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Innovations in visual computing for DCC professionals



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Features

COVER STORY

Forever More

8 Eleven years ago, the dream team at PDI/DreamWorks introduced us to *Shrek*, a CGI masterpiece that spawned sequels and even a holiday special. In the fourth and last in the series, *Shrek Forever After,* the artists embrace new techniques for the first-time cast and give the returning characters a digital makeover for their first stereo 3D appearance.

By Barbara Robertson

Rare Mettle

16 Thanks to the technical wizardry of Industrial Light & Magic, Iron Man is well-suited for his appearance in the sequel *Iron Man 2*. The crew outfitted the film's actors in digital armor that redefines the term "power suit," and seized this golden opportunity to use the studio's new energy-conserving shader set to paint a better picture of the action.

By Barbara Robertson

To Hell

24 Visceral Games confronts the devilish development issues resulting from its decision to run *Dante's Inferno* at 60 fps, balancing the animation, environments, effects, AI, physics, and more in every scene to run optimally at this bandwidth.

By Karen Moltenbrey

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Editor's Note NAB 2010 Heats Up

2 Following on the heels of a well-attended Game Developers Conference, NAB drew a respectable crowd in terms of attendance, bringing a glimmer of hope for other industry conferences and exhibitions scheduled for later this year. No doubt showgoers were pleased by what they saw from vendors at the expo. See what impressed me most.

Spotlight

4 **Products** HP's new Z workstation line, including the Z200 SFF ultra-compact tower, plus the EliteBook 8740w mobile workstation. Safe Harbor's Tsunami workstations. Autodesk's 2011 finishing products. Nvidia's Digital Video Pipeline. AMD's ATI FirePro V8800.

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ON THE COVER

Iron Man is back and ready for action, thanks to ILM, which devised a better and badder power suit for the hero. This time around, the crew made far more digital replacements and alterations to the practical armor. See pg. 8.

NAB 2010 Heats Up

Another year, another trip to the desert for the annual NAB conference and exhibition. Under the bright sun (and bright lights) of Vegas, what did I find to be the hot news and offerings for the digital content creation industry? Here are my top picks:



1. **Attendance.** Okay, this is not a product, but there is some news here. NAB officials contend that attendance at this year's conference was up by several thousand showgoers from last year (accounting for a six percent increase), which is not bad considering the down economy. Unlike last year, when I walked down the front steps of the South Hall and down the main aisle unencumbered, this year saw some crowds, as folks stopped to check out Grass Valley to the left and Microsoft and AJA to the right as they entered. While NAB notes that the figures are preliminary, comparing 2010 registered attendees to 2009 actual attendees, the news does offer a glimmer of hope as we continue into the 2010 trade-show season. GDC 2010 attendance was on par with the previous year, and I can only hope that with SIGGRAPH 2010 being held in Los Angeles, we will see a crowd.

2. **Stereo 3D.** Last year, the Content Theater was brimming with stereo 3D content, and this year was no different. Unless you have been living under a rock for the past 18 months, you know that stereo 3D is no longer the *next* big thing; it is *the* big thing. And, the lines to get into the theater this year snaked all the way through the lobby area outside the North Hall. Sponsored by Sony and RealD, the sessions focused on trends in stereoscopic 3D production in digital cinematography, live sports production, visual effects, large-format filmmaking, underwater videography, and more. While ESPN provided a detailed account of its recent activities, what really packed in viewers was a Q&A about the work on *Alice in Wonderland*, along with some clips from the movie. Another attention-getter was the panel discussion (and clips) from *How to Train your Dragon*.

3. **Adobe.** It seems as if we have been waiting for a year now, but finally Adobe has revealed its latest gem: CS5, with Adobe Photoshop, Premiere Pro, and After Effects now native 64-bit applications on both Mac and Windows!

4. **Blackmagic.** For the past several years, Blackmagic has increased its stage presence at the show, and this show was no different. In an expansive booth, Grant Petty ticked off a long list of new products, including 3D versions of DeckLink HD Extreme and HDLink Pro, multiple new USB 3.0-based products, a complete evolution in color correction with DaVinci Resolve (now on Mac), a new, portable UltraScope, some new routers, a fantastic new router control panel, and more. Petty addressed Blackmagic's view on stereo 3D, too. In a nutshell, he notes that while stereo 3D is the current buzzword, whether it will prove to be the cornerstone of the future is still undetermined. Therefore, Blackmagic is rolling out products that it sees as necessary in the industry, adding stereo 3D functionality to them as a plus for those needing them.

5. **Autodesk.** The company clearly has control over the market, and at NAB, it rolled out 2011 releases of Flame, Flare, Flint, Smoke, and Lustre, featuring stereo 3D workflow support, new creative tools, and improved interoperability.

6. **The Foundry.** Nuke 6 and NukeX 6 has arrived for compositing, along with Mari, an impressive 3D texture-painting offering originally developed at Weta.

7. **The rest.** HP made its new, big product rollout just prior to NAB. Also showing off new wares was Boxx. On the graphics card side, AMD and Nvidia continued to break boundaries, with Nvidia unveiling a digital video pipeline, and AMD rolling out the V8800 and a number of other cards while previewing others. And, AJA continued its winning streak by unveiling Ki Pro Version 2.0, with support for Avid systems. A compositing plus: Eyeon revealed Fusion 6.1, the newest version of its 3D software, complete with a next-generation GPU supercomputing framework. NewTek's latest TriCaster production system was unrivaled, and RED continues with its crowd-pleasing offerings.

What did you find impressive at the show? Let us know in a blog on the *CGW* Web site.



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HP Rolls Out New Offerings



At a recent launch event, HP introduced its latest offerings to journalists from around the world, including the addition of the six-core Intel Xeon 5600 (Westmere) processor in its modular Z line—the Z800, Z600, and Z400. The new processors can accommodate up to two Intel six-core processors with Hyper-Threading turned on, offering 24 threads of power to run at one time—all deskside.

The HP Z800 offers the latest Intel Xeon 5500 and 5600 series processors, providing up to 12 processing cores, 192GB of ECC memory, 10TB of high-speed storage, and dual Nvidia Quadro FX 5800 graphics cards.

The HP Z600 also offers Intel Xeon 5500 and 5600 series processors and as many as 12 processing cores. It additionally provides up to 48GB of ECC memory, 6TB of high-speed storage, and professional 2D and 3D graphics cards up to the Nvidia Quadro FX 4800 or dual Quadro FX 1800.

The HP Z400 offers as many as six processing cores using the latest Intel Xeon 3500 series processors, providing up to 24GB of ECC memory, 8TB of high-speed storage, and Nvidia Quadro FX 4800 or dual Quadro FX 1800 cards.

The HP Z400, Z600, and Z800 are available now. Pricing starts at $929 for the HP Z400 workstation, $1579 for the HP Z600 workstation, and $1799 for the HP Z800 workstation.

Adding to its Z workstation line, HP introduced the Z200 SFF ultra-compact tower, sporting a dual-core processor option based on the Intel Core i3 and i5, or a quad-core option based on the Xeon 3400 series. With a starting price rivaling those of traditional desktop computers ($739), the HP Z200 SFF breaks new ground with a space-saving design that is almost two-thirds smaller than the Z200 mini-tower workstation. Available now, the HP Z200 SFF supports up to 16GB of ECC memory and up to 2TB of high-speed storage. It also includes professional 2D and 3D graphics options.

On the mobile side, the company introduced its most powerful mobile workstation to date: the EliteBook 8740w, sporting an optional HP DreamColor display and featuring a 17-inch diagonal display, a range of Intel processors including Core i7 Extreme Edition, and support for up to 16GB of memory.

The 8740w offers a choice of the ATI FirePro M7820 with 1GB of GDDR5 video memory or the Nvidia Quadro FX 2800M or Quadro FX 3800M, both with 1GB GDDR3 video memory. Users selecting the ATI FirePro configuration benefit from Direct X 11 and multi-display support. The EliteBook 8740w is available now for $1999.

PRODUCT: WORKSTATIONS

Safe Harbor Unleashes Tsunami

Safe Harbor Computers rolled out a new workstation solution engineered to take full advantage of the Adobe Mercury Playback Engine with PNY graphics and 64-bit processing. Each system is custom-configured with memory, storage, capture card, PNY display card, and Adobe software.

The Mercury Playback Engine is Nvidia GPU-accelerated, 64-bit native, enabling users to work more fluidly on projects in SD, HD, 2K, 4K, and beyond; open complex projects faster; add effects; and work on multiple high-resolution layers in real time with no rendering.

Nvidia Quadro FX 3800, 4800, and 5800 graphics cards by PNY are the driving force of the Mercury Playback Engine, with GPU-accelerated effects taking the load off the system processors to deliver a feature-rich editing experience.

Safe Harbor's Ready-To-Edit Tsunami Workstations are available now; pricing varies according to configuration.

PRODUCT: WORKSTATIONS

Nvidia Unveils Its Digital Video Pipeline

Nvidia took the wraps off its new Quadro Digital Video Pipeline, a turnkey system that simplifies and accelerates the production of live 3D broadcasts. The Quadro Digital Video Pipeline solves the complexity of acquiring, processing, and delivering both traditional and 3D content by leveraging Nvidia GPUs.

The pipeline fully enables 3D workflows by processing simultaneous right-eye and left-eye video streams in real time. By pairing this system with Nvidia 3D Vision active-shutter glasses, broadcast operators and directors can preview stereo 3D content at full resolution during production. During acquisition, the system ingests four HD-SDI feeds (or two stereoscopic 3D feeds) simultaneously, using the GPU to debayer raw camera data in real time, so directors see the highest quality, color-corrected images. At processing, it renders and composites real-time 3D graphics, virtual effects, and transitions. Then, it outputs the right- and left-eye HD-SDI streams with audio, for immediate previewing and broadcasting.

The next generation of the Nvidia Quadro Digital Video Pipeline is available now; pricing varies with configuration.

PRODUCT: STEREO 3D

AMD Heats Up Market with the ATI FirePro V8800

AMD launched the first of a new family of ATI FirePro professional graphics solutions with ATI Eyefinity technology, starting with the ATI FirePro V8800, the only professional graphics solution supporting ATI Eyefinity multi-display technology and Microsoft DirectX 11 technology. With ATI Eyefinity technology, professionals can use up to twice the screen workspace with a single card. With one ATI FirePro V8800, users can drive up to four independent 30-inch displays, enabling 16.4 million pixels in vivid color detail. ATI Eyefinity technology works seamlessly with AMD'S ATI FirePro S400 Synchronization Module.

The ATI FirePro V8800, priced at $1499, delivers 2.6 teraflops of raw computing power with the highest memory bandwidth (147.2GB/sec) available in any single-card professional graphics solution (more than two times the compute power of the previous generation), enabling users to manipulate complex, photorealistic models in real time.

In the coming months, AMD plans to round out its next-gen ATI FirePro family, offering a number of solutions to meet the various 2D and 3D needs of professionals working in CAD, DCC, broadcast, medical imaging, and financial services.

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Autodesk Announces 2011 Finishing Products

Autodesk rolled out the 2011 releases of its creative finishing products for visual effects, editorial finishing, and color grading—Flame, Flare, Flint, Smoke, and Lustre—which offer new creative tools and improved interoperability, and introduce an end-to-end stereoscopic 3D (S3D) finishing workflow for TV and film.

Smoke 2011 features new tools for editing, viewing, and compositing stereoscopic 3D content. It provides a drag-and-drop conform of AAF or XML files from Apple Final Cut Pro or Avid Media Composer, and has native in-application support for RED RAW media and H.264 QuickTime. Launched in December 2009, Smoke for Mac OS X is gaining ground in Mac-based creative workflows by offering, for the first time on that platform, an all-in-one editorial finishing solution. With integrated tools for editorial, conform, color correction, keying, tracking, painting, rotoscoping, compositing, and 3D visual effects, Smoke can reduce the need for editors to work with multiple applications to deliver higher-quality finished content. Smoke—priced at $14,995—is also available as a turnkey solution for the Linux operating system.

The 2011 releases of Flame and Flare, meanwhile, add new creative tools and help further integrate advanced 3D capabilities with a new GPU-based pixel-shader rendering pipeline that helps improve the quality of rendered results and enables support for new texture mapping and lighting effects. Included is a new Substance procedural texture library with at least 100 near-photorealistic textures that can be applied to 3D objects, 3D text, or surfaces; native in-application support for RED RAW media and H.264 QuickTime; and support for individual rendering layers when soft-importing OpenEXR media files. The versions also support a number of 3D compositing enhancements.

Lustre 2011 features S3D capabilities that enable advanced creative look development by helping to give colorists control over color and lighting effects in both stereoscopic and standard grading workflows, with new support for grading of OpenEXR media files, RED workflow enhancements, and open management of grading metadata.

The releases vary in price based on configuration.

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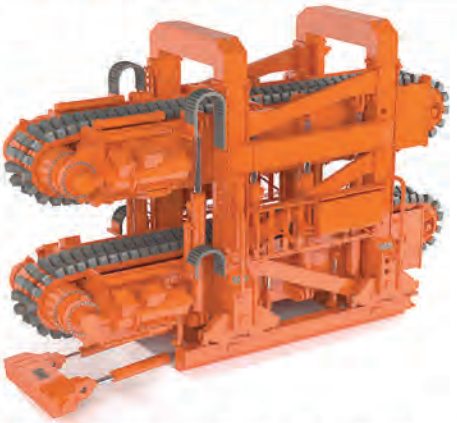
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Sequels can be a little like high school reunions. You want to revisit old friends, but when you arrive, you realize you landed in some kind of alternate reality. The prom princess is now a tough cookie. The class clown turned into a donkey. The flirt got fat. From far, far away, high school may have seemed like a fairy tale. But, stuff happens.

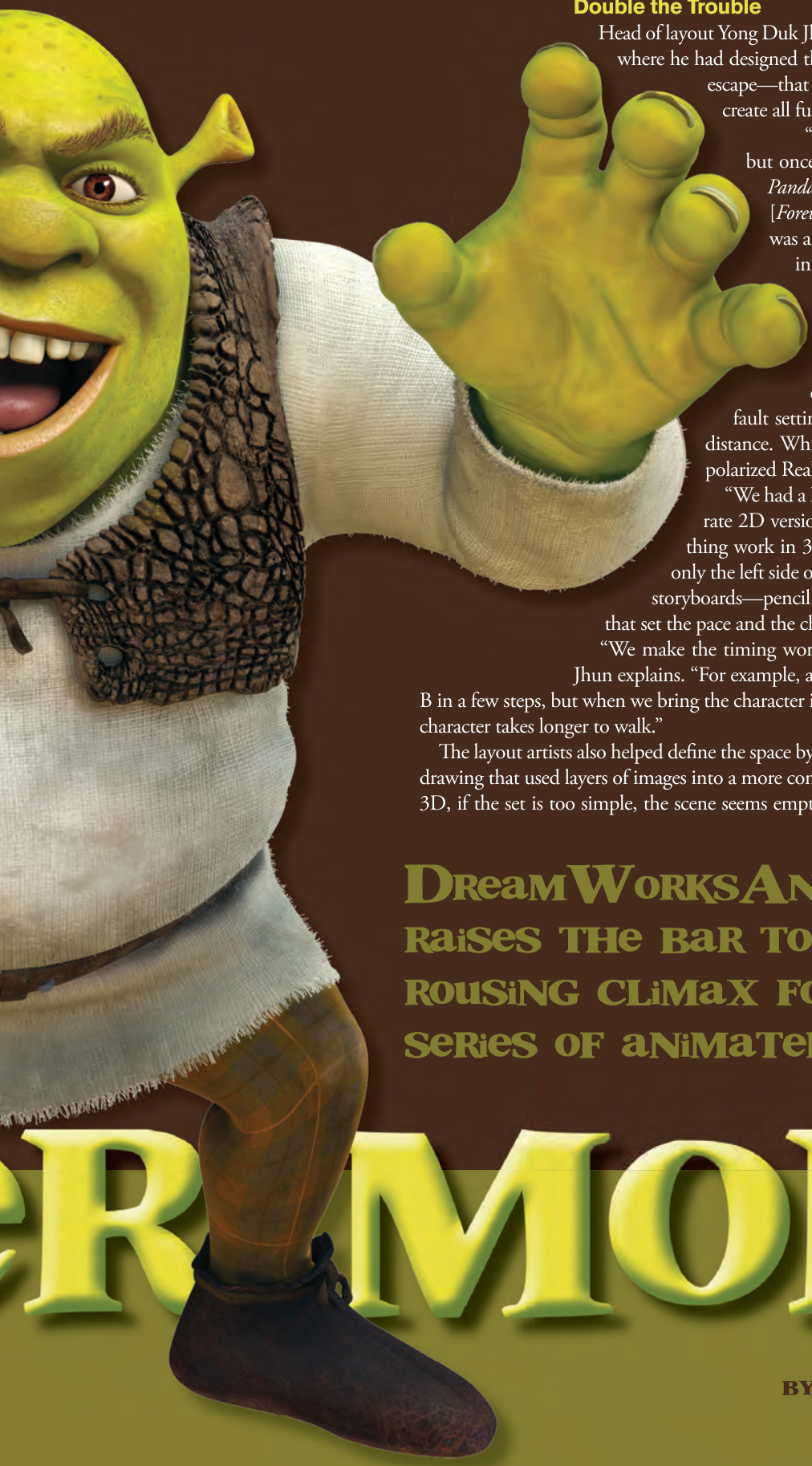
So, too, with the characters in *Shrek Forever After,* the latest and last in a series of four animated features from PDI/DreamWorks that started with the Oscar-winning *Shrek* in 2001. In this film, all the familiar fairy-tale characters except Shrek change personality and sometimes size after he spins them into an alternate reality. The circus master for the wicked whirlwind is the devilish Rumpelstiltskin, who persuades our favorite green ogre to sign a magical contract. When Shrek does, the Kingdom of Far Far Away rips apart and reforms itself into a rougher, darker world.

The characters have the same voices—actors returning for the final *Shrek* chapter include Mike Myers (Shrek), Cameron Diaz (Princess Fiona), Antonio Banderas (Puss In Boots), Eddie Murphy (Donkey), and Julie Andrews (Queen Lillian). But, in the alternate world Shrek enters, every character we know has led a different, horrible life. Donkey doesn't recognize Shrek and gallops away from him. Princess Fiona is still an ogre, but now she's an athletic warrior who tosses her long hair in defiance; in this world, ogres are hated and hunted. Even the gingerbread cookie is a hardened gladiator. "Gingy is forced to fight animal crackers to the death," says director Mike Mitchell. "It's a violent scene. Crumbs fly everywhere."

This is the first *Shrek* Mitchell has directed, though like many on the crew of approximately 500 artists, he has worked on previous *Shrek* films. "We held onto as many of the stars from previous films as we could, and we also injected a new energy by bringing in artists from *Southpark* and people I worked with on other jobs, like *SpongeBob*," Mitchell says. "But, we made sure everyone was a gigantic *Shrek* fan. The challenge was that this sequel had to be as good as all the ones before, to be the best ever. And it's in [stereo] 3D."



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DreamWorks Animation Raises the Bar to Create a Rousing Climax for the Popular Series of Animated Features

...ER MORE

BY BARBARA ROBERTSON

Double the Trouble

Head of layout Yong Duk Jhun moved onto *Shrek* from *Kung Fu Panda,* where he had designed the stereo 3D sequence—the leopard Tylon's escape—that helped persuade CEO Jeffrey Katzenberg to create all future animated films in stereo.

"I wasn't a big fan of 3D a long time ago, but once I started working with stereo for *Kung Fu Panda*, I became one," Jhun says. "For *Shrek 4* [*Forever After*], we were in 3D right away, and it was a lot different. Traditionally in layout, we put in cameras and shoot actors. Now we've added another asset: depth. We made 3D a big part of the storytelling."

Helping Jhun and the artists was a tool developed by Phil "Captain 3D" McNally called Happy Ratio, which gave them default settings for camera convergence and interocular distance. While the layout artists worked, they wore the polarized RealD glasses.

"We had a lot of discussion about whether to do a separate 2D version," Jhun says. "We decided to make everything work in 3D, and for the 2D theaters, we would play only the left side of the camera." The layout artists started with storyboards—pencil drawings in 2D from the story department that set the pace and the character's emotional journey.

"We make the timing work in a real 3D space using real 3D assets," Jhun explains. "For example, a storyboard character might walk from A to B in a few steps, but when we bring the character into the 3D set, the distance is farther so the character takes longer to walk."

The layout artists also helped define the space by adding assets that transformed a simple 2D drawing that used layers of images into a more complex and deep stereo 3D scene. "In [stereo] 3D, if the set is too simple, the scene seems empty," Jhun says. "So we're forced to put more



People are afraid of ogres in the alternate reality that Shrek entered after signing Rumpelstiltskin's magic contract. Technical directors created many of these background characters by using the rig to sculpt variations of a generic model.

objects or assets into the scene to make it more interesting. But, we had to compose the scenes carefully so the audience wouldn't be confused about where to look." In addition, to help the audience know where to look, the layout artists sometimes used a slight depth of field.

As in any film, focusing the audience's attention is important. In stereo 3D films, though, focus becomes a question of comfort as well as attention. Because people watching a stereo 3D film need time to adjust their eyes, the layout artists tried to compose shots that kept the same area of focus when the scene changed after a cut. When the shots were short, the artists might add extra frames. When that was impossible, they used a special blending technique.

"It's very hard for an audience to adjust from far to close," Jhun says. "In 2D, the audience doesn't have to calculate the depth between an object and a character, but when you put depth into a scene, they do, and our brain takes a little longer to adjust. So, some shots got longer than they would have in regular 2D filmmaking. But, if that wasted storytelling time, we used something we called 'blending.' Even though an object is supposed to be far, we bring it closer and then let it slowly go deep, and the audience should not realize what we're doing."

The layout artists also used this ability to move characters subtly in depth to intensify an emotional story point. Jhun describes how this worked for a pivotal scene with Shrek and Rumpelstiltskin talking in Rumpelstiltskin's carriage.

"As the scene became really intense," Jhun says, "we brought the characters close to the audience and pushed the background farther back even though the [carriage and characters] did not move. It created a slight uncomfortable feeling in the audience. Without any dialog, you can tell this is an intense scene, that something is not quite right. You can feel it."

Techniques such as that, which the layout artists used during shots and during cuts, helped create a depth rhythm to support the story. "We put a lot of energy into designing shots," Jhun says. "This is the last movie, the final chapter, and it's in 3D, so we put a lot of effort into making it more dramatic." In addition to the 3D techniques, the layout artists used camera drift and longer shots to enhance character emotion and give the film a more sophisticated look. And handheld virtual cameras gave a traveling sequence a documentary realism.

During a sad, serious sequence with Shrek and Fiona, for example, the camera drifts in and out as the characters connect and disconnect, and for this sequence, the stereo is neutral. "Some directors with an animation background are genius directors, but they fall in love with a storyboard or image in their mind before it comes to layout," Jhun says. "Mike [Mitchell], who was a live-action director, gave us the opportunity to explore scenes with a camera."

Animators started performing the characters blocked into the scenes once the layout was about 70 percent close to final. When animation was final, the layout artists did another stereo 3D pass and brought the scenes 95 percent close to final. "We give the animators the camera, but we know some shots should be driven by animation," Jhun says, "so we redo the camera based on the acting."

The layout artists tweaked the last five percent once lighting had finished. "Sometimes the scenes look really different with light and textures, and the stereo 3D becomes a little overwhelming," Jhun says. "And other times, we ramp it up a tiny bit more to make the shots more sophisticated."

Personality Change

Jason Reisig, who was an animator on the first *Shrek*, led a team of approximately 35 animators who he organized into four teams, each with a supervisor, and then organized the work by sequences. "The animators on *Dragon* used a traditional animation workflow, which made sense because they had a significant number of hero characters," Reisig says. "We had fewer main characters and many sub-characters, so the supervisors cast teams of animators per sequence, and in those shots, the animators worked on all the characters. It kept us light and flexible."

For reference, the animators have Webcams at their desks and acting rooms where they can record themselves. In addition, for a battle between the ogres and witches, they mocapped three people doing fighting moves. "The cycle animators played with that motion-captured data and used it as reference," Reisig says.

In the early days of PDI/DreamWorks, and for the first *Shrek* film, the rigs for the characters, which were mostly bipeds—if not human, then human-like—included restraints you would expect in a human character. Animators could rotate a character's shoulders, hips, and head in only very specific, anatomically correct ways. For the cartoony characters in *Madagascar,* the studio created a more flexible rig, which the animators have used since, even

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for non-cartoony characters—except for those in the *Shrek* films. Reisig asked for a change.

"I said that we had to get rid of the old, stilted *Shrek* rig," Reisig says. "We had to have a more flexible rig. The old one was too puppet-like, and it was causing problems with the animators. So on the legacy characters, we tried to keep the basis of the classic rig and retrofit a new system. For the new characters, we used all the newest methods we had."

The task of retrofitting the newer types of controls onto the classic rigs and fitting the new characters with new rigs fell to a group of character technical directors led by J.J. Jay and Andy Kao. "We wanted to allow animators to get a broader range of acting, so we started with the existing rigs and folded in the newer controls," Jay says. "The technical challenge was to allow the animators to do the things they are used to doing now without changing the look of the characters as they deform."

Animators working with the new characters, and new versions of the old characters, though, used RIG, the new system. "One of the advantages of having a homegrown tool is that we can take a [rigging] concept and do what we want with it," Jay says. "For example, we use our elastic cage deformation quite a bit as a lower-level part of our deformation." This was key in animating Puss In Boots, who becomes a fat cat in Shrek's alternate reality. A fat cat that sometimes walks upright on two legs, and sometimes gets down on all fours. When Puss changed from biped to quadruped, his hips and shoulders changed, and his belly had to move appropriately. The portly Puss also had to deform properly—and automatically—when the animators positioned the character in what Jay calls "interesting poses." (DreamWorks is submitting a SIGGRAPH sketch on the techniques the TDs developed to move Puss's plump body.)

"We played around with keeping the elastic cage the same distance from the joints that drive it, which gave us fake volume preservation," Jay says. "We had to do some layering and localized blending, but [the rig] provided nice shapes right out of the box, and it allowed the animators to see the deformed body. There was no simulation; it was all animator-controlled. They didn't have to rely on a downstream department."

The flexible RIG extended into character design, as well; the TDs used the system to reshape a generic character into a variety of individual characters. "Sometimes the art department drew variations and we tried to hit them," Jay says. "Sometimes we needed help from the modeling department. But the TD department did most of the variations."

To create more than 16 types of ogres, the riggers started with a default body and individual rigs for each of the four ogre families. "Once we get the rig working with the default model, we can use the animation controls to create variations," Jay says. "We can go a certain percentage in any direction with the rig and it behaves well. The deformation allows us to create pleasing shapes by varying the body and the face. Then we lock in the controls."

In addition to providing sculpting controls for character variations and preserving Puss's pudgy volume, the rigs also moved most of the characters' hair and fur automatically. Consider a character that shakes its head, for example. "The animator would focus on the head movement and then initiate a simulation pass," Jay says. "The system would execute their animation and modify the values for the guide hairs. When the animator looks at the shot after simulation, the hair is moving on its own." If the animators didn't like what they saw, they could change simulation controls or hand animate the motion by moving the guide hairs.

In Shrek's alternate reality, though, Fiona's long hair required a separate simulation by the character effects team. "It's wild, and it falls over her shoulders in front and behind," Jay says. "Putting that into the rig would have impacted its performance."

Total Effects

When we first see Fiona, she stands atop a hill. She pulls off her helmet and her luxurious, long, red hair blows in the wind. "Her wavy, flowing red hair is an integral part of her character," says visual effects supervisor Doug Cooper. "Our character effects supervisor, Oliver Finkelde, started with the long hair system for *Shrek 3,* looked at the tools in Maya and Syflex, and put several pieces together to develop a new hair system for the film."

In addition to updating the rigs and developing a new hair system for Fiona's locks, Cooper points to new setups for multiple-layered clothing, a magical "poof," and a world-changing event as interesting technical challenges on this film.

For the clothing, the character effects team developed a system that could simulate multiple layers of clothing at the same time. "Before, we had done multiple passes with one layer becoming rigid for the next layer's simulation," Cooper says, "but the look wasn't believable, especially when you had a thin under-layer pushing around leather on top. Sometimes people in production take things



TDs retrofitted new controls onto the classic rig used for many of the legacy characters in *Shrek,* like Shrek and Donkey (top), but to move the now-pudgy Puss In Boots (bottom), they applied a newer and more flexible system aptly named RIG.


06
Slightly dangerous
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Layout artists kept the stereo neutral and used traditional techniques, like camera drift, to heighten the emotion in some dramatic scenes, such as those between Fiona and Shrek (top). For the intense scene between Shrek and Rumpelstiltskin (bottom), however, they applied stereo depth purposefully to drive a feeling of discomfort.

for granted in legacy films, but *Shrek* has been in development 14-plus years. Nothing just loaded and ran."

Alex Ongaro, head of effects, led the teams that created the magical poof and spun Shrek into and back out of alternate reality, with effects artist Andrew Kim contributing to both. The poof is a filigree pattern of gold dust that occurs when Shrek signs the magic contract and at other points in the film. The technique involved directing particles to follow modeled shapes yet still react to wind and other dynamics in a scene. "Imagine bi-dimensional swirling particles," Ongaro says. "We animated the particles procedurally, saved them on disk, and then instanced those geometries into a Maya scene that was dynamic, so the wind and turbulences affected them." (DreamWorks is submitting a SIGGRAPH sketch on this procedure, too.)

Once Shrek signs the contract, the world he knows rips apart into a storm of papers that fly around and reassemble into an alternate version of the world that Shrek thinks, at first, is the same world. Ongaro again worked with Andrew Kim on this world-changing event.

"We started developing the concept while the movie was still in storyboards," Ongaro says. "We decided that since everything centered on the contract, why not imagine that the world is made of paper that tears apart?"

To create the effect, the artists used a combination of tools, including Side Effects Software's Houdini. They started by building a simplified version of the set using simple planes, which sounds easy enough. "The problem was that this is a stereo movie," Ongaro says. "We needed to go from a 3D movie to effects in paper." The answer was to render the final lighting version of the scene from both eyes and then project the images on to the set made of simple planes.

"Basically using projection mapping from the camera and the two different eyes gave us the 3D effect once it was on the planes," Ongaro says. "We took this environment and tore it apart procedurally in Houdini. From Houdini, we knew where the edges were, so we could have them affected by fields. The paper needed to deform, but instead of doing that in Houdini, we did it at render time with a displacement map, a world-space noise map."

In addition, they sent a spherical tornado of gold light into the scene as the world tears apart. "It was very challenging," Ongaro says. "The lighting department had to update the papers like they were tearing apart, with light coming from the outside."

The tornado is made of millions of particles, which needed to look as if they were backlit, as if they had subsurface scattering. Custom tools handled global illumination and ambient occlusion within the tornado, but the self-shadowing didn't look right. "We decided to compute normals from the particles to do a quick and dirty ambient occlusion pass," Ongaro says. "We'd take a group of particles, compute the difference between the vectors, and get a gradient. We'd point the normal in a less-dense area."

In addition to these effects, the team grew trees with a previously developed system, poured martinis using Maya, kicked dust with Maya particles, filled the air with smoke using a volume renderer, and helped the characters create mud angels using particles and displacement maps. Perhaps the most beautiful effects, though, are the god rays filled with glittering dust.

"The beams of light come into the audience, and you can almost taste the dust," Mitchell says. "You want to run your fingers through it. It's bizarre."

For this effect, the artists developed a particle shader within the studio's proprietary rendering system. "We couldn't create the god rays in compositing because this is a stereo movie," Ongaro says. "So we used particles as the source of the rays, and at render time, filled cones with particles that fade off. It turned out to be beautiful."

Come Again

Even though this is the last *Shrek* film, it is not the last reunion for at least some of the familiar characters. Already under way is a film titled *Puss In Boots*, which is scheduled for 2011. And with DreamWorks promising three films a year in the future, many of the crew on this film will reunite on another film. In the 10 years since DreamWorks Animation created the first *Shrek,* which won the first Oscar for Best Animated Feature, computer graphics technology and the artists using it have advanced at lightning speed. But, they aren't out of school yet.

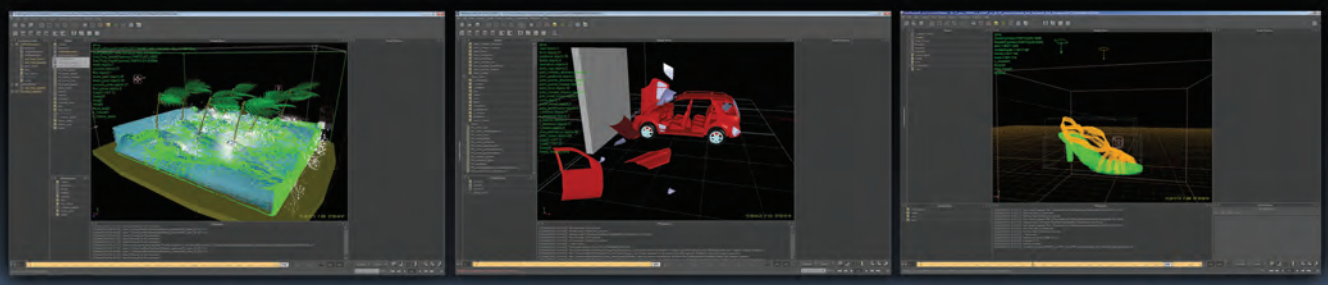
"We have a lot of experience and great artists who are masters of their craft, but they just keep getting better," Cooper says. "Everyone's skill set and ability and understanding of what they are building and making allows us to keep making richer pictures. We're always coming up with new techniques. We take so much for granted, but in fact, no one is a total master of this medium because the medium hasn't been around long enough to be mastered."

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INDUSTRIAL LIGHT & MAGIC UPS THE ACTION AND HEIGHTENS THE LOOK OF THE FIRST IRON MAN SEQUEL

BY BARBARA ROBERTSON

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It's no secret now that Iron Man is technology whiz Tony Stark (Robert Downey, Jr.), the gazillionaire head of Stark Enterprises. The first film, directed by Jon Favreau and released by Paramount Pictures, ended with Stark's dramatic revelation and earned more than half a billion dollars at the box office. So, what's a sequel to do? More.

"I feel like we have more room to run on this one," says Ben Snow, visual effects supervisor at Industrial Light & Magic (ILM), who landed a third Oscar nomination for *Iron Man*. Overall supervisor for the film was Janek Sirrs, who won an Oscar for *The Matrix*.

"It's a bigger film than the first one," Snow adds. "[Favreau] succeeded in capturing the fun parts of the first one in terms of Robert Downey's performance, and he upped the action. The effects are more spectacular. I think around 14 houses worked on the film."

In *Iron Man 2,* Stark is a rock star hero. But the government, the press, and everyone else wants the technology embedded in his heavy-metal suit. Stark's tight grip on the technology opens the doors to a competitor, Justin Hammer (Sam Rockwell), who tries creating a duplicate suit. Then, a Russian madman with ulterior motives, Ivan Vanko (Mickey Rourke), persuades Hammer to build drones, not suits. Vanko, who has a smoldering chip on his shoulder, builds his own suit out of drone parts and becomes Whiplash. Meanwhile, Tony's friend Jim "Rhodey" Rhodes (Don Cheadle), turns an Iron Man suit into a War Machine. What does all this mean? Lots of action. Lots of digital suits.



Tony Stark (Robert Downey, Jr.) makes his grand entrance in *Iron Man 2* wearing the superhero suit he created. The stage and the first rows of people are real. Artists at Industrial Light & Magic created everything else–the Iron Man suit, the crowd, and the expo building–using computer graphics tools.

If the effects crews succeed, the audience will believe that Robert Downey, Jr. and Don Cheadle are inside the suits, but they rarely are, or at least not totally. For the last film, ILM created proprietary shaders that mimicked the metal used for practical suits so well that at times Downey's suit had some practical parts and some digital parts. For this film, knowing that ILM could add anything he didn't want to wear, Downey often wore an Imocap suit (from ILM), with a partial suit on his upper body and a helmet. Sometimes, only the Imocap suit. Ditto for the stuntmen.

"What was funny is that Don Cheadle arrived on set wearing the whole suit," Snow says. "He saw Robert Downey, Jr. in tracksuit pants with [Imocap] bands on it. Pretty soon, Don isn't wearing the whole suit, either. Legacy Effects did a great job of making the suits lighter and more wearable, but the actors were still reluctant to wear them. And even when they did, we ended up touching up the shots. I think there was no shot that we didn't touch digitally."

Suit Up

When we last saw the Iron Man, he was wearing a red and gold Mark III, a superhero upgrade from the silver Mark II. In this film, Stark keeps the Mark III, but with a few tweaks, more gold paint, and a few new weapons, it becomes the Mark IV and then the Mark VI. A retailored and upgraded Mark II now fits Rhodes rather than Stark, and, equipped with almost every gun in the book, becomes the War Machine.

"The only suit we didn't do is a nifty suit called the suitcase suit," Snow says. "We did some artwork for it, but Double Negative ended up executing it. During their sequence, Ivan Vanko [Mickey Rourke], the son of a Russian genius who helped Tony Stark's father develop the technology, uses his glowing electrical whips to lay waste to the suit while Tony is racing. And that's the end of that suit, which is the Mark V."

ILM worked directly with Pixomondo on that studio's sequence. "The client knew the work



In this shot, the actors' faces, the grass, and the shrubbery on the right are the only non-CG elements. On set, Robert Downey, Jr. (left) and Don Cheadle (right) wore Imocap suits and partial helmets. ILM added the CG suits, replaced the helmets, created the digital drones in the background, and the rest of the environment.

was going through the third parties, but we supervised it and handled it all," Snow says. "We sent the sequence to Pixomondo, where Justin Hammer is showing Ivan Vanko some drones he's building. We built and painted a drone, and gave it to Pixomondo, and they did the shots. They did a terrific job. We also worked with Svengali, which did some matte paintings of the Stark house for us, and with The Embassy, which did a sequence with the damaged suit at the end."

Although ILM still keeps most of its secret sauce secret, the studio feels comfortable sharing more technology and knowledge with the studios they deal with directly than they would otherwise.

"We still have to recognize that we have proprietary tools that give us some advantages," Snow says. "But, our aim is to establish relationships with the third-party vendors where we know the people, know how to work with them, and build the same kind of trust that we've built with ILM Singapore. ILM Singapore has been a huge asset on both *Iron Man* films. Singapore has all our tools, identical workstations, security cards, everything, but this was the first time we have sent lighting work to them. They do top-quality work now that is not distinguishable from ILM. We want the same sort of situation with our third-party vendors."

Costumes Are Characters

When the actors appear fully suited in the film, the suits are, of course, mostly empty geometric shells manipulated by animators to perform as if someone were inside. The artists paint, render, and light the suits—in other words, the CG characters—to appear as if a director of photography shot them on location.

Bruce Holcomb led the modeling team. Ron Woodall supervised the painters. And, Doug Smythe turned the studio's new energy-conserving lighting technology into more intuitive tools. Holcomb and Woodall have worked together on so many films at ILM, Holcomb teases that people call them "Bron." "We're an amalgam," he laughs. "That's the best thing about this film—our friendship. We help each other with jobs, and the process becomes very fast."

Woodall adds, "I've been fortunate to work on a number of shows with Bruce. We're like-minded in the things we think would be cool, so the days are easy and we have a lot of fun."

For Holcomb's group, the work entailed streamlining the Iron Man Mark III and adding more weapons, building War Machine (which is a modification of the silver suit), creating the drones, building the suit that Ivan Vanko's character wears, creating suit parts to

Just Like the Movies

"This new technology is fun," says Doug Smythe, digital production supervisor, of ILM's new energy-conserving lighting. The new energy-conserving shader set works within Pixar's RenderMan and communicates with ILM's proprietary Zeno lighting tools; Smythe created a suite of plug-ins for the new tools.

"It's like moving from really good Impressionist paintings to photographs," he adds. Smythe, who has received three technical Oscars and an Oscar for best visual effects in the film *Death Becomes Her,* is a photographer in his spare time.

"It's fun to use the same kinds of techniques in the computer that I would use with a camera in the real world," says Smythe. "I can actually work in CG and light a CG character the same way as in a portrait studio. We haven't been able to do that until recently. We don't have to ask, 'What colored CG point light will approximate a light source? Do I darken or brighten? What hue?' We just have a picture of the source light and use it directly. It's liberating."

Smythe explains: "You can take several pictures at different exposures to get an HDRI of a light source. That picture is the texture for the light. So, the CG light will emit light with the brightness and color at every pixel direction you had in that original image of that light source. If you move more than a fraction of an inch from the surface, the color from one square inch blends with the next. And farther away, you see amorphous light." Just like light in the real world.

Or, the crew might take a large photo of an entire set and crop out a small, rectangular area of interest to use as a light source. "If we have a bonfire burning in a section of an image, we might take a rectangle surrounding that area and put the moving footage on an animated sequence of images," Smythe says. "So, now we have a bonfire light that casts bonfire shapes and colored light onto whatever CG character happens to walk by. And we can put several of these throughout. Or, we might treat the entire spherical environment as a light. We can have round lights and rectangular lights. And we can put texture images on the lights if we want."

As light from these sources bounces through the scene using raytracing algorithms, collecting, reflecting, and absorbing colors, the energy-conserving calculations make sure that the sum of light reflected from and absorbed by the objects in the

complete the partial suits the actors wore, and modeling damaged versions of the suits.

Woodall's team painted texture maps for all the suits. For the last film, cleverly written proprietary shaders used the orientation of UVs to control the spread of the specular and achieve the suits' brushed-metal look. For this film, the texture painters had an easier time.

"Our entire lighting pipeline changed with *Terminator,*" Woodall says. (See "Shades of the Future" in the May 2009 issue.) "Before, the specular always spread perpendicularly to the brushing. To get a bow-tie specular effect on our burnished disks that matched the real suit, we had to unwrap the geometry in UV space and lay it out vertically to match the grain in a texture map. On this film, we could project the texture map with a clockwise gradient from black to white straight onto the geometry and it took about five seconds."

For the Iron Man Mark IV and VI suits, Holcomb, whose background is in industrial design, modeled in AliasStudio's curve evaluation with B-spline surfacing. "I find it to be a very useful tool for the swoopy-type feel of models, like the *Star Trek Enterprise* and these models," he says. "I always like to use B-splines to start a process, and in Studio, you define the curve first."

The drones—one style for each branch of the military—all began with base-level geometry that the modelers propagated from one model to the next. "Because 70 to 80 percent of the parts were similar, we could immediately start painting," Woodall says.



Tony Stark's rival Justin Hammer (Sam Rockwell) builds robotic drones in the film. ILM put anti-aircraft guns on the backs of the Army drones pictured above, and outfitted other drones with different weapons that represented the Air Force, Navy, and Marines.

Each drone, however, sports weapons and a paint job particular to its branch of the military. Army drones can fire an anti-aircraft gun carried on their backs. The Air Force drones fly at Mach speed. Navy drones shoulder surface-to-air rockets. And the Marine drone, the only one with a camouflage paint job, just looks tough. "The Marine drones were going to be played as the toughest, but we downplayed them to play up Ivan's super drone," Woodall says.

To build the new War Machine suit, Holcomb and co-worker Rene Garcia started with Legacy Effects' digital files for the practical suits, and then streamlined the suit and added weapons using concept art created at the studio and by Aaron McBride, VFX art director at ILM. For this model, the new drones, and the suit Whiplash kludged together, Holcomb worked with Autodesk's Maya using polygons and subdivision surfaces.

"War Machine was a big, fun project for us," Snow says. "We gave Ron Woodall and Bruce Holcomb a style sheet that showed what the weapons looked like, and then they went crazy coming up with new technology and new weapons."

scene is never greater than the original light source, that it's physically accurate.

"The total amount that goes out can't be more than goes in," Smythe explains. This formerly wasn't necessarily the case with CG lighting, which often produced highlights brighter than the light source causing them. But, until HDRI, visual effects artists did not use photographs to calculate the entire amount of light in a particular location.

Now, the visual effects artists do, and ILM is using that information to calculate physically accurate digital lighting using light sources from the real world. "We have shaders for the surface materials, and different shaders for the various light sources and a bank of lights," Smythe says.

The math for doing these calculations is not new, but computers haven't been fast enough to process the calculations for film production, nor algorithms smart enough until now. Even so, ILM uses a technique called "importance sampling," which steers the raytracing calculation toward areas that matter—usually the brighter areas—to help speed the calculation time. And, lighters can turn switches on and off during the multi-step process to trade quality with render time.

"There's a fight in Tony Stark's house in *Iron Man 2,* in the kitchen and in his personal gym," Smythe says. "The lighting is harsh, and he has tight spotlights in the ceiling that create bright circles of light on the floor." As the CG characters—the red and gold Mark IV and the silver Mark II metal suits—bang through the rooms, the lights hit them and change as they move.

"The animators position the characters and move them around," Smythe says. "Then a multistep process in the tool kit does the computations. The CG character affects the environment, and the environment affects the character." For this scene, lighting artists who opted to use the new lighting solution especially benefited when a shiny suit fell to the floor.

"We could compute the illumination on the floor as indirect lighting using color bleeding [as before], or turn the entire floor into a light with bright spots where the lights shine down," Smythe says. "We finally have something close to the physical result we'd get from a real light source. Brightness falls off with distance in the same way. And, it's not just an approximation. We've done tests comparing CG lights to real lights on real objects. It's not perfect, but we're closer than we ever have been. And, I think there's a noticeable difference, a richness and detail we didn't get with the old-style point light sources and simpler surface shaders. Ambient and reflection occlusion were great tricks in the day, but we can do better than that now." –*Barbara Robertson*



The Unisphere in the lower left of the image is one of the few buildings still standing on the 1964 World's Fair site in New York City. It's also one of the few real elements in this image of the Stark Expo site in *Iron Man 2*, which ILM Singapore built and sent to ILM in San Francisco for final touches.

Even so, the artists kept the ideas within the limits of real mechanics. "We looked at how things actually get deployed," Holcomb says. "We added a lot of flare to [War Machine], but he definitely has a real-world feel."

On the Surface

War Machine existed as a practical suit with a metallic-looking surface on set that the ILM crew used for lighting reference as well as a jumping-off point for the modelers. "We wanted to capture the feel of the practical suit, but Jon Favreau wanted to go beyond it," says John Walker, lead technical director, who helped develop the look of the digital suits. "So, we introduced more surface texture and played with the materials to get a true metallic response. It was a team effort with Ron Woodall." Woodall painted, Walker developed materials, and the combination provided a surface that reacted in the way the visual effects supervisors and Favreau wanted when lit.

"Most of his armor is a dark, black metal," Walker says of War Machine. "His face plates and biceps were sort of a brushed aluminum, and we didn't want the aluminum to pop more than the rest of the armor. Also, he was in a dark environment, so we needed a nice sheen with good edges. We have to do a lot of tweaking to get material to read as raw metal, and paint to read as dull or shiny paint. Ron [Woodall] and I tried to hit the artwork exactly, but in the end, it's what looks best."

New shaders that worked with the new energy-conserving lighting technology helped fit the characters into footage shot on location under artificial lighting, and look real in digital environments. "We [created] materials that behaved better, were more energy-conserving, and promised to be easier to use when they got to sequence lighting," Walker says.

Special settings helped the crew match Iron Man's look from the first film. Until *Terminator,* TDs set separate values for specular and reflection. Now, specular and reflection are one and the same; they're unified and grounded in physics. Even so, some technical directors who had honed their skills using the former methods continued working with the familiar lighting tools. For his part, Snow prefers the new tools and believes they help the lighting artists mature as filmmakers (see "Just Like the Movies," pg. 18).

"I actually did a shot on this show, a chase scene under the freeway, and it was like lighting a shot on set," Snow says. "I could go in with a blank slate and create a set of lights from environment spheres shot on set, and put those lights in my scene just like in the real world. Doug [Smythe] has created a suite of plug-ins for managing the new lighting tools that made the process easy; it was very intuitive. You can get something out of the box now that looks real, so you can spend your effort thinking about how a director of photography would approach the shot. It's not about, Does this suit look like metal? It's about, How can I approach this creatively?"

On the Ground

In addition to building the digital prosthetics—that is, the parts of the suit that the actors didn't wear—the full suits, and the drones, ILM created huge environments in which much of the action takes place. In the film, Tony Stark rebuilds the Stark Expo that his father had created as a modern-day technology expo. In reality, the action takes place in New York City on the site of the 1964 World's Fair, which is now a park. Whenever possible, ILM started with helicopter plates of that site shot by Sirrs, and then replaced everything except the freeways and the Unisphere, one of the few World's Fair buildings still there. ILM constructed all the other buildings seen in the film as well as the grounds. The challenges were creative and technical.

"Mike Riva, the production designer, had created the expo design, but Jon [Favreau] didn't ever quite say, 'This is it,'" Snow says. "So, when location photography ended and we had to build the site in postproduction, we asked Jon to articulate what he didn't like." Favreau told them that he felt the art was too *Blade Runner*- and *Minority Report*-ish. More importantly, he told them that he had grown up in Queens, across the road from the site.

"We thought that maybe he was trying to imagine what this fair was like in his youth," Snow says. "And if you think of his style, it's kind of retro. So, we used the 1964 World's Fair as the departure point. We tried to capture the essence of that and update it, and it was a win."

The crew found a world of reference on the Internet and even discovered plans for buildings that had been impossible to build at the time. With the creative challenge tackled, the task of actually building the digital Stark Expo fell to the crew at ILM Singapore. "They worked largely in [Autodesk's] 3ds Max," Snow says. "But we also mixed in some of our Zenviro tools for certain fast-moving scenes because we like the motion blur better, and CG water that we created in [Pixar's] RenderMan."

Much of the action starts in a Japanese garden in the Stark Expo site. Although Favreau wasn't sure he wanted a set built, Snow and Sirrs convinced him that it would help pin down the action. Everything beyond a 20-foot area, though, is CG.

The sequence ramps up with the drones chasing Tony Stark in his Iron Man suit. Once in the Japanese garden, War Machine, Tony's friend Rhodey, helps him fight the drones. The garden fills with gunfire, sparks, explosions, fireworks, and lights. After several minutes of shooting, Stark tells War Machine to duck. He pulls out new lasers, spins around, and slices the drones in half. And then, with the drones split in half, Whiplash shows up.

"So that gave us the ability to use some of those lighting tools I was touting earlier," Snow laughs. "We used the whips, explosions, gunfire, all of that sort to make something a little more edgy and atmospheric."

Marc Chu, who was an associate animation supervisor on the first film, led the animation team who created the characters' performances for this sequence and the others. "It was a big challenge to make all the characters feel unique," he says. "Iron Man is nimble. War Machine is less nimble. And the drones were like muscle cars."

Although Cheadle and Downey wore Imocap suits fitted with chest plates to capture the light, it wasn't always possible to rely on

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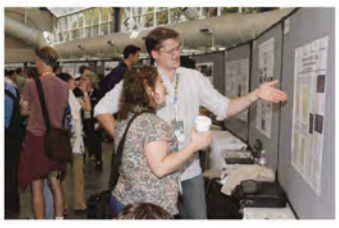
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the captured data for the performances—the superhero suits have a more heroic build than the actors, and the performances needed to be more dramatic, as well. To choreograph the fighting, the animators motion-captured themselves fighting on ILM's stage. They could see the action applied to characters in a virtual set, film it with a virtual camera, and then show it to Snow for approval.

"It was fun for the animators to act the shots out themselves," Chu says. "They weren't getting data handed to them. It was their own data. They were War Machine, Iron Man, and Whiplash."

Everything and . . .

When the animators finished a performance, the shots often moved to Timothy Brakensiek in the creature-development department for rigid-body simulation and other effects, and then back to Holcomb. "We wanted the damage to look realistic," Snow says. "We wanted to rip up the metal and see it bend and flare open. We built entire interiors so when we chop the drones apart, we can see inside, and we hand-modeled the peeling open. It was a cottage industry."

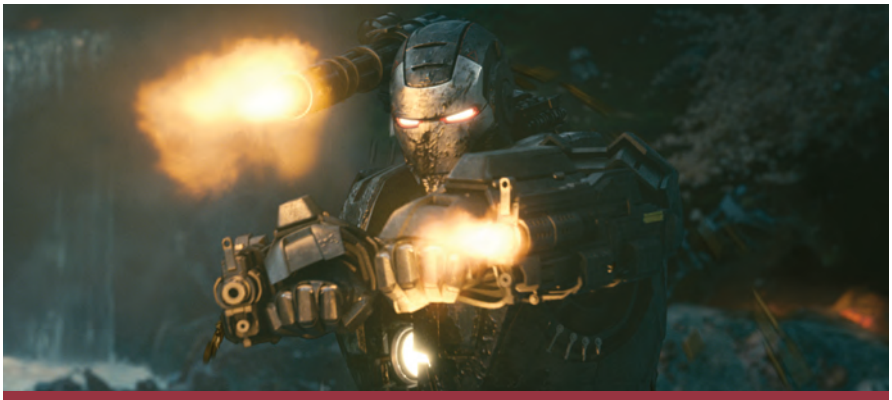
Holcomb, Garcia, painter Jean Bolte, and Woodall created the suit damage, with Walker managing the levels of damage in the shaders. To slice the drones, they used two versions of one model: one for above and one for below. Shaders drove the slicing; Smythe revised a technique similar to one he had used to decapitate C-3P0 in the droid factory in *Star Wars: Episode II,* and suck pit droids into engine parts during a pod race.

"We make the part that's cut off invisible, then add the displacement that distorts the shape right at the edge," Smythe explains. "Then we put the opposite of that on the other piece and make the other half invisible. That way we could have the top half fall off while the bottom stands there."

Woodall and Holcomb are especially proud of the damaged goods they created for this show. "We tried to make it look like the damage on automobiles," Holcomb says. "Sometimes we've gone in with only a couple days left to make a bend look better."

Woodall adds, "It's something we're always chasing. You always want to do better in the next film. Things don't happen for real in CG. You have to make them look like they're real."

Surprisingly, though, the two describe something quite ordinary as their most difficult challenge. They built suits for superheroes, working weapons, and military drones. They even created the interior of a C-17 for this film. They built everything, but the hardest asset was the kitchen sink. During a sequence early in the film, Tony Stark gets drunk at a party in his house and puts on his Iron Man suit. Rhodey puts on the silver Mark II and tries to calm Stark down, but Stark rips the sink out of an island in his kitchen and smashes it into Rhodey. Then he tears the kitchen apart. "We turned the kitchen into a pristine asset and damaged it," Holcomb says. "It was a difficult process."



War Machine powers through the climactic battle using weapons added to what was once a silver Mark II Iron Man suit. To light the suit in this shot and others, ILM developed new tools and RenderMan shaders to take advantage of the studio's new energy-conserving lighting algorithms.

Woodall adds, "A guy in a suit of armor is one thing, and because he's moving, we don't fixate on it. But, everyone has seen a kitchen counter. It needs love."

For the first film, Favreau concentrated on character development. He didn't sacrifice character development for the sequel, but the action definitely exploded. And when the action explodes on screen, there is an equal and opposite reaction in postproduction. Fortunately, ILM and the other visual effects studios that created the action for the film were up to the challenge.

Barbara Robertson is an award-winning writer and a contributing editor for *Computer Graphics World.* She can be reached at BarbaraRR@comcast.net.



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TO HELL

ARTISTS AT VISCERAL GAMES TAKE PLAYERS TO THE DEPTHS OF THE NETHER-WORLD IN DANTE'S INFERNO

BY KAREN MOLTENBREY

In the 14th century, Dante Alighieri set the world ablaze with his allegorical tale "The Divine Comedy," an imaginative epic poem that describes his journey, as the main character, through the three realms of the dead: Hell, Purgatory, and Paradise. The piece is considered one of the greatest examples of world literature, serving as an inspiration for many artists throughout the past several centuries, from Geoffrey Chaucer and John Milton, to Henry Wadsworth Longfellow, Karl Marx, and T.S. Eliot. And more recently, the 3D artists at Visceral Games, which used "The Divine Comedy" as the basis for its *Dante's Inferno* computer game.

"*Dante's Inferno* is a big, epic action/adventure game that's loosely based upon Part One of 'The Divine Comedy,'" says Jonathan Knight, executive producer/creative director of the title. In fact, it is Knight who is credited for the game's conception.

The original literary work presented a spiritual journey in which Dante, halfway through his life, becomes assailed by three wild beasts after becoming lost in a dark forest. He is led from the woods by the Roman poet Virgil, first to Hell and then Purgatory, where

Artists at Visceral Games looked to the macabre when designing *Dante's Inferno*, an interactive re-imagining of "The Divine Comedy."

Dante must overcome obstacles—temptation and sin—to achieve the ultimate goal: eternal bliss in heaven, guided there by the "ideal woman" Beatrice. The interactive title, from Visceral and published by EA, places a contemporary spin on the poem. In the new medium, Dante, a mercenary soldier during the Third Crusade, pursues dark forces that have dragged his beloved Beatrice to the fiery depths. During this journey through the afterlife, the player, as Dante, must battle hideous monsters within the Nine Circles of Hell in an attempt to save Beatrice. The game—which plays out within the first cantiche, or part, of the three-part poem—ends as Dante leaves Inferno, or Hell, and makes his way to Purgatory.

Hellish Vision

While "The Divine Comedy" offers a haunting description of Hell's nine circles, *Dante's Inferno* goes one step further, giving it a visual interpretation under the art direction of Ash Huang. "The game brings to life the vivid and detailed worlds imagined by Dante Alighieri," says Knight. "Each of the Nine Circles is its own world, with unique art direction, environments, effects, creatures, and back stories."

Huang worked with lead concept artist Jeff Adams, and together they forged Visceral's contemporary vision of Hell. Huang and Adams worked on the game's concept art throughout production, from the initial stages all the way through content lock. "Given the original nature of so many of the creatures and environments, concept art was an integral part of every step in the production," says Knight. In fact, concept art was made for every facet of the game: characters, environments, props, weapons, the UI, and cinematics. Further direction was provided through 2D and 3D storyboards.



The detail in the game's imagery is apparent here, in Hell's City of Dis, as Dante makes his way to the Circle of Anger, to face the molten giant Phlegyas.

Hell's Inhabitants

The characters of *Dante's Inferno* range from the realistic knight Dante and the beautiful Beatrice, to the hideous Lucifer, and all manner of monster and creature in between. The character model concepts were driven by the sins by which the characters were condemned in Hell: Limbo, Lust, Gluttony, Greed, Anger, Heresy, Violence, Fraud, and Treachery, the Nine Circles of Hell. The theme from each sin is incorporated into the character design—Gluttony's multi-headed, mouth-snapping Cerberus is but one example.

The concept designs for these characters were created in high detail using Pixologic's ZBrush, and then optimized in Autodesk's Maya to adhere to in-game polygon budgets—a process Erik Holden, technical art director, says proved particularly challenging throughout the game's production.

Once the concepts were approved, the team—guided by lead character artist Vince Fung and senior character artist Lisette Titre—began building models, starting with a low-resolution in-game version first, before tackling the high-res sculpt in ZBrush. Then the artists moved to coloring and incorporated fine detail in the models, until they reached the desired visual quality. At that point, the ZBrush assets were optimized and re-exported back into Maya, before they were integrated into the Visceral Games proprietary engine.

The characters—from the gigantic Cerberus to the knee-high unbaptized babies—are visually complex, with their costumes sometimes consisting of visual effects elements. As a result, the character modelers often worked closely with VFX leads Jeff Kuipers and Sandy Lin, as well as VFX artist Seth Hall, on combining the model and effects assets to complete a character's look. Holden points to the smoke Lucifer and fire minions as prime examples of this workflow.

Some of the so-called "bosses" in the game, such as Cerberus, Phlegyas, King Minos, and Cleopatra, required more attention than others. "In several instances, we had to rework the UV layouts to give more resolution to specific parts of the character that got unexpectedly close to the camera," says Holden. "Changes in gameplay cameras gave us fits from time to time." Without hesitation, Holden names Gluttony's Cerberus, with its three unique heads, long necks, and large-body appendages, as the most difficult character to create: Each head and several of the satellite heads had functioning mouths, complete with wagging tongues and gnashing teeth.

Characters whose surface style varied greatly were particularly hard to texture—some characters had flesh, cloth, metal, and fluid in the same surface area. Using a combination of Adobe's Photoshop and ZBrush, the crew created the various texture maps: diffuse, color, normal, specular, reflection, ambient occlusion, and chrome. Due to time and resource constraints, the artists used photographic reference or painted textures for the diffuse maps, and then derived normal and specular maps with Photoshop or Ryan Clark's CrazyBump for non-specific surfaces.

"For some of the more organic surfaces, such as many of the intestinal-shaped floors and walls in Gluttony, we used ZBrush to create all the maps," says Holden. "These worked well and, as intended, were quite grotesque." For some objects and more specific environmental elements, like the tormented human figure statues, the group did a full ZBrush sculpt, exporting low-res geometry and a full set of textures.

Just as there was a range of character models used in the game, there was a similar range of animations required for them. The animation and rigging primarily was done in Maya, where it was hand keyed. Aside from the usual biped variety, there were characters that required special rigs to account for tentacles, wings, and other appendages (some quite unusual and others quite imaginative). "Let's just say we weren't limited as to how far we could push our characters," says Tristan Sacramento, lead character animator.

As Sacramento points out, the in-game animations were the result of a collaborative effort among the animators, designers, and pro-

grammers, who worked in little pods, enabling them to get things done quicker and more efficiently than if they had kept the departments separate. "Many ideas came from random conversations while getting coffee or just by standing in a person's cubicle," he notes. After an idea was initiated, "we quickly prototyped and tested it in-game to see if it is actually any fun. If we saw the potential, then we would go through the motions of getting an animation from blocking, all the way through to final. Being able to quickly iterate and see the animations in-game is key. An animation is not final until all the little bells and whistles—blends, rumbles, shakes, and VFX treatments—are added."

While working in those pods, each animator was able to explore his or her own preferences for a particular character. Sacramento, for instance, started by looking at reference from games, movies, YouTube, or even film clips he took of himself performing various movements. "Acting out your animation gives you a better sense of how the animation should feel and where the weight and force is coming from," he adds.

Nine Circles

The environments, like the characters that inhabit them, have a unique theme and are reflective of the sin associated with that particular Circle of Hell; these are in addition to three smaller levels used in the lead-in to the game. In Lust, the architecture contains sexually suggestive forms; in Gluttony, the landscape resembles the internal organs of a creature. As a result of their specificity, very few of the environments could be reused, creating a tremendous amount of work for the environmental artists.

Because *Inferno* runs at 60 frames per second (nearly double the average), there was not much wiggle room when building the environs, particularly when there was more combat than usual (which created the added expense of the associated effects). According to Holden, there were times when the budgets ran over, requiring the group to strip down the environments to free up clock cycles for extra characters or combat elements.

"Strangely, one of the smallest levels caused the biggest headaches," says Holden. The Phlegyas Rampage level, wherein the player controls the giant demon, gave the group "fits" with the frame rate and caused a lot of rework. "The level was simple enough," he notes, "but the fact that Phlegyas walked through the environment destroying buildings with a breath weapon and his fists generated a huge number of particles, which ate up frame time like crazy. We had to use the simplest environmental shaders to get it to work and be as exciting as we had envisioned."

To facilitate the environment creation process, the team, led by Rich Larm, devised a system to render textures in-game at 60 fps with the studio's particle system. They were created in an off-screen buffer and then used with any material for environments as well as characters, visual effects, and so forth. "You can get an animated but infinitely variable texture and normal map this way," says Holden. "We did the writhing bodies in the wall-climb, fluids, and more with this system."

In Kuiper's opinion, the area within the circle of Anger presented the effects team with some of the biggest issues. The environment is wind-torn, the sky boiling, and lava and steam boil from below, while at the same time, Phlegyas smashes the arena and blasts Dante with fire attacks—while other enemies descend at the same time. "During all that, Dante can do any number of VFX-intensive magical attacks," he says. "Balancing high-quality VFX with performance was more difficult on this game than any other I've worked on."

Firelight

Inferno had two lighting leads: Matt Christmann, who focused on technical issues, such as tool scripting and support, feature requests, and testing; and Rachel Cross, who focused on artistic and production issues, such as artist collaboration and mentoring, tracking, and communication. However, as art director, Huang set the color script for the title and reviewed the lighting progress throughout to ensure consistency across all the levels since different lighters often handled adjacent rooms. Associate art director Meagan Carabetta provided lighting concepts for each zone, painting over unlit screenshots to provide a snapshot of the final look of the game. This gave production a clear picture of what the end result should look like so that no time was wasted on unwanted work.

The team used a number of lighting techniques, including occlusion, which was baked in using Maya's Mental Ray (from Mental Images). In addition, the crew used direct and indirect illumination using Illuminate Labs' Turtle, baking most of the environmental geometry light into the vertex colors. At runtime, dynamic lights were used, and according to Christmann, each mesh could be affected by as many as eight



A character's aesthetic reflects the sin associated with a particular Circle of Hell wherein the character can be found, including Anger (left) and Gluttony (right).

The most difficult animations were the full-on cinematic QuickTime events (QTE), which consist of the player character, an enemy character or two, some weapons, a few cameras, and likely a piece of the environment. "These animations tend to be on the lengthy side," Sacramento points out. "Considering that an average attack animation is roughly 45 frames for a single character, these QTEs can range from 500 to 1000 frames for all the components." Moreover, these sequences usually include two to four branch points where the player can succeed or fail, and the failures have to be animated separately for each branch.

"Managing all these parts of the sequence can be daunting," Sacramento adds. "Yet, these are most likely the highly memorable moments in the game."


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Visual effects, most of which were created with Alchemy, Visceral's proprietary VFX system, are commonplace within the environments, adding to their overall complexity.

light sources, depending on the shader—vertex-shaded point lights, pixel-shaded point lights, and directional lights, for instance.

Visceral Games thought it necessary to judge the quality of the geometry in-game, says Christmann, so lighters had two dual-CPU or quad-core Xeon workstations with 4GB of RAM, allowing them to set up and iterate on two scenes simultaneously—polishing the one scene while the other baked.

Despite these steps, the game's 60-fps render cycle remained an obstacle. Lighters were careful as to where they spent their cycles; lighters and environmental artists made trade-offs so that they could adhere to the budget. In many cases, the crew was able to use low-res shaders in the backgrounds, says Christmann.

The game, for the most part, is forward-lit, with Dane's cross being the only per-pixel point light. "It's always stuck on the hero, so the player will always be moving per-pixel detail around the gameplay, says Christmann. "For the in-game characters, this light was stolen to improve lighting quality."

The directional shadow-casting light affected the character and environmental shaders differently. This lighting method was used for depth-map shadow, while character shaders also received diffuse and specular illumination from this source. Meanwhile, environmental shaders received only specular illumination, as their diffuse lighting was already pre-rendered in Turtle. This added some per-pixel illumination detail without washing out or over-brightening the scene. Specular cube maps also provided another source of per-pixel detail.

Meanwhile, many of the things that people assumed were lighting elements—light beams, glows, fire, and so forth—were done by the VFX artists during their passes through the world, Christmann notes, and not by illumination methods.

An Effect on the Game

Inferno is packed with visual effects from the beginning to the end. The title has many traditional environmental effects: water, fire, wind, fog, lighting, and weather. In addition, Hell has many specific effects, such as boiling skies, the dead plunging on fire from the heavens, a tornado of tormented souls, or sinners boiling in rivers of blood or lava. "For the first time, we had characters made completely of fire and smoke that were made entirely of effects," says Kuipers.

Other notable character effects include Phlegyas, a 50-foot-high molten giant who breathes fire and goes on a rampage demolishing buildings in Hell's city of Dis in the Anger circle. In addition, Dante has dozens of VFX-intensive magical attacks, and each boss battle with Minos, Cerberus, and Lucifer was packed with its own unique effects. VFX were even used to do final color tuning from level to level and other postproduction touches, like bloom, depth of field, and motion blur.

To generate the effects, the team used Alchemy, the studio's proprietary VFX system, as well as an in-house materials and shader system, Maya, and Photoshop. Alchemy, though, did the heavy lifting, accounting for 95 percent of the work, while the in-house materials system enabled the artists to create custom shaders for specific uses, such as water or tornados. Maya, meanwhile, helped build mesh particles, do fluid and dynamic simulations, and generate textures for animated fire, smoke, and blood, for instance. Photoshop enabled the artists to hand-paint various particle textures.

Kuipers describes Visceral's particle system as "feature-rich," allowing for a great deal of flexibility. "We have a concept of 'smart' versus 'dumb' particles," he explains. "Dumb particles are extremely cheap, and we can put thousands of them on screen at the same time because they use pre-calculated data. Smart particles can be interacted with dynamically, using forces, wind, normal mapping, or collision. They are more expensive, but when we need that extra control or interactivity, they are invaluable." The team also used meta particles, mesh particles, stretched particles, and distortion particles to achieve the desired outcomes.

As Kuipers explains, Alchemy is so much more than a particle system; it is a sophisticated VFX sequencer. "The particle system is just one small part of what Alchemy is," says Kuipers. He explains: "Think of it as a real-time compositing package, wherein each VFX is made up of multiple layers, and each layer can be a variety of different types, called 'modules.' Some of the modules the VFX artists have at their disposal include particles, procedural geometry, trails, distortion, dynamic lights, optical effects, light beams, decals, motion, forces, shape emitters, post FX, masking, messaging, and even sound."

Lest we forget, this is Hell, so fire was an absolute necessity. To create that effect digitally, the group used a combination of various elements, including procedural geometry, particles, animated textures, and dynamic lights. Maya Fluid Effects provided specific looks for the animated fire texture sequences. "We had to make the fire look believable and perform well at 60 fps," says Kuipers. "Normally, we layer many elements to keep the fire looking as random as possible. However, with our performance constraints, we had to be careful with overlapping elements because the fill rate was our big performance killer."

Another challenging effect involved the Smoke Lucifer, which had to be a reasonable in-game match to the prerendered treatment given the character in the cut-scenes. The prerendered version consists of fluid-dynamics-driven smoke and millions of particles. The in-game version, meanwhile, had to approximate that look in real time and maintain the frame rate. "This was no small task to pull off. Maintaining 60 fps was our biggest challenge across the game, especially when there were a lot of effects on screen combined with lots of combat," Kuipers points out.

By confronting potential digital imagery demons from the beginning, the artists at Visceral Games were able to avoid falling into a hellish nightmare during the title's two-year development period. This allowed the team to accomplish its goal of sending players to Hell, a visit—in this instance—they welcomed. But at the end of their journey through the Nine Circles of Hell, players receive a divine reward: Purgatory, which is also the next cantiche (main part) in "The Divine Comedy," thus opening the gate wide for a sequel to the game. ■

Karen Moltenbrey is the chief editor for *Computer Graphics World.*

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Review

By **GEORGE MAESTRI**

Graphics Card

Quadro FX 3800

Nvidia's Quadro line of professional graphics cards is always one of the best on the market. The cards push the limits of what workstation graphics can do. The cards run the gamut from entry level all the way up to some of the fastest graphics hardware available. The Quadro FX 3800 is Nvidia's top midrange card, and it offers some new features and a significant performance boost over the previous-generation card.

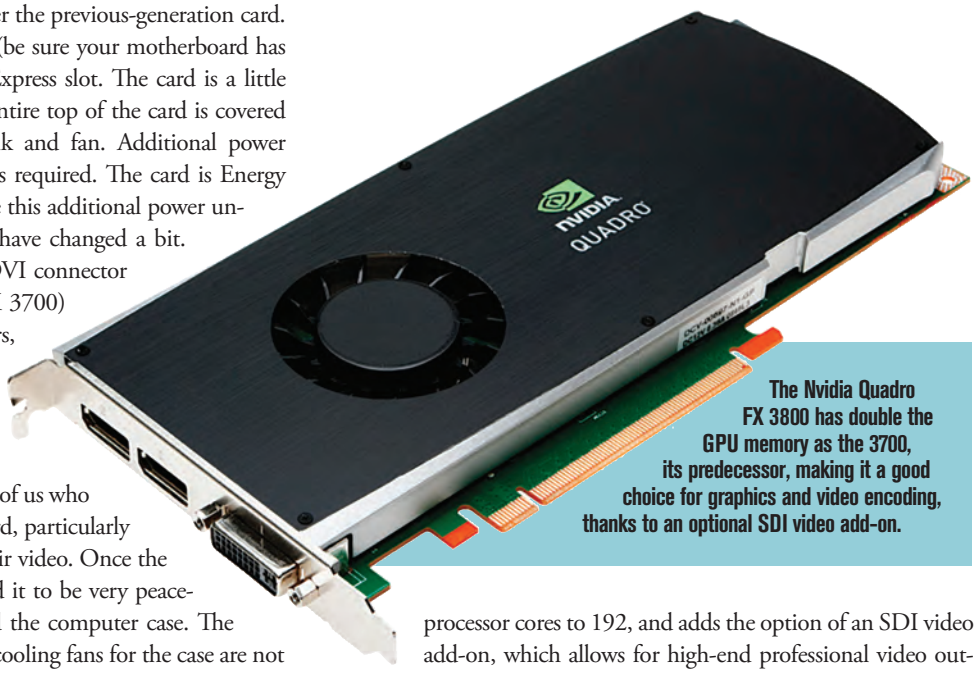
The Quadro FX 3800 is full length (be sure your motherboard has clearance) and occupies a single PCI Express slot. The card is a little thicker than a standard card, and the entire top of the card is covered with an attractive aluminum heat sink and fan. Additional power through a standard six-pin connector is required. The card is Energy Star-compliant, however, so it won't use this additional power unless required. Connectors on the card have changed a bit. This iteration has only one dual-link DVI connector (as opposed to two on the Quadro FX 3700) but adds two DisplayPort connectors, which is the emerging standard and also adds DRM to the mix.

The card runs fairly quiet. Nvidia rates the card's noise level at below 40 decibels. This can be very nice for those of us who like our systems to be seen but not heard, particularly those who also do audio along with their video. Once the card was installed inside a case, I found it to be very peaceful—not a peep from the card escaped the computer case. The card also runs fairly cool, so additional cooling fans for the case are not required, again keeping noise to a minimum.

The Quadro FX 3800 is configured using Nvidia's control panel, which gives users robust control over the card and OpenGL settings. One of the nicer features is the option to let the 3D application decide the appropriate OpenGL settings for the card. This is driven by Nvidia's Application Configuration Engine (ACE), which automatically configures the graphic hardware for whatever software application is chosen. If you're switching between applications, such as a CAD program and a 3D authoring package, you won't have to reset your settings every time you start a new application. Other features of the control panel include options for color correction and application-specific overrides to the default OpenGL settings. For those using Autodesk's 3ds Max, the card comes with a special set of drivers used to accelerate that application.

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As for the guts of the card, the specifications of the Quadro FX 3800 show the inevitable march toward more, better, and faster—which is standard practice in the graphics card business. Compared to its predecessor, the Quadro FX 3700, the 3800 doubles the GPU memory to 1GB of GDDR3. The QuadroFX 3800 also increases the number of processor cores to 192, and adds the option of an SDI video add-on, which allows for high-end professional video output in 8-, 10-, or 12-bit formats.

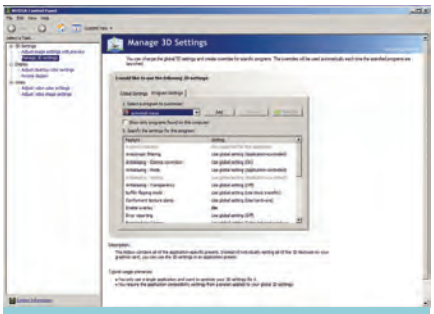


The Nvidia Quadro FX 3800 has double the GPU memory as the 3700, its predecessor, making it a good choice for graphics and video encoding, thanks to an optional SDI video add-on.

The SDI daughter card can be used for real-time broadcast applications, such as greenscreen and weather reports, but also for real-time compositing and other applications. The fact that SDI is available on this level of graphics card is also nice from a budget standpoint.

Those who are using the card for video applications will not only be happy with SDI, but also with the additional processing power of the card. The extra GPUs give the card power that can be used for graphics as well as for other tasks, such as video encoding. For artists who do a lot of video editing and encoding, Nvidia is offering Elemental Accelerator, which is a video processing plug-in for Adobe Premiere Pro CS4. The application leverages Nvidia GPUs to dramatically speed video decoding, processing, and encoding to H.264 and MPEG–2, with acceleration up to 10 times that of CPU-based encoding. This is one place where the parallel processing power of the GPU really shines through.

For those running multiple operating systems, particularly people on



The control panel lets the card determine which features to use based on the application.

the OS X platform running parallels, Nvidia's SLI Multi-OS can be helpful. This is a new SLI feature available on the FX 3800 that allows users to run multiple operating systems concurrently, while maintaining graphics performance. By installing two graphics cards and linking them via SLI, each card can carry the graphics load for its own operating system, while driving the same displays.

The Viewperf benchmarks show that this card is a solid performer and extremely fast. The card is almost twice as fast as the previous generation, and the card's speed is creeping up close to that of the Quadro FX 4800. This makes it hit the sweet spot in terms of price and performance.

Of course, benchmarks are synthetic tests; real-world performance can differ considerably. So, I tossed the card in one of my production machines and used it in day-to-day production for more than a month. The card was rock-solid and fast. As a test, I loaded an extremely heavy Autodesk Maya scene from a production my studio was animating. The scene ran noticeably faster than it did on the Quadro FX 3700 that was previously in the machine. I also ran a test of H.264 video encoding in Premiere CS4. With Elemental Accelerator turned on, the speed increase was a factor of eight at minimum, sometimes more, depending on the content. This speed increase alone can make the card worth the investment for any studio doing a lot of encoding.

Overall, I really liked the card. It offers a lot of power and performance for the price, and represents the best value in the Nvidia line. For those who have a serious need for graphics power, this is a quality card that will serve you well. ■

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PRODUCTS

For additional product news and information, visit CGW.com

News from NAB

The 2010 National Association of Broadcasters (NAB) Show, held last month in Las Vegas, set the stage for a wealth of new product releases, many of which are presented on this page. For more news from NAB, visit www.cgw.com.

SOFTWARE

DCC

Creative Suite 5

Adobe Systems announced Adobe Creative Suite 5, the latest version of its design and development software suite. The Adobe Creative Suite 5 Master Collection includes Photoshop CS5, Illustrator CS5, InDesign CS5, Flash Catalyst CS5, Flash Professional CS5, Dreamweaver CS5, Adobe Premiere Pro CS5, and After Effects CS5. Creative Suite 5 products feature integration with online content and digital marketing measurement and optimization capabilities for the first time. Another new component, Adobe Flash Catalyst, provides the ability to design interactive content without writing code and to improve collaboration between designer and developer. Adobe Creative Suite 5 Master Collection boasts more than 250 new features. Photoshop CS5 gains Refine Edge, for better edge-detecting technology and masking results in less time, and the ability to remove an image element and replace the missing pixels with Content-Aware Fill. New stroke options allow Adobe Illustrator CS5 users to create strokes of variable widths and precisely adjust the width at any point along the stroke. Adobe Photoshop, Adobe Premiere Pro, and After Effects are now native 64-bit applications on both Mac and Windows; whereas the Nvidia GPU-accelerated Adobe Mercury Playback Engine in Adobe Premiere Pro CS5 helps open projects faster, refine effects-rich HD sequences in real time, and play back complex projects without rendering. The Roto Brush tool in After Effects helps users isolate moving foreground elements in little time; and, Dreamweaver CS5 supports content management systems Drupal, Joomla, and WordPress. Adobe offers Creative Suite 5 Master Collection for $2599, Creative Suite 5 Design Premium for $1899, Creative Suite 5 Web Premium for $1799, Creative Suite 5 Production Premium for $1699, and Creative Suite 5 Design Standard for $1299, as well as 15 point products.

Adobe Systems; www.adobe.com WIN MAC

VIDEO

3D Blu-ray

Sony Creative Software presented its Blu-print Blu-ray Disc authoring application and Z Depth 3D subtitle offset editing application. One of the first professional 3D Blu-ray Disc authoring products on the market, Blu-print 6 authors 3D titles in accordance with the Blu-ray Disc Association (BDA) 3D Blu-ray disc specification. Blu-print 6 enhances workflow for production facilities and professional video editors, offering the import of MVC-encoded content, support of 3D menu graphics and subtitle graphics, and Java integration. To assist editors creating 3D subtitles, Z Depth generates the necessary offset metadata file, helping editors more accurately and easily position subtitles when creating 3D Blu-ray Discs. Blu-print 6 and Z Depth will be available in June 2010 through Sony Creative Software Professional Services.

Sony Creative Software; www.sonycreativesoftware.com WIN

Maxon Cinema 4D



Maxon Computer unveiled its Cinema 4D Broadcast Edition for creating dynamic broadcast graphics. The new product is designed to offer ease of use, quick workflow, fast rendering, and seamless export to compositing tools such as Adobe After Effects, Apple Motion, and Apple Final Cut Pro. The Broadcast Edition combines the company's Cinema 4D and its MoGraph module, as well as a library of 3D models, materials, cameras, lighting setups, and video clips. The Broadcast Edition is capable of 3D graphics with dynamic camera moves, animations, presentations, and such classic broadcast elements as lower thirds and openers, info graphics, and title sequences.

Maxon Computer; www.maxon.net WIN MAC

Open-Source Platform

EditShare, maker of cross-platform collaborative editing and shared media storage, has transformed the newly acquired Lightworks solution into Lightworks Open Source. It is being called the industry's first open-source development initiative for a large-scale, non-linear editing (NLE) platform. The Lightworks Open Source platform provides a gateway into the NLE's core engine, enabling creative developers to implement novel features and workflows.

EditShare; www.editshare.com WIN MAC LINUX

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Check out the video at www.wacom.com/Cintiq









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