE ASSET ID

A useful example of using a database during development is for the generation of asset IDs. I touched on this briefly in my article "Practical Hash IDs" (December, 2005). The idea is that, for the purpose of efficiency (both speed and space), it's best to refer to assets using a unique 32-bit ID. In the article, I suggested using 32-bit CRCs for the ID. That approach has a number of advantages, but there is still the problem with collisions, and if you're going to use databases in a broader manner, it makes more sense to generate the IDs using the database.

The simplest way to do this is to have a table that consists of an ID and an asset name (as a string). The ID field will be an integer and set to autoincrement. See Listing 2. Then whenever you add an asset name to the table, a unique ID will automatically be generated. To find the 32-bit ID number of any string, we simply look to see if it's in the database; if not, we add it. Then we just query the database for this string. See Listing 3 for a function that implements this.

These IDs are typically baked into the data as part of the build process, but can also be used

LISTING 2 SQL that Defines the Simple Table of IDs

```
CREATE TABLE `table1` (
  `id` int(11) NOT NULL auto_increment,
  `name` text,
  PRIMARY KEY (`id`)
)
```

directly in the code in the exact same way as was outlined in "Practical Hash IDs."

Note here that what we are doing is not a run-time process. The database is only intended to be used during game development for the initial creations of IDs by the team. If you are using CRCs, then it's quite easy to modify this code to check for collisions.

TRACKING ASSERTS

A common issue during game development is what to do about asserts and warnings in the code. Warnings are often ignored by non-technical staff, and manual solutions such as "when you see this warning, come and tell me" are not very reliable. The line between asserts and warnings is often blurred in order to facilitate uninterrupted development. Asserts, which should indicate some fatal error which requires immediate attention, sometime have an "ignore" option, which gets switched on by the creative staff who don't care so much about tracking down your bugs. In a development environment with a large number of people, there could be a lot of asserts or warnings being fired off by your code. It quickly becomes very difficult to separate signal from noise and to get the information to the correct person. Clearly,

some automated system would be useful.

Here we can easily use a simple database table to track these things. Listings 4 and 5 show a simple implementation of this.

The macro `NewAssert` is a drop-in replacement for the standard `assert()` macro. The only parameter is a test that must return true. If it returns false, then the macro calls `SQLAssert` with `#test` (a string containing the actual test code), and the standard file and line numbers. `SQLAssert` then formats a string that will add these to the database.

In addition, there is a more sophisticated assert macro, `NewAssertM`, that takes an additional parameter which is actually a list of parameters enclosed in parentheses. These are passed to the `assert_printf()` function, which treats it as a `sprintf` into the `assert_buffer`. The `assert_buffer` is then passed to the database. This allows you to add an arbitrary string to the assert info in the database. Usually this would contain the values of various variables involved in whatever you are testing. See the example usage at the end of Listing 5.

So what we have now is an assert macro (or a warning macro), and you can track every single instance of it firing. You no longer have to rely on the artists and level designers (or even the

LISTING 3 Get a Unique ID for a String Identifier

```
uint32 GetID(const char *name)
{
  char select_query[1024];
  char add_query[1024];
  MYSQL_RES *result=NULL;
  MYSQL_ROW row;
  uint32 id = -1;
  sprintf(select_query,"SELECT * FROM table1 WHERE name='%s'",name);
  if (!mysql_query(handle,select_query)) {
    result = mysql_use_result(handle);
    row = mysql_fetch_row(result);
    if (!row) {
      sprintf(add_query,"INSERT INTO `table1` (`id`,`name`) VALUES (NULL,'%s')",name);
      mysql_query(handle,add_query);
      mysql_query(handle,select_query);
      result = mysql_use_result(handle);
      row = mysql_fetch_row(result);
    }
    id = atoi(row[0]);
    mysql_free_result(result);
  }
  return id;
}
```

testers) to accurately report what's going on. You can even leave it in for beta versions and gather a large amount of data from a geographically diverse set.

The example shown includes a field for "machine," which is intended to hold the machine name. With this field, you can identify if a particular warning is going off a lot for one particular user. You could quite easily extend the assert logging to hold any additional information that might be useful, such as the IP address or the current level name.

Since this is a standard database, it's very easy to query, extract reports into spreadsheets, and even generate graphs and web pages from the information in the database. You can generate some pretty interesting metrics, too, such as which source files trigger the most assertions or what day of the week has the highest rate of problems.

The "time" field in the table is set to "default CURRENT_TIMESTAMP," which means that whenever the assert fires, this field is set to the server's current date and time. This can be very useful in tracking down bugs, as you can see when an error or warning first occurred, and attempt to correlate that with whatever was changed around that time. Timestamping can be useful for prioritizing fixes as well. If a particular assert has been triggering for several days (or weeks) and nothing is being done about it, then it might be that it needs to be downgraded to a warning, or an informational message (or you might need to fire someone). This kind of high-level overview of issues can be useful when there are a large number of developers on a team.

OTHER USES

The two examples above don't completely take advantage of the vast power of a relational database server. The data structures are essentially flat, and there is nothing "relational" about them. Normally a database would have

LISTING 4 SQL Table for Storing Asserts

```
CREATE TABLE `asserts` (
  `assert` text,
  `message` text,
  `file` text,
  `line` int(11) default NULL,
  `machine` text,
  `time` timestamp NULL default CURRENT_TIMESTAMP
)
```

multiple tables, cross-indexed with each other to avoid data duplication. But there's nothing wrong with using a database in this simple manner. It might seem like overkill to use it for logging, which you might do to a CSV text file, but it does not cost us anything to do it like this, and you immediately get the benefits of multiple remote connections to a robust repository and very sophisticated filtering and report generation. The fact that we are barely using any of the features of the database is beside the point.

With that in mind, there might be other obvious areas where a database could be used instead of plain logging. User input could be logged if your database is fast enough. Many gameplay metrics could be logged in early test versions, such as how long it takes to complete each goal in each level.

This data could be collated over thousands of runs and used to fine-tune the difficulty level of a game.

Remember, once you have the basic database set up and the connection software in place, it's very easy to add arbitrary new tables and to start recording whatever you like. ❌

RESOURCES

MYSQL

A Powerful open source database server.
<http://dev.mysql.com>

DuBois, Paul. "Writing MySQL Programs Using C," in *MySQL*, Third Edition. Sample chapter available online at www.kitebird.com/mysql-book/ch06-03ed.pdf.

LISTING 5 Assert Replacements that Log Asserts to a Database Table

```
char assert_buffer[1024];
void assert_printf( const char* text, ... )
{
  va_list a;
  va_start(a, text );
  vsprintf( assert_buffer,text,a);
  va_end(a);
}

void SQLAssert(const char *assert, const char *file, int line)
{
  printf ("%s, %s, %d\n",assert_buffer, file, line);
  char query[2048];
  sprintf(query,"INSERT INTO `asserts` (`assert`,`message`,`file`,`line`,`machine`)
VALUES ('%s','%s','%s','%d','%s')",
        assert,assert_buffer,file,line,GetMachineName());
  mysql_query(handle,query);
  if (0 /*don't ignore*/ ) __asm int 3
}

#define NewAssert( test)\
if( !(test)) { \
  assert_buffer[0]=0; \
  SQLAssert(#test,__FILE__,__LINE__); \
}

#define NewAssertM( test, params )\
if( !(test)) { \
  assert_printf params; \
  SQLAssert(#test,__FILE__,__LINE__); \
}

// Usage, note extra parentheses:
NewAssertM(p==NULL,("p not NULL (%p)",p));
NewAssert(p==NULL);
```

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STEVE THEODORE

PIXEL PUSHER

CUSTOM TOOLS

Environment Artists and Game Editors

HOLLYWOOD DOESN'T HAVE TO REINVENT

the camera every time they make a movie. But they're even luckier that they don't have to invent hammers, nails, and paint either. They build all sorts of stuff—sets, camera tracks, props—but working with common tools like hammers and nails makes you part of an enormous well-served market. When lots of folks need the same things you do, your needs will be more easily identified and met. The bewildering array of nails, screws, bolts, brads, tacks, rivets, staples, and other fasteners on display at your local Home Depot is proof of that.

Unfortunately, when the games business goes shopping for tools, it ends up at the mom-and-pop hardware store, not the giant big-box home improvement emporium. Despite our economic successes, we're still a niche business for tools vendors. Even if you lump games in with Hollywood and TV production, the global market for full-featured 3D packages of the Max-Maya-XSI variety is still less than half a million seats. That might sound like a lot, but compared to the market for, say, Photoshop, it's a drop in the bucket.

Add in the fact that we're still smaller than the pretty-offline-render side of the 3D business. On top of all that, remember that our engines and tool chains are incredibly diverse. Is it any wonder that the order of the day is usually "you'll take what you get and like it?"

ENVIRO ARTISTS

If games as a whole are underserved, the discipline that really bears the brunt of this tools drought is environment art. The sad fact is, you can find scads of good

software for designing your own patio or managing your recipes, but there are only a handful of packages dedicated to our most unique and difficult art task.

Max, Maya, and XSI have all made gestures in the direction of supporting world builders, but none of them really grapple with the unique challenges of building game environments. And none of them really shine when it comes to managing huge volumes of data, organizing hundreds or thousands of materials, or traversing the huge physical scope of game worlds, either. Walkthrough cameras and snapping tools are nice, but they aren't enough to turn software that's best for looking at single, highly detailed character from the outside into a tool for building big worlds from the inside.

When the market won't give you the tools you need, it's time to ask if you can make your own. One of the interesting side effects of the next-gen revolution (it's 2008 already; can we stop calling it next-gen yet?) is a renaissance in homegrown art tools. Content has become so expensive that studios are finally taking tools seriously, rather than trying to scale their output by simply tripling the size of the art team.

The popularity of .Net languages has made it easier for coders to build slick, professional applications. The relentless march of graphics hardware has made it possible for even homegrown apps to get decent 3D performance as well. After years of hoping that the major packages would save us, the hour of DIY tools seems to have arrived again.

We shouldn't overstate how far the pendulum is swinging. There are still plenty of studios that confuse "tools" with "exporters" and think merely getting polygons out of Max or Maya means "job done." There are also, to be fair, plenty of engineers who respect tools development enough to know that a full-featured 3D app is a major engineering effort, and who shy away from trying to rebuild something so huge in the compressed frame of a game production

cycle. Building your own tool is a major investment, they say, and it's safer to try to manhandle a regular 3D package into shape than to build and maintain a tool from scratch.

Tools may not make an artist, but they can certainly break one. Planning and advocating for the right tools is a critical job for every art department. It's also a difficult and delicate game of hot potato, as it can easily devolve into arguments about making other people work hard so we don't have to. To negotiate effectively for tools that will help us do our jobs, it's important to have some good strategic principles that help distinguish "good for the team" from "good for me, but not for you, pal."

With that in mind, here are some of the key considerations when deciding how far you want to go down the road of custom tools.

GAMEPLAY

The paramount factor to remember when designing your own world-building tools is the nature of the game you're making. This sounds like a truism, but you don't dare forget how intimately the choice of tools is going to affect your game's final character. In particular, you'll have to decide just how to balance your artistic desires for precision, control, and detail with the ability to quickly and iteratively refine play spaces.

Max and Maya are very powerful and provide exact control. They'll empower you to fiddle with every vertex in your world till the cows come home. Unfortunately, that level of control may be more curse than blessing if you're working on a game in which careful calibration of the play spaces is a key to success. If your game's success hinges on multiplayer action, for example, flexibility may be more important than precision. If moving a doorway is going to cost you days of retexturing, shuffling around UVs, or fiddling with sliver polys from bad Booleans... well, you're not going to move that door, even if it's adversely affecting gameplay. If changing

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the slope of your terrain means manually rebuilding separate meshes for the render, player navigation and physics, you're going to be pretty leery about tweaking the subtleties of your terrain.

There's no pain like shipping a map you know is un-fun just because fixing it would take too long. It's no coincidence that so many multiplayer-heavy titles use CSG editors (Valve's Hammer, Epic's UnrealEd) or fast height field-oriented terrain editors like EA's Battlefield Editor, since neither of these require careful UV management or as much attention to vertex level detail as conventional art packages.

Of course, plenty of games aren't so dependent on delicately-tuned play spaces. A fighting game with a static stage or a fixed-camera game of the RESIDENT EVIL variety, for example, would benefit more from the per-vertex detail of 3ds Max or Maya than from the ability to quickly sculpt a terrain mesh. Games with more confined play spaces and lower density environments don't stress the capabilities of the big two packages so severely either. Games with more formalized play spaces can strike a balance by assembling hand-built puzzle pieces to get a mixture of flexibility and precision control at the expense of some variety.

The point is not that traditional packages can't do environments well, it's that the definition of "well" includes a lot of assumptions about the role of speed and detailed management that you need to consider with care.

ENGINE INTEGRATION

If iteration is critical for some kinds of gameplay, it can also be important for getting the most out of all our fancy-pants rendering technologies. There's a school of thought—exemplified by tools like Crytek's CryEdit—that says the best editor for your game is the game engine itself.

The advantages of tightly integrating your tools and your game engine should be obvious. For starters, you can build and texture your world with the textures and materials your players will see, so that artists get immediate feedback. Having game controls and game physics running can also make it easier to see your level from the player's point of view, complete with animation and interactive behaviors. Not only does this cut down iteration time, it's also a great corrective

to the level artists' perennial temptation: worrying about how the level looks in the overhead view that only the author ever sees. To round it all out, your game engine probably has better interactive performance than a standard app—after all, it's optimized for the kind of content you're creating. At least, you'd better hope it is!

Making your engine and your game co-dependent can involve serious risks, however. Above all else, it's a strategy that demands rigorous commitment from the engineers, because a compromised engine can end up stalling the entire art staff. It's also going to be a challenge if your game isn't destined for PCs. Creating an engine that really looks the same on a PC and a console is a serious challenge. But if you can't pull it off, the benefits of using your engine as an editor are lost.

It would be nice if there were some way to hedge against the risks of integrating world editing into your engine. For several years now the major 3D packages have been touting the ability to run your own renderer inside their editor windows. This is a very attractive idea in theory, but in practice it may not be much protection from the risks inherent in the engine-as-editor strategy. It reduces, but doesn't eliminate, the dangers of engine breakdown or the divergence between PC and console rendering. Maintaining good interactive performance within your package can also be a problem—you're not getting much value from integrated rendering if your artists all work in wire frame to keep their frame rates up.

POLITICS

Of all the calculations involved in designing a tools path for your world editing process, the trickiest calculations are the human ones. Level building is a uniquely cross-disciplinary business. There are a number of very different models for the designer-environment artist relationships, and your tools should be a natural extension of your overall process. In some companies, both jobs are handled by a single person: a "level designer" rather than a "level artist." At the opposite end of the spectrum are companies that have designers doing all their work on paper and simply presenting their maps to artists

for implementation. In some places, the artists supply puzzle piece modules to designers, who snap them together to create missions. The varieties of artist-designer relationships are enormous.

Despite their variety, though, in every case that relationship has to be expressed in the tool chain. Studios using the "level designer" model are often inclined toward editors like Hammer or UnrealEd, which emphasize design flexibility and integrate game entity placement right into the authoring tools. On the other hand, companies that have artists and designers who don't work in the same application tend to need designer-specific applications for placing things like player spawns, triggering volumes, and placing game objects—the alternative, teaching a non-artist enough Max or Maya to let them navigate and place objects without breaking things, is a recipe for trouble.

When you sit down to plan your next set of level tools, think about both ends of that artist-designer relationship. Look how your artists and designers cooperate now, and consider whether that relationship would benefit from a shared editing environment. Obviously, no piece of software is going to magically build creative cooperation on its own, but an upgrade to your tool chain is a great opportunity to upgrade the relationship between artists and designers as well.

COSTS AND BENEFITS

If you're still wondering whether you ought to be designing your own custom world editing tool, that's good. Building a world-class world editor is not a slam-dunk proposition; it's a major undertaking that deserves serious thought. At least we're fortunate that they confluence of graphics hardware and new development tools has made it a thinkable option. Nobody wants to end up like one of those workstation-era companies that were handcuffed to doomed hardware and software platforms.

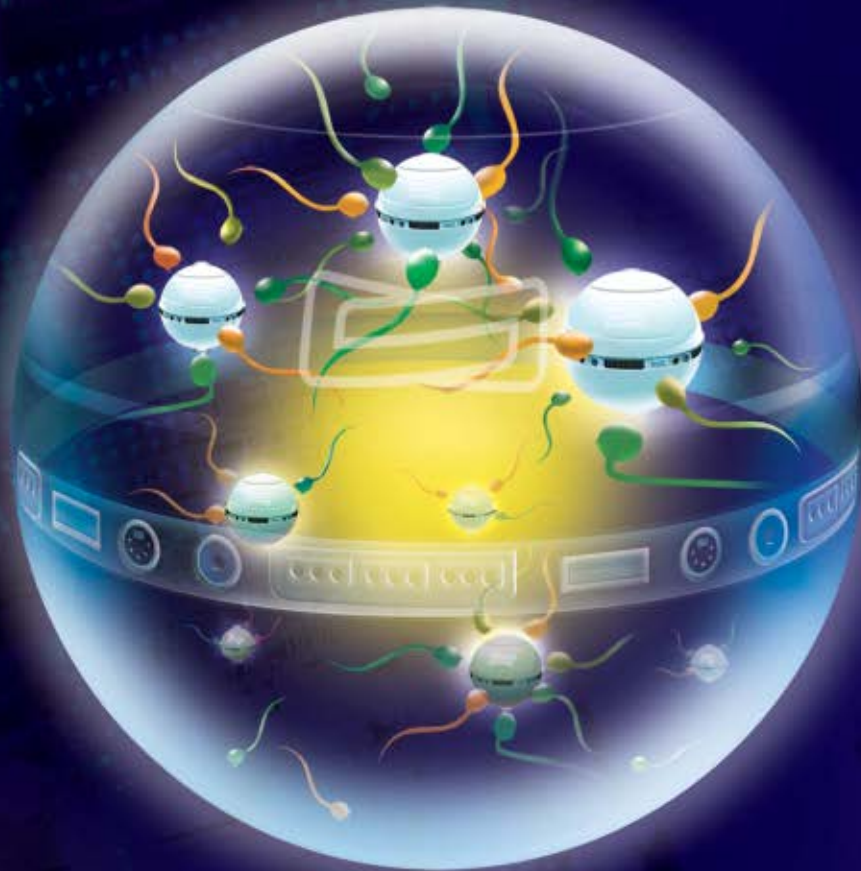
When you do sit down to ponder the question, take the opportunity to ping your friends at other studios for more information as well. The industry does a great job of solving problems, but not so well at sharing solutions. Doing a little better on that score really is a slam-dunk. ❖



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» GAME SHUI

ORANGE BOX,
GOLD STAR

IN 2005 A SMALL GROUP OF DIGIPEN students released a game called *NARBACULAR DROP*, which ended up netting the team not only a slew of awards, but also jobs at Valve and the opportunity to turn the concept into the game *PORTAL*.

I've been eagerly awaiting *PORTAL* ever since I saw a brief trailer months ago that perfectly conveyed the high concept—a hand-held device that shoots

into a portal on the floor at the feet of an enemy robot and watch it shoot out one of the walls. You can even project a new exit portal while in free-fall, and on higher levels it becomes mandatory.

This core concept, a few straight forward lock-and-key mechanisms and hazards, and a series of challenges are all the building blocks the game needs. That also makes it a wonderful example to study for good game design principles.

THE ORANGE BOX

I picked up *PORTAL* as part of "THE ORANGE BOX," a creative marketing and distribution gimmick that bears comment itself. *PORTAL* is a pretty lightweight and short game with expensive production values, so it looks like it costs quite a bit per minute of gameplay. I expect it would have been tough for Valve to break even had they sold the game as a single sale. But by selling it as part of a package with several *HALF-LIFE 2* episodes—as well as *TEAM FORTRESS 2*—it provides plenty of value for your money. The fluorescent orange box is, like *PORTAL* itself, memorable and uncomplicated.

In previous columns I've mentioned a principle Einstein espoused: "Keep it as simple as possible, but no simpler." How appropriate that this physics-based game manages to follow his advice so well. The game itself is its own tutorial, gradually introducing elements of complexity as the player progresses without compromising the fun, which is easy to describe but extremely hard to do well.

I actually didn't trust the game's simplicity at first, sure that I had missed something. But I became increasingly reassured as I laughed at the narration. The increases in difficulty are handled masterfully too, with the last few levels getting quite challenging but never feeling unfair.

COLOR ME FUNNY

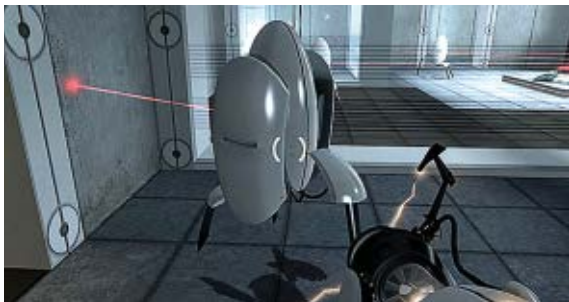
In the December 2007 column "When Tales Wag the Dog," I talked about how storytelling can complement gameplay, and this is a wonderful example of an appropriate and deft use of humor, something we've seen too little of in recent years. Situations that would otherwise have been a trifle frustrating are softened by humor to the point where I tried dying just to see what would happen. There are also intriguing and impressive hints of a deeper and more serious story beneath the surface narrative.

The narrator or main AI voice, written by Erik Wolpaw of Old Man Murray fame, who also wrote some of *PSYCHONAUTS'* wonderful dialogue, captures a sense of cynical and ironic humor that reminds me strongly of the old paper game *Paranoia*, blended well into the *HALF-LIFE* fictional world. If you enjoy this concept, I also recommend the books *Jumper* and *Wildside* by Steven Gould, which play with similar ideas of portals and teleportation taken to logical extremes.

One other game this reminds me of, surprisingly, is *KATAMARI DAMACY*, which also took a very simple concept, tied it to a funny and minimal narrative, and then explored the possibilities. *PORTAL* is much more realistic looking and less whimsical, but the two are both great incarnations of solid design principles.

VIBRANT EXTENSION

The game builds to a supremely delightful conclusion, with an ending song that simultaneously made me feel great, delved further into the main character in the game, and got me to laugh repeatedly. A week after finishing the game I can't get the song out of my head, so let me end by quoting its opening lines: This was a triumph! I'm making a note here, HUGE SUCCESS. It's hard to overstate my satisfaction. ❄️



"There you are!"

teleportation portals onto walls, floors, and ceilings. One mouse button fires an orange portal, the other a blue one. Step (or jump or fall) into one and you come out the other. Simple and elegant.

The complications come from what you can do with the portals. If you shoot one onto a distant wall, and put another next to you, you can teleport past the intervening hazards. Put one on the floor and the other on the ceiling directly over it, and you can fall endlessly, building up speed to a terminal velocity. Or drop

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ROB BRIDGETT

» AURAL FIXATION

POST-PRODUCTION AUDIO

REQUIREMENTS FOR SOUND ALPHA

CINEMATICS:

By Production Alpha, cinematics must be final and locked. The three ensuing weeks up to Sound Alpha will be where the audio post-production is done on these movies.

WEEKS 1 AND 2:

foley recording & editing
sound design
dialogue premix
music premix

WEEK 3:

final assembly, mix and export of all assets

IN-GAME:

Sound production work on in-game audio will also continue during this three week period up to Sound Alpha—getting all sounds tuned and all mixer snapshots in place during this period is essential for successful post-production sound design and mix. Scheduling should also ensure all mastered dialogue and mastered music is provided and implemented by the Sound Alpha date.

ADDING QUALITY TO GAME AUDIO

is always a challenge, yet there is something that costs nothing which allows an audio team the time to do a higher-quality job. That one missing element is post-production time.

Post-production is where the most quality can be added to a video game's soundtrack. This is the only stage at which the sound team will get its hands on finished and tuned game content. There are two important production dates that enable this to occur, Sound Alpha, and Sound Beta.

Sound Alpha ensures that all mastered assets are received and implemented, while also allowing for qualitative audio post-production to occur on cinematic movie assets. Sound Beta ensures time is set aside for prioritized sound effects replacement and iteration, while the final mix ensures balance of the entire soundtrack in the context of final gameplay.

As such, creation of and adherence to scheduled time is the most fundamental part of post-production audio. A post-production audio team will need to be assembled and their time allotted accordingly. Due to the proximity of post-production audio to Gold Master Candidate, scheduling is absolutely critical. Raising these dates with the project manager and producer as soon in the planning process as possible is advised.

SOUND ALPHA

Ensure that a Sound Alpha date is built into the production schedules, this will occur three weeks after Production Alpha. Ensure a Sound Beta date is similarly scheduled three weeks after production Beta. Strict adherence to production dates is essential for this process to work. If Production Alpha moves, for example, Sound Alpha must also move accordingly.

SOUND BETA

The Sound Beta date is a total lockdown of all audio tuning and occurs three weeks after Production Beta. It is suggested that this period consist of Phase 1—post-production sound design, and Phase 2—Post-Production mixing. Both of these should be done in a calibrated environment with a post production sound designer or mixer.

Post-Production Sound Design. This period consists of at least a week of replacing, improving, and iterating on sound effects in-game. Drawing up a list of the most important effects in the game or weakest areas and spending some quality time replacing and refining these sounds is essential for quality. A fresh and trusted pair of ears on the game at this stage is crucial. A post-production sound designer will be able to hear things that the sound director has become accustomed to over the years of production. Memory footprints will generally be unaffected at this stage as the sound effect replacement will essentially be swapping of already-implemented wave files.

Post-Production Mixing. A full in-game mix of the entire game is carried out over a two to three week period on a calibrated (and preferably THX standard) mix stage. If the game supports 7.1 the game must be mixed to this standard and the fold-downs checked regularly (stereo and 5.1). Note that prior to mixing the game will need to support some form of "mixer snapshot" mixing technology that allows mixes to be edited and saved in run-time. Mixes, or mixer snapshots, are groups of busses containing volume, pitch, LFE, LPF, HPF, DSP parameters arranged on a mixer board—connected to a hardware controller such as Mackie Control Universal—and installed at various points in the game.

It is advisable that the majority of mixer snapshots be installed by Sound Alpha and ready for tuning by the time the game hits the mixing stage. This way a full play-through can be achieved. Mixing is carried

out by tuning snapshots of mixer busses divided into four categories; default 'base mix' (the overall maximum levels of all the busses in the game are defined in the base mix); generic gameplay events (any generic gameplay event such as 'taunting' or 'rage mode' that occurs in multiple places throughout the game should have their mixer snapshots defined); generic locations (any generic locations should have their mixes done before a full play through, such as 'interiors' or 'exteriors' 'underwater'); and specific events or locations (cinematics scenes, mission specific scripted camera movements, mission specific scripted events all these specific mixer events can be identified and mixed by doing a full play through of the game).

It will be beneficial for the sound director to make a list of all the above prior to the mix and to assign mixer snapshots to these in order to facilitate a quick and efficient mixing process.

At the end of each day, any changes should be sent via VPN back to the version control software. At the beginning of each day a sync to the fresh build should be performed. It is critical that the sound programmer is present for the mixing in order to support any additional requests and also to ensure that the build remains stable for the mix. The sound programmer should be housed on-site in a separate iso-room at the rear of the mix stage, continuing to work and fix bugs remotely from there. ❖

DATE	PRODUCTION DATES	SOUND PRODUCTION DATES
1/2/2005	ALPHA	
1/21/2005		ALPHA
2/2/2005	BETA	
2/21/2005		BETA
7/3/2005	GMC	GMC

An Example of a post-production audio schedule.

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. You can email him at rbridgett@gdmag.com.



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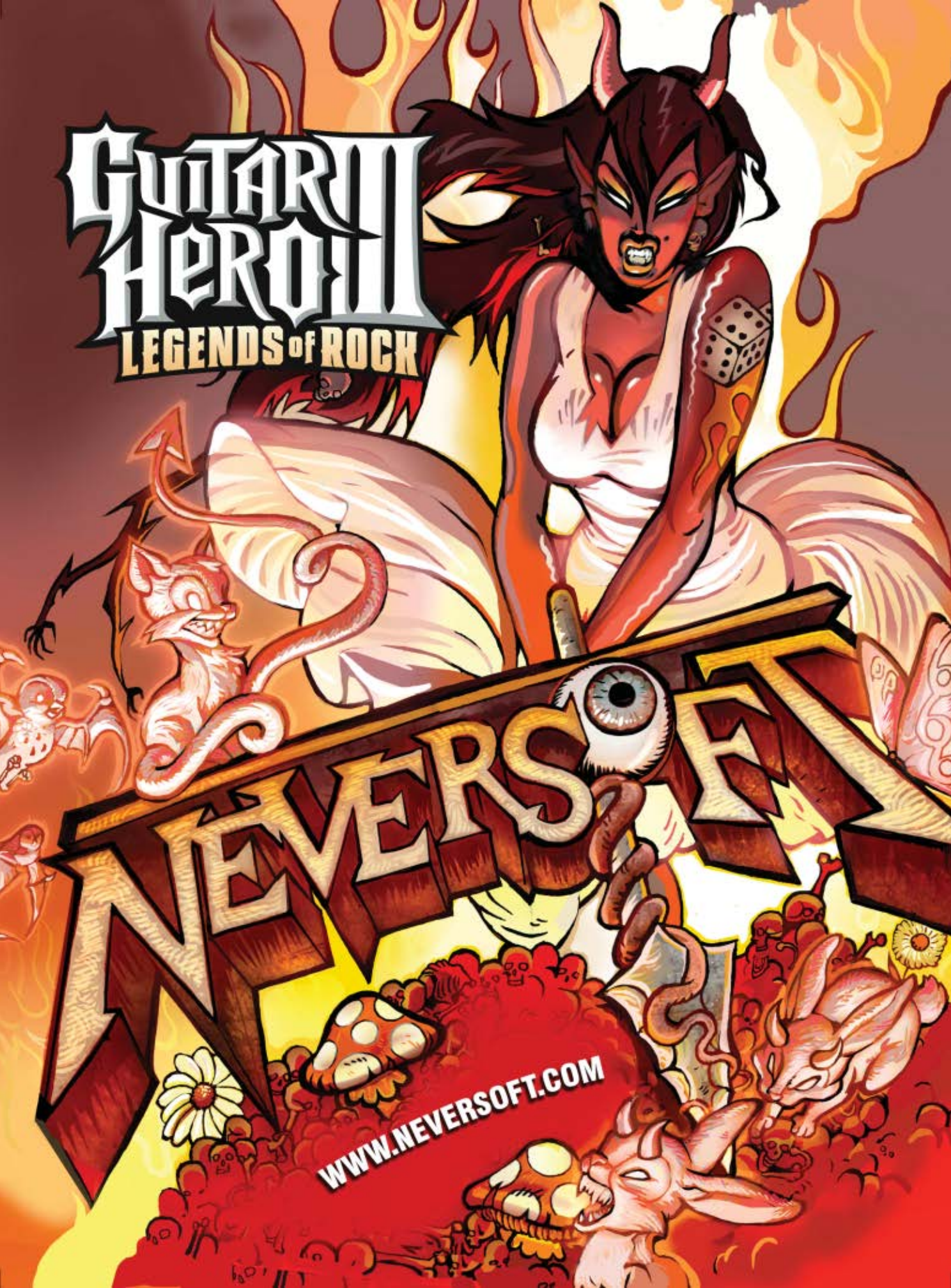
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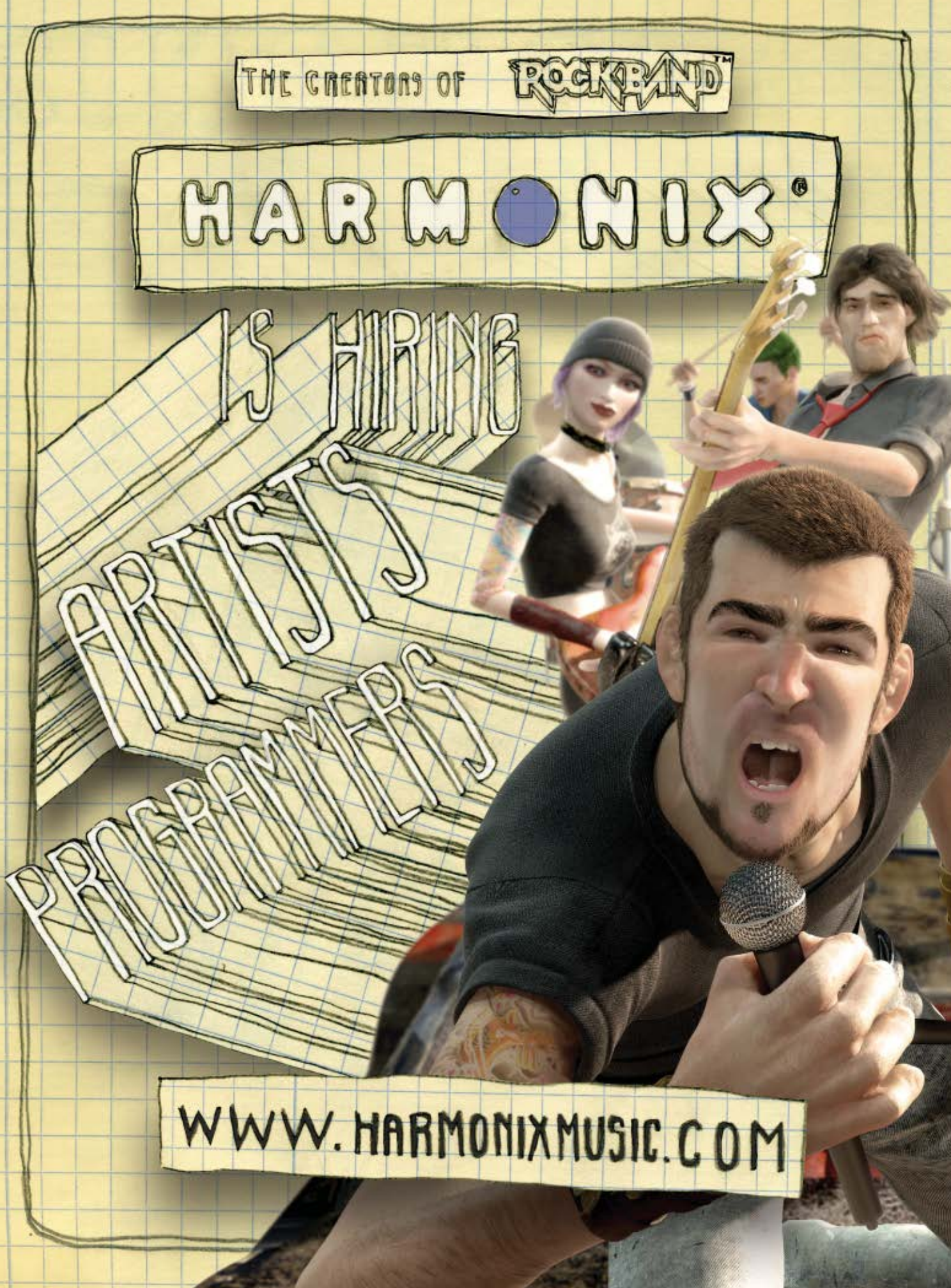
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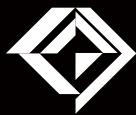
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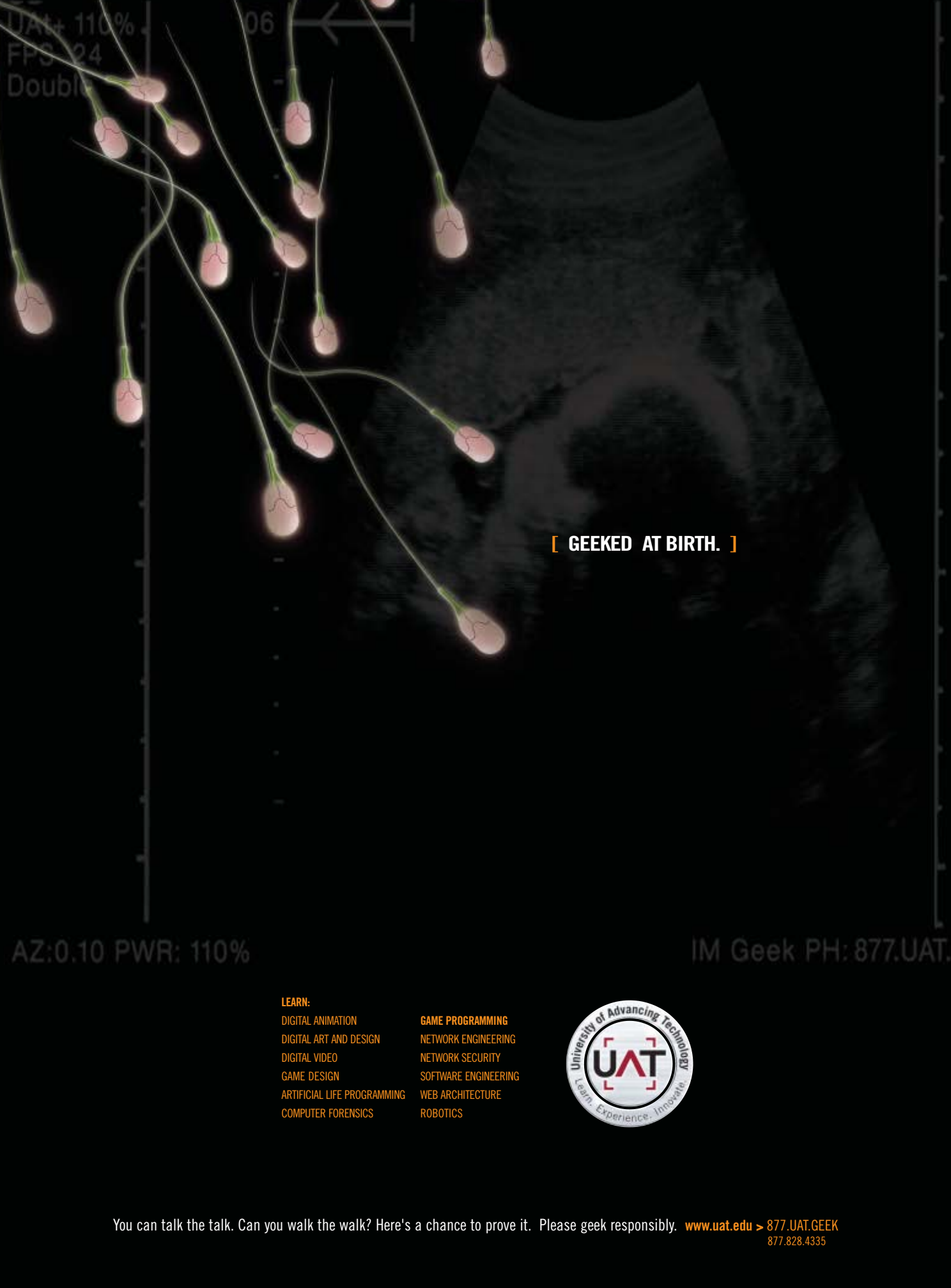
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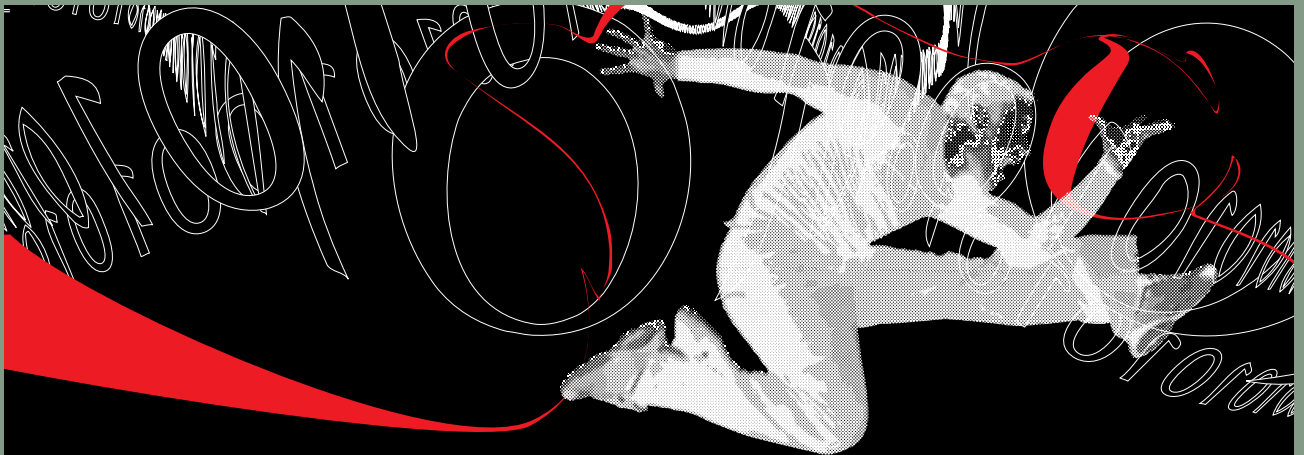
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BRADIC—Louisiana State University	25
Carnegie Mellon University	71
Center For Digital Imaging	71
Collins College	64
Devry University	14
Digipen	65
Ecarocon	39
Eidos	58
Electronic Arts	43
Epic Games	13
Fabiano Communications	67
Foundation 9 Entertainment	47
Full Sail Real World	69
Gnomon School of Visual Effects	62
Harmonix Music Systems	56
International Game Technology	58
Masters of Digital Media Program	69
Naturalmotion LTD	3
NetDevil LTD	31
Neversoft Entertainment	54
Paynova	37
Perforce Software	19
Queensland Government	60
RAD Game Tools	CV4
Replay Solutions LLC	CV3
Santa Barbara City College	68
Scaleform Corporation	9
Seapine Software Inc	21
Somatone	11
Sony Computer	55
TechExcel Inc	22
Terminal Reality	35
The Guildhall At SMU	24
Thomson Course Technology	6
THQ Inc	59
Vancouver Film School	63
WMS Gaming	60



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» BUSINESS LEVEL

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The Business Side of Starting a New Development Company

GAME DEVELOPERS ARE STARTING TO realize the lucrative potential in taking the entrepreneurial plunge and going solo. However, running a business is a much more difficult endeavor than many initially think, because of the dreaded corporate and legal side. Perhaps the most overlooked decision can also be one of the most crucial to the success and taxation of the business: the legal formation of the company. The first step even before working on projects is to decide how to form your business. Proprietorship. Partnership. S corporation. Limited liability company. C corporation. Which form is best for your new business? The decision can be difficult. Each business form offers both advantages and disadvantages that developers should be aware of.

PROPRIETORSHIPS AND PARTNERSHIPS

A sole proprietorship is a simple and inexpensive way to begin operating a business. Unless you operate the business under a name other than your own, generally no legal documents or forms need to be filed other than any licenses or permits required by your state or local government. As the sole proprietor, you have complete control over the business. However, a sole proprietorship is limited to one owner. So if you have multiple owners, or expect to in the near future, a sole proprietorship isn't right for you.

With a sole proprietorship, business income is reported on your personal federal income-tax return and taxed at

personal income-tax rates rather than corporate rates. If your business is a partnership, it must file a partnership return, but your allocable share of the business' income, losses, deductions, and credits passes through to you to be reported on your personal tax return.

The greatest disadvantage of a sole proprietorship or partnership is that, as the owner or general partner, you are personally liable for all obligations of the business. Creditors of the business can go after your personal assets if the business assets are not sufficient to cover the business' debt liabilities. While game developers don't always have as much liability as other industries such as construction or manufacturing, in today's litigious society one can never offer oneself enough protection from disaster-chasing attorneys.

CORPORATE FORMS

Incorporating your business limits your personal liability for business obligations, but generally involves greater start-up and operating expenses, as well as added paperwork. A corporation is a distinct legal entity that is responsible for paying its own debts and obligations. Shareholders risk only the loss of the funds they have invested.

C Corporations. A C corporation is taxed separately from its owners at corporate tax rates. This can result in double taxation. Corporate income may be taxed once to the corporation and again to the shareholders when it is paid out as dividends or the corporation liquidates. The corporation cannot deduct these dividend payments. However, it can deduct reasonable compensation paid to you and other owners. So, small corporations often pay out all or most of their net income to the owners as compensation, especially if the owners' top personal tax rate is lower than the corporation's rate. For reference, the top federal personal rate is 35% in 2007, while the corporate federal tax rates vary

significantly, based on taxable corporate income. The highest corporate federal tax rates may be as high as 38%.

S Corporations. With an S corporation, income, losses, deductions, and credits pass through to you and other owners to be reported on your federal tax returns just as they do with a partnership. Thus, S corporation income generally is taxed only once. Businesses operating as S corporations must meet several special requirements. For example, an S corporation cannot have more than one class of stock outstanding nor more than 100 shareholders. (A husband and wife are considered one shareholder.) Also, unlike other business forms, it cannot selectively allocate income and deductions.

LIMITED LIABILITY COMPANY

As an alternative to incorporation, consider operating your business as a limited liability company (LLC). For the most part, forming an LLC is simpler and involves less paperwork than incorporating your business. Like a corporation, an LLC provides owners with protection from personal liability for business debts and obligations.

However, most LLC owners can choose to have their businesses treated as partnerships for federal income-tax purposes. Partnership treatment means that income, losses, deductions, and credits pass through to the individual owners (called "members") to be reported on their individual income-tax returns, so LLC income is not subject to double taxation. Partnership tax treatment also permits an LLC to specially allocate income and expenses among its owners to the same extent that a partnership can.

Choosing the right business form for your business isn't an easy decision. Your financial planner or attorney can offer additional assistance in making your choice, so that you can spend your time on what you specialize in. ❖

SCOTT D. NELSON is a registered representative of Lincoln Financial Advisors, operating through Sagemarc Consulting. Contact him at SDNelson@gdmag.com.

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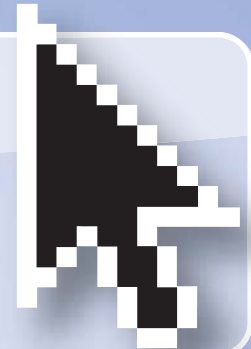
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