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Features

Cover story
Merry Tales 12
CHARACTER CREATION | The third time’s a charm, as DreamWorks encounters character-creation “firsts” in the making of the latest Shrek animated film.

By Barbara Robertson

Grindhouse Graphics 18
VISUAL EFFECTS | In the double-bill film Grindhouse, directors Quentin Tarantino and Robert Rodriguez use digital and practical techniques to create a period look for their modern-day movie.

By Martin McEachern

Fast Forward 26
CG ANIMATION | Disney moves its technology forward to tackle character, clothing, hair, and environmental challenges in the time-jumping Meet the Robinsons.

By Barbara Robertson

Scratching the Surface 32
CAD | Digital tools put a young designer on the fast track to creating a concept car.

By Karen Moltenbrey

A Dragon Tale 36
GAMING | Game artists work collaboratively with VFX artists to make Eragon interactive.

By Martin McEachern

On the cover:
While Far Far Away is “throne” into chaos in Shrek the Third, DreamWorks artists show they have the situation well under control, pg. 12.

April 2007 • Volume 30 • Number 4
See it in Post
Also see www.cgw.com for computer graphics news, special surveys and reports, and the online gallery.
A Growing Trend

Computer game development is, well, no longer a game. It’s big business. Retail sales have risen dramatically, thanks to the latest-generation consoles. These new platforms, along with suped-up PCs, advanced wireless devices, and powerful handhelds, are bringing a new level of realism and immersion to the genre that’s great for gamers but challenging for developers. Looking for inventive ways to create unique, compelling content more efficiently, developers, designers, artists, and programmers last month descended on San Francisco for the 20th annual Game Developers Conference. Over the years, GDC has evolved from a programming show to one that embraces other aspects of game development, including design, audio, visual arts, production, and business and management for PCs, consoles, portable devices, and mobile gaming. As a result, attendance has been steadily rising. This year, GDC boasted more than 16,000 conference-goers, expo attendees, exhibitors, speakers, media, and analysts—a figure that represents a 30 percent increase from last year.

One factor contributing to that growth is the new consoles, which are requiring developers to look beyond standard game development tools and technology. To that end, it was not surprising to see a much bigger expo floor area filled with the latest software and hardware offerings geared to game development. This year, there were 262 exhibitors, including those in the Career Pavilion, representing a 32 percent increase from 2006.

“The game industry is growing, and GDC typically follows the budget growth of video games,” says Jamil Moledina, executive director of GDC. “The new generation of game platforms require larger budgets, and developers need to hire more people and investigate new content-creation tools—and GDC can help make sense of those needs.”

With E3 becoming an intimate, invite-only event this year, some attendees were curious as to whether GDC would fill any void left by that show’s demise. However, as Moledina stresses, GDC will not turn into an E3-like show for playable games; rather, it will continue to focus on game development and provide an atmosphere of learning and community for the industry.

If there is one thing to take away from this year’s GDC, it is that game development is expanding and growing in sophistication as an art form. Now more than ever, digital art students are looking at the game industry for a career. “Video game development is perceived as something that people want to pursue,” Moledina says. “College students are very excited about participating in this sector.” Helping to foster this newfound attitude are the art schools and colleges, many of which are now offering game development and provide an atmosphere of learning and community for the industry. Moreover, the industry itself is emerging from the “stereotype gamer.” And within the digital arts arena, game development is perceived as something that people want to pursue,” Moledina says. “College students are very excited about participating in this sector.” Helping to foster this newfound attitude are the art schools and colleges, many of which are now offering game development and provide an atmosphere of learning and community for the industry.

The new consoles are requiring developers to look beyond standard game development tools and techniques when creating their new titles.
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Gelato 2.1 Delivers Hair-Raising Results

Nvidia recently served up Gelato 2.1, its high-quality, GPU-accelerated rendering software, which now includes support for Joe Alter’s Shave and a Haircut software for computer-generated hair and fur effects. With support for Shave and a Haircut, Autodesk Maya users can easily add Gelato to their rendering pipelines.

Gelato is final-frame rendering software for the creation of high-quality CG images that is accelerated by the Nvidia Quadro FX and GeForce graphics hardware. Originally developed to render film and broadcast visual effects and animation, Gelato is well suited for any 3D software application that requires high-quality rendering, such as animation, game development, CAD, industrial design, and architecture.

Other enhancements in the release include support for Autodesk Maya 8.5 and 3ds Max 9.0. In addition to supporting fog lights (volumetric effects for spotlight cones), Gelato 2.1 sports performance improvements, including faster raytracing and ambient occlusion. The product’s improved stereo rendering features new off-axis and parallel projection modes and a better anaglyph (red/blue) display in the image viewer.

Gelato 2.1 is available as a free download at www.nvidia.com/gelato, while Gelato Pro 2.1, priced at $1500, offers advanced rendering features and greater scalability for professional production pipelines.

Imagineer Systems Starts Its Motor

Imagineer Systems rolled out Motor, the company’s first offering in its new initiative to deliver sophisticated, high-end visual effects and design capabilities to mainstream visual effects artists.

Specifically designed to be more affordable and accessible to a wider range of effects artists, Motor delivers a unique approach to rotoscoping for high-quality matte production within commercial, film, and corporate video postproduction. Motor is built on Imagineer’s 2.5D planar tracking and spline technology, previously afforded only to high-end visual effects design tools.

The product not only tracks x and y motion, but also tracks perspective, and it does so on entire regions of the frame, without having to isolate individual tracking points. Because it is tracking regions and not points, the process is extremely fast.

Motor enables users to rotoscope footage three to four times faster than they can with traditional tools through integration between the tracker and rotoscope capabilities, yielding higher-quality matte production in less time. The tool also supports popular design platforms.

Motor is available now and ranges in price starting at $1595 for a single-user node-locked license, to $6995 for a 10-user cross-platform floating license.
Alienware Enters the Fourth Dimension

Triggering the start of a new evolution in the company’s workstation line, Alienware has introduced its most powerful offering to date: the MJ-12 8550i, powered by the Quad-Core Intel Xeon processor 5300 series. As the first Alienware workstation to offer quad-core processing, the MJ-12 8550i represents the initial offering in a series of upcoming workstation solutions from Alienware.

The Quad-Core Intel Xeon processor 5300 series injects the MJ-12 8550i with 50 percent greater performance than previous-generation Intel Xeon processors. This helps Alienware’s latest workstation deliver unparalleled performance per watt and expanded virtualization capabilities, ideal for demanding creative professionals, such as CAD engineers and digital content creators.

To maximize both storage space and data access speed, the MJ-12 8550i is available with up to four 15,000 rpm Serial Attached SCSI hard drives. Also well suited for memory-intensive applications, the workstation includes up to 16GB of DDR2 FBDIMM memory, and is equipped with a choice of Nvidia Quadro FX and ATI FireGL graphics cards.

Pricing for the MJ-12 8550i varies according to system configuration.

Right Hemisphere 5 Makes Global Debut

Right Hemisphere, a provider of enterprise-class solutions for the manufacturing market, has rolled out its latest offering, Right Hemisphere 5, an integrated suite of visual product communication and collaboration solutions.

The software is designed to eliminate inefficiencies in the enterprise and to help manufacturers get their products and support materials to market faster. Right Hemisphere’s software integrates with and extends all major product data management and product lifecycle management (PLM) systems, and enables the re-use of accurate and up-to-date product information. The software also automates the delivery of product information to those in the extended enterprise, in whatever format is required, including corporate document standards, such as Adobe PDF and Microsoft Office. This means stakeholders across the extended enterprise—including sourcing, sales and marketing, manufacturing, training, and service and support functions—can more rapidly and painlessly incorporate visual product information into their deliverables.

Right Hemisphere 5, aimed at solving communication and collaboration problems, includes new releases of Right Hemisphere’s software stack, including major improvements and feature additions to its flagship Deep Exploration client and Deep Server enterprise software. The solution contains robust technical illustration capabilities, such as detailed view creation, symbols, new and improved line-style materials, WebCGM output, 3D true-type fonts, legacy illustration sheet support, thrust-line generation, improved Adobe PDF callouts, and more.

External workflow support for post editing and collaboration processes make PDF creation more flexible and powerful. Also, advanced parts and bill of materials (BOM) management, including new metadata display and editing tools, ease the management process while enriching the document information. Version 5 also includes updated management tools and new assembly and part workflows, and delivers enhanced 3D PDF publishing capabilities for manufacturers.

The Right Hemisphere 5 platform delivers enhanced, interactive 3D PDF files that users can author without JavaScript programming knowledge.

Right Hemisphere 5 Deep Exploration, Deep Publish, and Deep View client software are available now in the Right Hemisphere e-store. Deep Exploration comes in two versions: the Standard Edition for $495 and the CAD Edition for $1995. Deep Publish, which allows users to more easily publish, view, and share 2D and 3D graphics within Microsoft Office and Adobe Acrobat applications, is offered as a free download. Right Hemisphere’s Deep View is a free viewer that enables users to view and interact with these 2D and 3D graphics in Microsoft PowerPoint, Word, or Excel. Right Hemisphere 5 Deep Server, meanwhile, will be generally available in early summer.
Nvidia Rolls Out New Quadro Solutions

Nvidia unveiled a new line of professional graphics solutions that include the Quadro FX 4600 and Quadro FX 5600, as well as the Quadro Plex VCS Model IV. These offerings move beyond typical graphics processing to offer compute-processing capabilities for algorithms, analysis, and simulation, for example, via the new Nvidia CUDA (Compute Unified Device Architecture).

Designed to tackle the extreme visualization challenges of the automotive styling and design, oil and gas exploration, medical imaging, visual simulation and training, scientific research, and advanced visual effects industries, these new Quadro solutions offer next-generation vertex and pixel programmability through Shader Model 4.0. This enables a higher level of performance and realism for OpenGL and DirectX 10 professional applications.

Additionally, the new cards offer 10-bit color output for greater color range and image accuracy. The Quadro FX 5600 offers an 1.5GB frame buffer for applications that have large datasets for volume rendering (such as medical visualization and oil and gas exploration), for interactive visualization, and for real-time processing of large textures and frames using full-scene anti-aliasing. The offerings also contain a new unified architecture that entails dynamically allocating compute, geometry, shading, and pixel processing power, resulting in optimized GPU performance. Nvidia’s CUDA technology and Quadro hardware combine to enable developers to solve complex visualization challenges.

The Nvidia Quadro FX 4600 is priced at $1995, and the Quadro FX 5600 carries a price of $2999.
Luxology Delivers Modo 203

Luxology has released Modo 203, with enhancements to the UV editing tools, faster rendering, and a new DXF translator plug-in that offers performance and workflow improvements—all of which provides a faster path to creating high-quality 3D content for game development, design visualization, film visual effects, video production, and graphic arts.

Modo 203 includes technology and user interface additions that combine to make development of high-quality UVs faster and easier. The UV unwrap tool has been improved so that UVs are laid out by the software with less angular and proportional distortion as compared to the geometric polygon volume. The UV pinning function has been improved, enabling users to interactively relax the UV data.

The seal hole option in UV unwrap also has been overhauled for more reliability on enclosed spaces in the mesh, such as eye sockets. Moreover, UV editing is improved by a move and sew option that enables the joining and scaling of discontinuous UVs in one step.

The Modo renderer sports additional speed injections, allowing for faster raytracing and ambient occlusion, and full-light “baking” operation. Irradiance caching also has been optimized, further cranking up global illumination performance on large-resolution renderings.

With the new DXF plug-in that reads and writes ASCII DXF files from inside Modo, architects and designers can import 2D and 3D entities from DXF files, including polymesh, arcs, circles, lines, points, polylines, and more. Layers in the incoming DXF files are automatically created as corresponding layers in the Modo scene to preserve file organization. At export, the new translator converts the Modo triangles and quads into a polymesh, with vertex connectivity maintained.

Modo 203 for both Mac OS X and Windows sells for $895; it is available free to registered Modo 202 customers.
Two thousand processors in a renderfarm. Think about how many computers that really is, how much memory they need (an average of 2.2GB each), and the infrastructure it takes to get them to work together to render all the digital images needed for an entire motion picture.

This can be an overwhelming thought perhaps, but large-scale computer-driven visual effects studios such as Rhythm & Hues employ dozens of programmers and technicians to take on these challenges. They guide, cajole, and push their huge networks of silicon and metal that feed the modern renderfarm in order to advance the state of the art with each new feature-film release.

**First Sparks**

The CGI industry began with a handful of studios that were as much research facilities as anything else, using mainframes and supercomputers to create their imagery. As technology evolved, new studios began to emerge, taking advantage of the new, cheaper microcomputers. Founded in 1987, Rhythm & Hues was one of these new types of facilities. The studio hit its fortunes to early production software from Wavefront Technologies. Over time, however, the studio slowly replaced the Wavefront software with its own. The studio’s proprietary animation software, Voodoo, emerged from this process, as did custom applications and systems for lighting, asset management, modeling, and compositing.

The original R&H renderer, called Wren, was a simple one. Over the years, Wren was completely refactored by developer Toshi Kato. The newly redesigned architecture enabled subsequent teams of programmers to repeatedly rewrite Wren and dramatically extend its speed and capabilities. Today, it is one of R&H’s key production assets.

As the studio celebrates its 20th anniversary this month, it’s an appropriate time to reflect on the key milestones in the development of this renderer and the challenges faced by its programmers that are indicative of the state of the seemingly magical art of rendering in general.

**Up to Speed**

One of the biggest advantages to using proprietary software is the economy of scale. By hiring programmers to write software for the various stages in the production pipeline, larger studios free themselves from expensive annual license fees for the tools they use. Also, they are usually free to choose the most cost-effective hardware without worrying about compatibility issues down the road—the software can be made to accommodate the hardware instead of vice versa.

Ivan Neulander is a Rhythm & Hues software developer and leader of the Wren development team. As he recalls, before the studio’s merger with VIFX (in 1999), the crew was using the Irix operating system running on SGI machines, and Wren would only work on that particular platform. With the merger, the studio acquired numerous 64-bit Compaq Alphas running Linux, which were much faster than the SGIs. Porting Wren to this platform was critical to the timely completion of R&H’s heavy fur renders for the movie *Cats & Dogs*.

Then R&H went to the IA32 (32-bit Intel) architecture, also running Linux. For a
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while, the studio supported Wren on all three platforms (SGI, Alpha, Intel). It was important to ensure consistent results between platforms, so that the group could render one shot on one platform and another shot on a different platform without worrying about discrepancies. “These kinds of transitions and multi-platform support would have been much more difficult with third-party software, whose release schedule is not always in sync with our production deadlines,” Neulander says.

The advantages of creating your own software extend to both creative as well as technical considerations. Having the source code lets you add new features and capabilities as technical directors request them, to enhance either the look or the speed at which that look can be obtained. One such feature developed by R&H is its fur shader, first developed for Cats & Dogs in 2001 and used on several films since then. “I think the work we did on Cats & Dogs was the finest work anyone had done up to that point, and it was the first movie to use our Kajiya-based hair rendering primitives,” says Neulander. “They featured a proprietary self-shading model that was not available in any other software at the time.”

According to Neulander, the R&H artists can define a hair strand with as many control points as they want, to control diffuse, specular, and reflective colors, as well as a host of other features. They can also shift hair tangents to offset specular highlights, to give it a more natural look. While Neulander admits that these are things that can be done using a commercial renderer like Pixar’s RenderMan, he notes that it would take a tremendous amount of shader writing to get the same feature that comes out of the box with Wren.

On Garfield I, R&H introduced improvements to its depth-map shadowing, as well as enhancements to Wren’s tiling mechanism, which allowed the artists to efficiently subdivide a frame full of fur into separate renders, rendering those concurrently on different hosts and stitching the results together at the end. With Narnia, the studio introduced several new features designed to reduce the memory footprint of Wren’s hair-shading pipeline, improved specular highlight control, and enabled efficient image-based lighting of hair with occlusion, using a combination of depth maps, raytracing, and an extension of its local self-shadowing model.

Looking Forward
Toshi Kato remains a developer at R&H, working on Wren’s internals. Wren originally was just a scan-line renderer; the kernel of the current Wren is primarily his work. Many people have since extended it and made large contributions to it. Currently, Kato is working on raytracing, mapping computations, and support for new kinds of shaders. And all these things require changes in the architecture of Wren to properly support those features. As Kato explains, raytracing is a critical part of R&H’s rendering solution. “If we need global illumination, we need raytracing,” he says. “It’s also used in ambient occlusion. Over the past several years, we have changed some of the functions from a front-surface-only rendering technique to raytracing. This empowers our artists to do volumetrics, global illumination, subsurface scattering, caustics, and other things.”

More recently, the studio has been concentrating on a more complex shading model for illumination. And as Kato points out, raytracing is needed for that kind of computation, but it’s difficult to control. “We need a major breakthrough, so I am working on new ways to do that,” he says. The Wren system requires the user to tweak many major parameters in order to optimize a scene, often so many that only expert users can do it; so, Kato is currently working on incorporating easy controls, or ideally no controls at all, for scene optimization.

Another enhancement under way at R&H is a programmable shading framework. This will allow technical directors to write programmable shaders for materials, lights, atmospheres, and similar features currently built into Wren. While other rendering systems already allow shader scripting, this approach will produce dynamically linked object code instead—shaders will first be translated into C or C++, and then compiled down into native machine code to run as fast as possible. Giving the artists the ability to write their own shaders that run at that speed opens a whole world of possibilities.

Some Sparks Don’t Ignite
Intrigued by the advances in the real-time rendering quality afforded by the latest generation of graphics cards, the R&H developers tried making a special version of Wren called WrenGL. The concept was to use the standard Wren interface to drive a hardware-only version of the existing rendering system for fast previsualization. However, the costs involved in installing OpenGL hardware in every render node made the project too expensive to implement, and the project was sidelined.

It may be surprising to learn that advancements in rendering speed don’t necessarily translate to faster render times—instead, the extra speed allows for more creative and technical quality in the resulting images. With all this fur, the woolly mammoth from 2006’s Night at the Museum took between four and seven hours per frame to render, depending on other on-camera content. This is no greater a number on average than Aslan from Narnia had taken the year before, or Garfield had taken the year before that. However, with each film, the capabilities—and the quality of the final images—grow.

Chief software architect Keith Goldfarb, one of the original founders of R&H in 1987, says this about the studio’s rendering approach: “In general, our emphasis has been on quality more than it has been on speed. That’s sometimes a difficult sell in Hollywood, but that has always been our niche.”

Gene Turnbow has been training technical directors as part of Rhythm & Hues’ Education Department and bridging the gap between the artistic and technical staff as a technical writer since 2003. The title on his business cards reads “Programator.”
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The Drawn Together images are courtesy of Comedy Partners.
Three is a charm, or so Far Far Away’s Prince Charming would like to believe, and he seizes his opportunity in DreamWorks’ *Shrek the Third*. The film begins with the king’s death and Shrek’s sudden ascension to the throne. Becoming king is not only a shock to Shrek, it’s an uncomfortable role for the oafish ogre to play—and he’s soon sailing off with his friends Donkey and Puss In Boots to recruit a replacement.

As the boat leaves the dock, Princess Fiona, Dragon, and a flurry of tiny Dronkeys (Dragon and Donkey’s children) wave goodbye. And then, at the last possible second, Fiona gives Shrek his second shock: She tells him she’s pregnant.

Into the void left by Shrek, Donkey, and Puss rides handsome Prince Charming, who persuades all the bad fairy-tale characters to join him in a palace coup d’état. They capture the princesses and the queen, and throw them in the dungeon.

Meanwhile, Shrek has found Artie, the king’s replacement, in a high school. “He’s the ultimate outcast,” says director Chris Miller of Artie. “He’s below the guys wearing retainers who are playing Dungeons & Dragons.” At first, Artie finds the new power position exciting, but when he considers the weighty responsibility, he freaks out. He doesn’t feel worthy.

“In this movie, everyone has a preconceived notion of who they are and what they’re supposed to do in life,” says Miller. “Every character in the movie has been told by society or people close to them that they’re supposed to act one way. Every character breaks free of that notion.” Every character except the queen and Fiona, that is. “They’re the strong characters. People around them change.”

**Fairy-tale Firsts**

To bring these characters and the fairy-tale kingdom of Far Far Away to life, a team of 350 people at PDI/DreamWorks Animation worked on the film’s 1320 shots. You’d think that with two films about Shrek already under their belts, along with several other feature anima-
tions, PDI/DreamWorks would have run across any CG technique a story could demand. Not so.

For *Shrek the Third*, the studio encountered several “firsts.” Shrek appears in a costume for the first time in this film. It was the first time that animators dealt with characters wearing high heels, the first time a character had a flowing beard, and the first time characters ripped off pieces of their clothing. It was also the first time lighters worked under completely overcast skies.

With more characters in *Shrek the Third* than in previous films and more costumes—23 key characters and more than 4000 generic characters—the crew not only created techniques to meet the “firsts,” they also advanced their rigging, costuming, and hairstyling systems.

Tim Cheung led the animation team. “We divided the animators into four teams, each with a supervisor, and had two animators dedicated to crowd animation,” he says. “Before, animators worked on crowds in addition to their regular shots.”

With the exception of the crowds, each animation team handled all the characters in a sequence, and each sequence took between six to eight weeks to complete. Cheung worked on all the sequences. “I tend to animate more than some animation heads,” he says. “I oversee all of it, but in particular, I make sure that Shrek is consistent throughout.” About half the animators had not worked on either of the two earlier *Shrek* films.

Cheung began working with character technical director supervisors Larry Cutler and Lucia Modesto about a year and a half before animation began to define and implement new controls, refine the existing controls, and test the new characters: Artie and a wizard named Merlin. “And Shrek got an upgrade,” he says, “which was great.”

**Building Characters**

Modesto and Cutler began by collecting drawings and other reference materials from the art department, the storyboards from the story department, and the 3D models from the modeling department. Then, they orga-
nized methods to make it possible for the animators to position the models in any pose they wanted. For Shrek 2, the crew largely had reused the models and rigs for the legacy characters. That changed with *Shrek the Third*.

“We set up all the original characters—Shrek, Fiona, Donkey, and Dragon—from the ground up,” says Cutler. “The exteriors had to look the same, but they had new controls that gave them more range of motion.”

PDI had modeled and rigged the original characters in 1998, and much has changed in the nearly 10 years since. For example, modelers originally built Shrek’s shoes into his model; he didn’t have toes. “Our tools and techniques are different now,” Cutler says. “We wanted to give Shrek better shoulders and arms. We added a scapula and a more detailed anatomical structure. And, we put in an ‘auto shoulder.’ It added complexity to the setup, but when the animators move the upper arm, the shoulder moves with it. They don’t have to deal with animating the shoulder.”

In addition, when Shrek steps into the king’s shoes, he’s dressed to suit the role in a costume with a cinched waist, high heels, poofy pants, and a ruffled collar that covers his neck and rests on his wig. And as if that weren’t enough for the riggers to deal with, his costume flies off.

Modelers delivered the characters, which they had built in Autodesk’s Maya, with their arms outstretched, in a T pose. The character TDs then built the armature, which is the skeletal structure, and the articulation points, which are the joints. Controls added to the armature created the system that the animators used to move the characters, that is, the animation system.

“We have tons of controls on top of the armature,” says Cutler. In addition to the auto-shoulder, for example, the TDs built a foot pivot system that enables animators to get walking behavior using three controls, even when the characters wear high heels.

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The faces changed the most. “As the skin slides over the bone, you can see the muscle changing volume and colliding,” says Modesto. “You can also see the bone structure underneath the eyebrows, and the Adam’s apple in the neck.”

Similarly, by using these muscle layers, the character TDs caused characters’ lips to fatten when pressed together, made the lower parts of eyes puffy, and gave Artie dimples.

Once the armature, joints, motion system, muscles, and fat were in place, the character TDs worked on hair and cloth systems.

“Normally, a foot rocks, lifts, and rocks down,” he explains. “With high heels, the heel is already raised and the toes are bent. But from the animator’s perspective, the controls are the same.”

Next, the TDs added muscles and fat using a proprietary system for deformation that represents muscles by building up layers. “It’s a simplified way of representing muscles,” says Modesto. The team didn’t use deformation, however, to cinch Shrek’s waist; they built an alternate body.

The effects team simulated Merlin’s beard (above) by running a single joint chain down the center (next page, left), applying a low-res deformation cage (center), then attaching hair to the face surface (right).

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**Hairy Tales**

“We threw out the simulation engine that we used for hair in *Shrek 1* and *2*,” says Cutler. “Now we have two engines: one for short hair and one for long hair. Merlin’s beard goes almost to the floor, so R&D wrote a simulation engine specifically for long hair and curly hair.”

In general, the hair systems use guide hairs driven off surfaces to control the overall head of hair’s shape and volume. “In *Shrek 2*, when Prince Charming tosses his hair, it was a one-off shot,” says Matt Baer, head of effects. “In *Shrek the Third*, we not only have complicated hair that’s hard to style, but it’s in motion.”
To move Merlin’s beard, the crew developed a technique they named the “rigid rod.” “It responds to character motion,” Baer explains. “But we can add forces.” Rather than using long lines or curves, they created a chain so that the beard wouldn’t split apart. Then, to prevent the pieces of the chain from moving independently, they used deformation. “Rather than one line, we had a polygon cage so we could use deformation techniques,” says Cutler. “That gave us more control points that we could access. We’d simulate the beard, but we also had a second layer with finer grain control.”

The TDs used the same system for Rapunzel’s long braid and Guinevere’s locks of hair that bounce near her face. Most of the other key characters, however, used the simulation engine designed for short hair. Of those, one of the most difficult was Sleeping Beauty, who has shoulder-length, straight hair. The effects crew simulated her hair on a shot-by-shot basis. “We wanted her hair to stick a little bit when it brushes against her shoulder,” says Baer. “Friction is the hardest.” For the generic characters, the TDs used the magnet-based grooming system developed for Shrek 2 (see "After Effects," May 2004).

**Many from Few**

One of the big advances for Shrek the Third was that the crew created major characters using generic models and rigs. “We had fewer unique setups in this film than in Shrek 2, but we had more characters,” says Modesto. “In Shrek, we had Men A, B, and C, because we couldn’t get enough variety from the generics,” says Modesto. In Shrek 2, we had Men A and B, and Woman A and B. In Shrek the Third, we have Men A and B and Woman A.”

Captain Hook, a master of ceremonies, Mable the bartender, the princesses, the witches, Lancelot, a hairdresser, and others, as well as people in the crowds, are all variations created from three generics: Men A, a thin model; Men B, a fat model; and Woman A. From those, the character TDs created five variations each for Men A and Men B, and nine variations for Woman A. “We didn’t need to have two women because the director didn’t need a fatter woman than we could get with Woman A,” says Modesto.

To modify the generic geometry even further, character builders could make arms wider and bodies taller using the joint structure, and by using the deformation layer, change the volume of the characters to make them fatter or skinnier. Because the faces of these generic models have the same fat and cartilage layers as the models for the principal actors, the crew could fatten or depress cheeks, thicken lips, grow and shrink noses and chins, and morph skulls into new shapes. Captain Hook got a hooknose, for example; Lancelot got manly jowls.

A “casting tool” created by the character TD department allowed the layout and surfacing departments to give the generics a selection of clothes, shoes, and hairstyles. “The important thing is having a variety of silhouettes of the heads,” says Modesto. “So we get that with hats and hair. In Shrek 2, the top of the skull had to be the same for every character, but in Shrek the Third, you can add hairstyles and hats that keep
the correct shape even though the cranium changes.”

To prevent fashion faux pas, the TDs built an early-warning system into the casting tool. “For example, if someone picks the wrong pants to go with a pair of shoes, they turn red,” says Modesto. “The casting tool creates only valid variations.”

Fancy Pants

In *Shrek* and *Shrek 2*, Fiona and the other female characters wore costumes designed so that, for the most part, only their skirts needed to move when they did. In *Shrek the Third*, some of the characters wear costumes that move from head to toe.

“Cloth was a big area of development,” says Baer. “We had layers of simulated cloth, characters that had worn spandex now had dynamic sleeves, and the characters acted with the cloth. That opened story possibilities.” Shrek’s tightly cinched costume pops open, for example. Even characters in crowds wore clothes that moved.

Character effects supervisor Bill Seneshen led the teams that worked with the apparel. To construct the costumes, the digital tailors built panels as if they were stitching together real clothes. Then, they placed the panels onto unmoving characters to check whether the clothes would wrinkle and fold correctly when the cloth relaxed.

For the cloth simulations, PDI/DreamWorks uses Maya cloth and sometimes Syflex. To help avoid unwanted collisions once the cloth starts moving—a skirt cutting through a leg, for example—they often used a second, featureless model of the characters. “The featureless figure acted as a collision body,” says Seneshen. “We could sculpt out areas on this figure to avoid collisions.”

During a scene in which the princesses decide to fight back after Prince Charming’s coup, Sleeping Beauty tears off the bottom of her skirt, and Show White rips off her sleeve. “The torn pieces are separate pieces of geometry,” says Seneshen. “We used texture maps and our fur shader to create tatters.”

To give women in the crowds skirts that flowed and the men tunics that moved, the character effects department devised a way to bake out simulations that they could apply to baked, looping walk cycles. “The system knows which simulation to use for a given cycle based on how many steps the character takes and how much distance it covers,” says Seneshen. “Our ‘mob team’ could tweak the rate of the stride.”

The character effects department’s team of 15 people also “finaled” the characters. “We’d retouch the geometry and underlying simulations, and do things like soft-tissue deformations,” says Seneshen. They might create a depression in a character’s cheek, for example, if the character comes into the department with his hand resting on his cheek. For this, they use sculpting tools in Maya and custom plug-ins.

The department also handled hair simulations, and animated all the props the characters interact with. “Anything that involves characters comes to us,” says Seneshen. “They’ll come to us if it involves cloth or strand simulation, if it wiggles, or if a character interacts with it.”

Effect-ive Characters

The effects department began work on *Shrek the Third* by coordinating with the layout department. Next, they created rough

Above, princesses prepare for battle. At right, top to bottom: Cloth panels for Sleeping Beauty’s tear-away skirt, the stitched panels unrelaxed and relaxed, the tear-away portion in green, and, at bottom, Beauty rips her skirt.
Character Creation

For fire, the crew decided to use Maya’s fluid simulator. “We liked the test we ran, but the question was how would we art-direct the fire,” says Baer. “The fire looked nice out of the box, but we needed to bend the timings. In one shot, the Dronkeys set a bed on fire; in another, a princess burns her bra. In addition, Shrek’s boat catches fire, the Dragon and the little Dronkeys all breathe fire, and there are numerous torches in Far Far Away. “Usually, we’re told that effects humor is not funny,” says Baer, “but we got to create funny fire—that is, fire used in funny shots.”

To art-direct all these various types of fire, the effects technical directors developed new ways to emit density and temperature into the grid used by Maya’s fluid simulator. “We tweaked the emitter, not the simulator,” explains Baer.

For the ocean, the team leveraged technology from Madagascar (see “Born to be Wild,” May 2005). When the water washes onto the beach, they art-directed each foam piece. “We created some with rough texture maps,” says Baer. “Some surfaces were like textured, stretching sprites that generated particles. Many of our tools are like little LEGOs. They start out as one-offs like Prince Charming’s hair in Shrek 2 or the foam pieces, and we propagate them into our tool set.”

Light Humor

The key challenge for the forests was creating artistic shapes with controllable shadows. “We tried to be good neighbors to the lighters,” says Baer. “We’d give them a tree-wedging grid so they could work with just a few leaves before turning on all the leaves.”

The increases in compute power as well as the team’s experience has made formerly exotic lighting techniques commonplace. Subsurface scattering, once reserved for hero characters, now softens the skin on generic characters and even on many of the characters in the crowds.

On Shrek 2, the lighting team used global illumination (GI) on characters, but on Shrek the Third, environments received the sophisticated lighting, as well. “Once we have the global illumination set up, we can plug it in within shots,” says Philippe Gluckman, visual effects supervisor.

That became particularly important for a sequence that takes place in overcast lighting. “We had to rely on subtleties to bring form to the characters,” Gluckman says. “GI helps. We could sculpt where we wanted to use it. We can set key directions and get fills.”

To choose areas where GI would help, the lighting team simulated scenes in coarse resolution before running the calculations on the full-resolution geometry. Also, to speed the process, they often used baked GI. “We’d calculate the GI once and apply it to many scenes,” Gluckman says. “It worked as long as things didn’t move.”

New, efficient ways to create characters and effects such as these helped PDI/DreamWorks create a richer, more highly detailed film than the series’ predecessors. Could the third Shrek film be even more popular than the first two? The first Shrek won an Oscar and raked in $484 million at the worldwide box office. Shrek 2 was nominated for an Oscar and did nearly twice as well at the box office, generating $920 million worldwide. It still holds on to seventh place in the all-time biggest box-office race.

“The fun thing about working on Shrek is that everyone wants to do it,” says Raman Hui, codirector. If the enthusiasm of the crew is any indication, look for a charmed third time for the fractured fairy tale.

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Fun Facts

- Shots: 1320
- Sequences: 37
- Frames: 130,000
- Shrek’s height: 7 feet
- Costumes designed: 4500
- Costumes used: 2500
- Number of costumes compared to Shrek: 10 times
- Generic characters: 4378
- Theater audience: 1373
- Number of new environments: 60
  - Bricks in the dock: 1602
  - Bricks in the sewer walls: 3196
- Tree branches: 62,173 per tree
- Tree leaves: 191,545 per tree
- Princess obsessions
  - Cinderella: cleaning
  - Sleeping Beauty: narcolepsy
- Length of Rapunzel’s hair extensions: 4 feet 6 inches to 85 feet

Barbara Robertson

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Supervixens, Cannibal Holocaust, The Savage Seven. These are a few of the hundreds of exploitation films that played in all-night marathons in the suburban drive-ins and inner-city grind houses of the ’70s and early ’80s. With their unbridled violence and lurid sexuality, they ignited the imaginations of two then-aspiring filmmakers, the now-famous Quentin Tarantino (Reservoir Dogs, Pulp Fiction, Kill Bill) and Robert Rodriguez (Desperado, the Spy Kids series, The Faculty).

When the two became friends in the early 1990s, they would often run exploitation double features in their home theaters to recreate the down-and-dirty experience for themselves and their closest friends.

While B-movie influences—from Roger Corman to the kung fu canon of the Shaw brothers—have always seeped into their films, in 2004, the two famed directors decided to combine their passion to produce Grindhouse, a blood-soaked double bill featuring Tarantino’s Death Proof and Rodriguez’s zombie horror flick Planet Terror, both linked together by a pastiche of faux movie trailers all designed to bring this bygone theatergoing experience to the masses. In recapturing the unrestrained spirit of these cheaply made films, both directors were forced to take their visual effects game in a whole new direction, aiming for a unique fusion of practical and digital effects that would both surpass and remain true to the handmade effects of the time.

For the first time, Rodriguez couldn’t indulge in the kind of hyper-stylized digital effects seen in Sin City or the Spy Kids films; instead, he and his effects house, Troublemaker Digital, along with The Orphanage and makeup wizards at KNB EFX Group created a photorealistic hybrid of practical and CG imagery. While Tarantino continued his long-standing tradition of eschewing CGI, relying instead on KNB and unbelievably dangerous stunt work, he turned to The Orphanage to digitally clean up many of his shots.

In Death Proof, Stuntman Mike (Kurt Russell) stalks Jungle Julia (Tamia Poitier) and two of her closest friends as they visit some of Austin, Texas’, most famous diners, such as Guero’s Taco Bar and the Texas Chili Parlor, before hunting them down behind the wheel of a muscle car called Deathproof. In Planet Terror, married doctors William and Dakota Block (Josh Brolin and Marley Shelton) are besieged during their graveyard shift by townspeople strocken with sores and bearing vacant eyes.

Leading the stand against the enraged aggressors are Cherry Darling, whose leg was ripped from her during a roadside attack, and Wray, her former significant other. With a machine gun bolted to her leg stump, Cherry and Wray lead warriors into the zombie-filled night.

“Our primary responsibility [for Death Proof] was to remove various objects required for the safety and success of the practical stunts,” says The Orphanage’s visual effects supervisor Ryan Tudehope. “A number of shots required paint and rotoscoping to remove cables, stage rigs, lighting, crews, and cameras. Also, for safety concerns, Tarantino had to shoot the collision of Deathproof with a red Honda in the middle of the road, when he wanted it to occur in the lane the red Honda was traveling in. In the end, we helped out by digitally moving the yellow divider lines.”

Another example of the more understated, supportive role played by digital effects in Tarantino’s film is a shot in which Deathproof slams into the Honda and flips end over end as it careens to a stop at the end of the road. “Amazingly, the
vehicle was piloted by a stunt driver,” says Tudehope. “The hydraulic rig required to flip the vehicle became visible on the underside of the chassis toward the end of the shot and required a digital ‘patch’ to cover the area.”

In all, Troublemaker completed 289 shots for *Planet Terror*, while The Orphanage delivered 107 for *Planet Terror* and 38 for *Death Proof*. The collaboration among the three companies was so close-knit, however, that in any given shot or sequence, it’s almost impossible to tell where one company’s work ends and another’s begins.

**Film Damage**

Aside from their ultraviolent subject matter, exploitation films shared another common trait: a degraded condition. As the prints traveled across the country from theater to theater, they would accrue so much damage—from scratches and fingerprints, to cigarette burns and missing frames and reels—that it became part of the soul and character of the genre.

In fact, while watching one film from his private collection that had a missing reel, Tarantino found that the narrative hole left an interesting mystery about what had happened at that point in the story. Film damage, in effect, led to unique and fascinating storytelling possibilities.

With that in mind, Tarantino and Rodriguez invested an enormous amount of work in celluloid damage. Tarantino damaged his film organically, manually scratching, burning, and cutting the work print and living with whatever destruction he inflicted. Rodriguez, on the other hand, sought a greater level of creative control, wanting the damage to serve as an emotional punctuation for events in the story. To that end, he charged the artists at The Orphanage and Troublemaker Digital with damaging his film digitally. The Orphanage processed one reel (number 2), while Troublemaker did the remaining five reels of *Planet Terror*. With rendering times averaging a few minutes per frame, and 25,000 frames per reel, it was a huge undertaking to process the entire film. To get the artists into the spirit of the genre, Tarantino invited the crew to a local theater in Austin, where he’d hold
Visual Effects

nightly screenings of his private collection of 1970s exploitation films, encouraging them to absorb the narrative nuances and celluloid aesthetics.

Both companies used Magic Bullet and Misfire, two Adobe After Effects plug-ins from Red Giant Software. Originally developed by one of The Orphanage’s partners, Stu Maschwitz, the tool set was significantly enhanced and expanded by a group led by damage lead Dav Rauch. The goal was to help the artists match the film damage references captured by animation supervisor Webster Colcord, who cut together clips from his personal library of old films and teaser trailers.

“We had all these different clips and references telecine’d, so we were able to bring them into our computer and study them frame for frame and even steal some of the scratches, dust hits, cigarette burns, tape marks, and all kinds of things that we wouldn’t have been able to come up with on our own, or with any third-party application or plug-in,” says Tudehope. “Our tool set [within Magic Bullet and Misfire] gave us a wide range of controls for adding scratches, micro-scratches, hairs, variable sizes and types of dirt, flicker, fingerprints, and splotches, even light bleed from the sound strip on the left side of the frame. We also had a bunch of edge fading and saturation anomalies that we picked up from some of our references, as well as grain diffusion, gate weave, and distortion.”

Directing his digital artists, Rodriguez had a specific methodology governing the severity, location, quality, and kind of damage he wanted throughout his film. “He was precise and patient with us as we dialed in the exact amount of damage,” says Tudehope. “There were a lot of shot-specific effects on top of all the generic ones; cigarette and tape burns had to happen at specific moments; large blotsches or burns, warbling, or a splice had to correlate to the story. Our first direction from Robert was, ‘Find a look for the damage that enhances the shot and gives it some kind of life without covering up the important effects or the acting.’ So, we used the damage to support the acting and story in unique and clever ways, but never to the point where it became too obvious that it was tied to the events in the story.”

For example, if a character is stabbed by a needle, the whole frame might shake slightly and flare suddenly with a red burn, but if that person gets stabbed again by the needle, the same effect would not be used again. “We wanted to use it in places where it would surprise people but not take them out of the story,” Tudehope explains.

Along with Magic Bullet and Misfire, Troublemaker Digital also added Eyeon’s Digital Fusion to its arsenal of film-damaging tools. “The rule of thumb for us was to focus first on areas where the mechanics of the camera or the medium itself dictated damage, like at the beginning or the tail end of the film,” says Troublemaker Digital’s Rodney Brunet. “Frame flutter, fingerprint blurs, and scratches were all used sparingly until Robert [Rodriguez] or the story dictated that they be exaggerated. Robert would also use the damage to help tell the story; for instance, if he wanted to push the story along, he would just cut part of the film, using it like a film burn.”

Cherry Darling

Brunet and his team at Troublemaker Digital were also charged with erasing Rose McGowan’s leg and replacing it with the digital machine-gun prosthetic, a laborious rotoscoping and compositing challenge tackled by Drew Dela Cruz using Autodesk’s Flame. First, to scan McGowan, Troublemaker turned to Eyetronics, which used its ShapeCam scanning system to capture all the actors and props, including the machine gun, at the Troublemaker facility.

Working in Softimage’s XSI, artists textured, rigged, and animated both a full model of Cherry and another of just her leg. “In most shots, the CGI part of her was the gun all the way up to the bandage. The CG-bandage was then blended into the live-action bandage, but there were a few cases where we replaced her entire leg all the way up to her thigh,” says Troublemaker’s Chris Olivia.

Because the film unfolds at night, finding an effective method of tracking McGowan’s leg in the live-action plate was a process of trial and error. In fact, the group tested a range of options, including glow-in-the-dark paint, fiber-optic, battery-powered tracking lights, LEDs, a colored stocking, and rigid casts. In the early R&D stage, artist Alex Toader wired some of those items inside a cast, but the cast proved too uncomfortable for McGowan. The best solution was to use a green stocking—just for lighting refer-
PROFESSIONAL RESULTS AREN’T ALWAYS PRETTY

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enoe—and hand-track her in XSI through the shot. “So all that data we calculated early on was useless,” says Brunet. “Had she been able to keep her leg stiff, the cast would’ve worked like a charm with [The Pixel Farm’s] PFTrack or [2d3’s] Boujou, or one of those object-replacement software packages, but it was just too cumbersome and difficult for her. The bounce light from the LED and fiber-optic lights created too much spill.”

Artists did use PFTrack and Boujou for tracking the camera, however. For Flame artist Dela Cruz, reconstituting the backgrounds to fill in the blanks around the erased leg was a constant challenge. “Once the actress was removed, we didn’t have the best information, or the lighting would change, so we’d have to look at each shot like a puzzle and just start tracking elements in the plate that we had and put them back, or make completely clean plates,” he says.

Helicopter Heroics
To remain consistent with the practical effects of the 1970s, Rodriguez tried to complete all the shots in-camera, a decision that entailed dangerous stunt work throughout most of the film, especially in a helicopter sequence and another featuring a large tow truck called the Killdozer. To help plan the stunts, Olivia worked closely with the stuntman to develop the action through animatics. “For example, when Cherry has to fly over the wall, we animatic’d those shots, guiding the stuntwoman, who was then placed in a harness and lifted by a crane. Another shot, in which a police officer gets thrown into a cop car, was directed by our animatic, as well.”

Rodriguez also appropriated one of Troublemaker’s animatics directly into the film while shooting “Machete,” one of the faux trailers in which Danny Trejo rigs a machine gun to the handlebars of a motorcycle and then launches into action. “Robert ended up liking the animatic, so instead of shooting [the stunt], we just used the animatic because the camera was so far away from the actor that we were able to get away with it,” explains Brunet.

At the climax of Planet Terror, the machine-gun-legged Cherry races to a rising helicopter sitting on a tarmac, clinging to a rope attached to its side, and dangles wildly beneath it as it soars away. On the tarmac set in Austin, Rodriguez used the front end of a helicopter—minus a prop and rotors—to shoot as much of the scene as possible, even lifting McGowan into the air using a crane and a harness. Completing the sequence was a team effort between The Orphanage and Troublemaker Digital.

“We created a second digital helicopter and also extended the real one, adding the props and the tail. Interestingly, our helicopter was a mix between a Black Hawk and a Sea Stallion, so it was a kind of hybrid helicopter, which is cool because it allowed us to have a bit of creative freedom over the design, which Robert ultimately liked,” says Tudehope. Modelers at The Orphanage built the polygonal chopper in Autodesk’s Maya based on photos of the real one taken on set, while artists at Troublemaker painstakingly hand-rotoscoped McGowan’s real leg and replaced it with the digital machine-gun prosthetic.

Then, using Maya, After Effects, and Digital Fusion, The Orphanage took over the plate from Troublemaker, disconnected McGowan with her newly added digital machine-gun leg, and put her on a 2D card inside a 3D environment, where they could move her around, make her swing on the rope, or make her smaller as she recedes into the distance. “The shot was very complex because we had to take over not only the motion of the real McGowan, but the motion of the real camera as well, which we had to blend with our virtual one to make it look like the helicopter was taking her out of the frame. So, it was a lot of motions that added up before it all finally came together with a bit of smoke and camera shake,” says Tudehope. For matchmoving the camera and actors, The Orphanage used Boujou and PFTrack.

For the full CG “hero” shots of the helicopter, showing it rocking and swaying under the influence of gunfire, buffeting winds, and Cherry, The Orphanage used Reactor, an Autodesk dynamics plug-in for 3ds Max.

The Killdozer
The second major effects sequence of Planet Terror features the Killdozer, a brutish tow truck trailing heavy metal chains and rigging. With Cherry Darling running alongside, the Killdozer careens out of control, veering off the side of the road before spinning and tumbling four times. For this shot, Rodriguez wanted Troublemaker and The Orphanage to deliver a horriﬁ c crash while still maintaining believability in the weight and rigid-body dynamics of the vehicle’s action. “It was a challenging shot,” says Troublemaker’s Toader. “She’s running next to the truck for 400 frames, meaning we had to animate and compose the gun leg with no clean back plate and no motion tracking, all the while matching the camera motion blur.”
While Troublemaker handled Cherry Darling’s animation, artists at The Orphanage worked on the Killdozer’s animation. After building a high-res polygonal model of the truck in Maya using photographic references, the team ran it through a series of dynamics simulations using Reactor for 3ds Max. The simulations gave the artists a sense of weight and mass, and what was physically possible under the conditions of the crash. Using the dynamics simulation as reference, the animators then hand-animated the truck in Maya, using a highly flexible rig developed by Daniella Calafatello.

The rig, which included IK splines for the chains, enabled the tires and axles to break apart, and allowed all the various sections of the truck to move independently so the team could vibrate the bed of the truck separately from the chassis and hood, for example. That way, the truck wouldn’t appear completely rigid as the various sections crashed under themselves. The hand-animated Maya truck passed back and forth between Maya and 3ds Max at least a half dozen times so that various parts could be dynamically animated in Reactor, such as the metal chains and rigging that swing around with the momentum of the flipping truck.

Once the artists finished the final dynamics simulations in Reactor, the team lit and rendered the shot using SplutterFish’s Brazil. The rest of the shots were rendered in Maya through Mental Ray.

**Blistering Effects**

One example of the film’s perfect marriage of practical and digital effects is the blisters that spread like wildfire across the bodies of the infected townspeople. KNB applied the blister makeup to the actors’ faces, but when Rodriguez entered postproduction, he wanted the blisters to pulse and drip fluid across the face. “It was a case of the best of both worlds. We had the amazing reference of the KNB blisters already on the actors’ faces and were able to use that for lighting reference,” explains Tudehope. Using polygonal patches modeled in Maya, his crew created a series of Maya blendshapes representing the different phases of the blisters, such as blown up and deflated. By blending between them, it looked as if they were pulsing and, sometimes, bursting open.

Because the actors’ faces were constantly moving, The Orphanage’s matchmove supervisor, Tim Dahberg, built a tool for tracking the faces in 2D and applying the tracks to 3D space by locking the points on the z axis. “It was a great way of ‘matchimating’ the digital blisters to the actors’ faces and getting them to deform properly as the people talked,” adds Tudehope.

Rodriguez directed the digital artists to make the blisters feel like a ‘70s makeup effect, in which little airbags may have been placed underneath synthetic skin, then blown up and down really fast to give them a sense of life. “That’s what we went for in Planet Terror. We didn’t want the effects to feel so over the top that they had to be CG; we wanted them to be more subtle, so that they

Tracking and replacing the actress’s leg in film, which was shot at night, was difficult and required trial and error. From left: The artists worked out the scene in 3D, tracked the shot (this one using PFTrack), and tested the digital replacement in an animatic. At right is the final frame.
Visual Effects

may have been possible back in the ‘70s,” says Tudehope.

And if the film’s melting confetti of flesh and gaping blister wounds were not gruesome enough, the bodies are also bathed in digital blood. Toader shot some of the blood practically with an HD camera, then added some of the finer spurting and splattering using Wondertouch’s Particillusion, the same software he used to ensnout the night air in layers of mist, fog, and smoke.

For lighting and reflection-mapping the digital environ-
ments, both companies used HDR images of the Austin set captured from a chrome ball by Troublemaker. “We would place those HDR images in 3D space, so our CG objects reflect the same objects that everything else in the scene is reflect-
ing. Everything, from our helicopter to the blisters on the side of someone’s face, is reflecting photographs of the set,” says Tudehope. For texturing, The Orphanage used Adobe’s Photoshop and 3D procedural textures developed in Maya.

While most of the rendering at Troublemaker unfolded through XSI’s implementation of Mental Ray, the rendering pipeline, set up and maintained by Kris Bushover and Jeff Acord, also employed the Apple’s Shake renderer and a Burn farm for Flame.

Retro Effects

Grindhouse is the first feature film to explore the idea of using CGI to produce hyper-realistic “retro” effects; and in re-creating the past, both The Orphanage and Troublemaker Digital were forced to collaborate more closely than ever before, forging a partnership that can only empower Rodriguez’s imagination for future projects, such as Sin City 2. “I found it helpful to call the guys at Troublemaker or visit the set in Austin so we could exchange ideas and offer input on each other’s shots,” says Tudehope. “Working with Robert is so much fun because every film he creates is really a new and unique adventure.”

Brunet echoes Tudehope’s enthusiasm about working with Rodriguez. “The cool thing about working with Robert is we all get to be generalists; we get to wear so many different hats. We’re compositors, 3D artists, we even get to write a bit of code. Sometimes that hurts us, because of the sheer volume of work we’re expected to deliver in such a short amount of time. Even so, I think we did a pretty good job.”

In viewing the end result, “pretty good” might be a mild understatement.

Martin McEachern is an award-winning writer and a contribut-
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The crew at Disney Feature Animation created tools and techniques to develop Meet the Robinsons in little more than a year

By Barbara Robertson
The theme of Walt Disney Pictures’ second 3D animated film, Meet the Robinsons, is “keep moving forward.” You could as easily apply that theme to the production of the film.

In the movie, Lewis, an orphaned boy and brilliant inventor, wants to find his birth mother. He hopes that his latest invention, a memory scanner, will help. But, a scoundrel wearing an evil bowler hat, named Doris, steals the invention. When Lewis nearly gives up hope, Wilbur Robinson appears out of nowhere,whisks him into the future to look for the Bowler Hat Guy, and introduces Lewis to the wacky Robinson family. In the studio, the artists who created Chicken Little rolled from that film straight onto this one. “We pretty much used the entire Chicken Little team,” says Robinsons’ producer Dorothy McKim, a veteran Disney production manager. When she joined the project, director Stephen J. Anderson had already boarded the entire movie and it was up on reels.

Anderson, who had been the storyboard artist on Tarzan and head of story for The Emperor’s New Groove, had identified with this story from the moment he saw the script, derived from William Joyce’s children’s picture book A Day with Wilbur Robinson.

“It’s a story about an orphan boy who wants to be adopted,” Anderson says. “I was adopted. You couldn’t pry the script away from my hands. The theme of letting go of the past and looking to the future came from my experiences.”

New Tools
When Mark Hammel, technical supervisor for Meet the Robinsons, evaluated the future for the crew assigned to create the film, one thing stood out. “We were scheduled to release in December 2006, a year after Chicken Little,” he says. “We ended up releasing in March, but a year between releases—or even a year and three months—is a tight time frame.”

With no time to make big changes to the pipeline, which might have altered a familiar workflow, the technical team looked for other ways to improve efficiency. Disney Feature Animation uses Autodesk’s Maya enhanced with in-house tools, plug-ins, and add-ons, Pixar’s RenderMan for rendering, Side Effects Software’s Houdini for particle animation and physical simulation, Next Limit’s RealFlow for fluid simulations, and Apple’s Shake for compositing. New tools helped “lookdev” (look development) artists quickly create complex environments, while character riggers set up characters swiftly, and technical animators moved cloth efficiently.

For look development on Chicken Little (see “The Sky’s the Limit,” November 2005), the studio had developed two tools, XGen and Shader Expressions. For Meet the Robinsons, the technical staff developed a proprietary 3D paint system. And then, they unified all three tools. “We created a consistent system among all our lookdev tools,” says Hammel.

Deep into Storytelling
As with Chicken Little, Disney is releasing Meet the Robinsons in stereo 3D and mono versions simultaneously. Phil McNally, who helped convert Chicken Little into stereo while at Industrial Light & Magic, led a stereoscopic team at Disney for Robinsons. His earlier involvement in this project resulted in new ideas for enhancing stories with stereo.

“I thought stereo 3D was just a gimmick,” says Meet the Robinsons director Stephen J. Anderson. “But Phil quickly pointed out that we could use it to tell the story.”

Rather than arriving at the tail end of the process and converting a completed film into a stereo 3D version, McNally began working with Anderson to pick scenes and shots best suited for stereo. “I made what looks like a heart-rate printout for the movie, with red zones and green zones,” McNally says. The red zones—the big chase scenes and other exciting shots—were targets for stereo 3D. The green zones gave the audience a chance to relax.

McNally and a team of eight at Disney used three methods to set up the stereoscopic camera and control the appearance of objects in stereo: depth (how far back or forward the object appears), position (in front or behind the screen), and framing.

The two most common techniques are depth and position. “We control the depth in a way that doesn’t require anything to be remodeled,” says McNally. “The separation between the cameras, the intraocular distance, puts depth into the scene. Positioning the zero parallax point determines whether characters are in front or behind the screen.” (The zero parallax point is the point at which the two cameras line up perfectly.)

The unique technique implemented for this film is an optical floating stereoscopic window frame. Although it goes unnoticed, a black edge always frames the stereoscopic window—that is, the hole through which you look deeply into space, or from which something flies out at you. The frame, typically...
For Robinsons, look development artists used XGen to grow hair and grass, sprinkle pebbles and dirt on a rooftop, stain sidewalks, and more. "It's such a central tool for look development, we started using it anytime we needed an efficient way to make something lush and detailed," says Marcus Hobbs, CG supervisor. The crew even used it to sculpt topiaries and to plant trees.

"It's an arbitrary primitive instancer generator," says Hammel. "It's a tool that can procedurally generate anything."

Shader expressions, the second tool in the new unified look development system, allowed artists to create procedural expressions on their own without writing procedural shaders.

And with the third tool, the 3D paint system, artists could work in 3D or import and export views into an external painting program like Adobe's Photoshop. "We extended and added our shader expressions to the 3D paint program and combined that with a similar feature in XGen, which gave us the consistent system," Hammel explains.

As a result, artists working in the 3D paint system could use the expressions, for example, to generate a texture map with a pattern and then, using the same language, create expressions in XGen to drive the twisting and drooping parameters for hair or leaves. "If the artists know how to use the expressions in one application, they know how to use them in the others," Hammel says. "They are very adept at finding uses for tools we don't think of, so the more general we can make a tool, the better."

Inventing Characters

There are three primary characters in the film—Lewis, Wilbur, and the Bowler Hat Guy—but there are dozens of secondary characters such as the Robinson family, the dinosaur, and Carl the robot, as well as crowds of schoolchildren and other background characters. "We've had as many as 65 animators working on the film," says Mike Belzer, animation supervisor.

With many characters and little time, the crew developed techniques and tools to prepare the characters quickly for animation and rendering, starting with the models. "We had only two different sets of geometry for the head and hands for the entire cast of characters," says Corey Smith, CG supervisor. All the characters, except for two who needed more facial detail, the Bowler Hat Guy and Grandpa, have the same topology—the same underlying geometry with the same number of points and the same ordering.

"Obviously we moved the points into different positions for each character," says Smith, "but having the same topology saved us tons of time. We could transfer blendshapes from character to character and weights for the facial setup, and lookdev could transfer weight maps and UV maps for texturing."

Modelers built blendshapes for Lewis first and then, using a tool called Blend Shape Adaptation, moved subsets of those shapes to other characters' heads. "We had about 90 percent accuracy," notes Smith. "The modelers and animators worked together to make adjustments, but it saved us so much time."

For facial animation, Disney animators used a composite of blendshapes and deformers. "Deformers are good for tweaking, but the animators always want that shape they worked with the modeler to get," says Smith. "We try to hit the main shapes that the animators want, and then layer the deformation rig over that." Although Lewis had approximately 45 shapes, most characters had less than 30. The goal was never to have a dead spot on the face.

At top: A new Studio Rigger tool devised by the model development team helped the riggers quickly set up multiple characters with similar characteristics from one template. At bottom: The rig for Doris, the villain, handled the complexities of a character that is shaped like a hat but walked on six legs and discharged a variety of clever tools.
“The blends got us 60 percent of the way there,” says Belzer. “The deformers pushed the facial animation further. We tried to push it as much as we could to make the characters more believable and fleshy.”

To quickly rig characters, three members of the model development team, Jesus Canal, Ryan Roberts, and Russ Smith, devised the Studio Rigger tool. With this tool, character riggers created a template that became a starting point for rigging different characters with similar characteristics. “Where we really pushed the efficiencies was in the character setup,” says Smith. “But if the animators need to see the characters in detail, they can crank it up.”

The riggers started with the template, moved the bones into the right place for a character, and told the system to “build rig,” and it applied all the template information to the new characters, from the deformers in the hands to the way the head squashed and stretched. “We have low-res proxy modes for the model in animation,” says Hammel. “Where we really pushed the efficiencies was in the character rigging user interface. When the animators selected a wrinkle, the rig automatically increased the model’s resolution.”

Using a system called “Shelf Control,” also built into Maya, technical directors designed user interfaces for the entire rig so that the animators could see the character with buttons and controls. “Because the animators have the same interface, they can move from character to character quickly,” Smith points out.

Doris, the villainous hat, had one of the most complex rigs. “She flies and walks like a spider on six little legs that look like metal folding blades,” says Smith. “Sometimes her top opens up and a claw comes out, she unscrews things, sometimes a lens or a harpoon comes out of the hat. She’s the Swiss Army knife of hats.”

Wrinkle While You Work
To help wrinkle the characters’ clothes, the technical animation team built a new tool, named Shar-Pei, into the rig. “We didn’t want to run cloth simulation on every character,” says Smith.

For this process, the cloth-animation team printed the characters in different poses, animators drew wrinkles onto those poses, and then riggers and modelers worked together to paint texture maps that defined the wrinkles. “They painted little height maps that displaced a surface in different directions,” explains Hammel.

Animators could select which wrinkles they wanted to animate—for example, wrinkles at an elbow when a character bent its arm—and then dial in the animation with sliders, using the wrinkle page in that character’s rigging user interface. When the animators selected a wrinkle, the rig automatically increased the model’s resolution.

Thus, Shar-Pei made it possible for the animators to see the final wrinkled silhouette. “We were trying to be efficient,” says Hammel, “but we ended up giving the animators a tool they probably would have loved to have had anyway if they’d thought to ask.”

Hairy Problems
In addition to speeding cloth animation, the technical crew needed to find ways to work with new types of hairstyles, from Grandma’s curly hair to Wilbur’s slick hair. “We had to enhance our hair system primarily for furry characters, not for human characters. For grooming the Robinsons’ characters, the technical team provided tools for drawing profiles and sculpting rough shapes. “A sculpted hair model had jumped out of the screen and into the theater. During a shot in which a dinosaur starts chasing people, however, McNally’s crew purposely allowed the dino to break through the frame to make it seem as if the animal had jumped out of the screen and into the theater.

Once the Disney team completed setting up the camera for the stereoscopic work, they sent RIB files for the mono movie (the left eye) to Digital Domain, where a crew rendered and composited the final image for the right eye and applied the floating window.

With each film, the potential audience has grown. For Chicken Little, Real D had installed its projection system in only 84 theaters (see “Superized,” January 2007, pg. 24). The goal for Meet the Robinsons is 700 theaters. The potential for using stereo 3D to help tell stories is growing as well. Look for Meet the Robinsons to open some eyes.

“You can control stereo from shot to shot and sequence to sequence,” Anderson says. “You can dial it back on dialog scenes and pump it up for the climax. It’s really exciting to see your story that way.” —Barbara Robertson
shape came with the model, so the animators didn’t get bald models,” says Hammel. “We could use that shape to help define where guide hairs would live.” When hairstyles were too complicated to represent with simple surfaces, the groomers drew curves in space to outline shapes that turned into representations for XGen. XGen handled the instancing—that is, grew the hair.

“We have a broad range of technical skills within the lookdev staff,” says Hobbs. “Some people are mad geniuses with technical skills, and some are artists and painters focused mostly on how stuff looks. So, sometimes we control color and density with texture maps, and sometimes we like to use expressions to get a look or hair behavior we like. We hop back and forth.”

Fading the opacity at the hair tips and making every hair slightly transparent helped add a sense of depth, and the transparency enhanced the backlighting. “We rely on backlighting to punch the hair silhouette and help separate the characters from the background,” explains Hobbs. Painted density maps controlled the amount of subsurface scattering on the characters’ skin.

**Here Today, Here Tomorrow**

Lewis moves back and forth between the present and the future, so the environments for each needed to be distinct and instantly recognizable, but not so dissimilar that it looked like he occupied two different films. “In our present day, everything is dark, dreary, and rectangular,” says McKim. “But the future has open spaces, blue skies, and beautiful colors.”

Although painters created a few backgrounds, modelers built most of the environments in 3D—the present-day orphanage and its rooftop, the Robinsons’ house inside and out, the invention company, the school gym, the present-day city, the future city, the evil future city, and others. “I’d say we had a dozen major environments, but the most complex were the future city and its counterpart, the evil future city,” says Smith. “Those were massive.”

Modelers blocked out those virtual sets using simple shapes, working with layout artists to position the camera. Then, they added details in areas where the camera would spend the most time. “They flushed out the shapes to get closer to the designs the art directors wanted,” says Smith. “We don’t have a separate set-dressing department.”

In addition to environments, modelers also built a flying car, a time machine, and several props. “We spent a lot of time detailing and rigging those,” says Smith.

“Effecting” Change

Although the effects team created a sprinkler system and sent lava spurting out of a volcano in a science exhibit, most of the effects happen during the climax of the film. “One of the possible futures is evil, so instead of a paradise of blue skies, puffy clouds, and grass, we have tons of smoke and smog,” says Hobbs.

To art-direct the pollution belched by thousands of fiery smokestacks, the team used sprites. “We used RealFlow to create The rectangular present day (at left, below) uses warm, autumnal colors; the future world of new beginnings (at right, below) is spherical splashed with the colors of spring.
“Refl ections are huge,” says Hobbs. “But we got good about when to turn them. We use the right package to get the right transitions and at faking off-screen stuff.” It’s efficient not to build geometry behind the camera in a 3D set, but that meant reflective objects in the set had nothing to reflect. So, the lights put something there—perhaps a painting on a card or a bit of animation from another scene.

Also, to speed rendering yet use ambient occlusion throughout the film, the lighting and rendering team watched for areas where the camera moved, but the background didn’t. “We’d raytrace once, get the occlusions, and save them as texture maps,” explains Hobbs. “For the next frame, we’d look up the values in a texture map instead of re-raytracing.”

Forward Thrust
Three years into the project and a few months after production had ramped up, Disney had bought Pixar Animation Studios, and as a result, Disney Feature Animation had three new sets of eyes evaluating the film: Pixar’s John Lasseter, Ed Catmull, and Andrew Stanton.

Layers of particle effects created in Autodesk’s Maya and in Side Effects Software’s Houdini, and then combined in Apple’s Shake, helped effects artists create a dark, climactic sequence.

“We were about 85 percent finished with animation when Pixar saw the movie,” says Anderson. “After we got the notes from the group, we had a six-hour note session. It was murder. But at the end of the day, John, Ed, and Andrew said, ‘You heard the notes. Now go away and fig-ure out which ones will help you make the movie better.’ They put the control back in my hands, and all the clouds parted.”

One of the major changes was to make Doris, the Bowler Hat Guy’s hat, the real villain, but Pixar’s influence extended beyond that. “They helped us plus the story,” says Anderson. “We redid about 60 percent of the movie.”

The animators were hardest hit by the story tweaks. “We dropped from over 80 percent animated to about 30 percent,” says Belzer. “The characters and sets didn’t change, but a lot of things hit the editing floor.”

For the rest of the crew, the impact was minimal—even helpful. “It only affected a couple environments,” says Smith. “While Steve [Anderson] worked on story notes, we did optimization passes. We sat with the animators and technical directors and cleaned up any issues and problems with the rigs. That little window gave us a great opportunity to catch up.”

In addition, the technical wizards at Disney and Pixar began exchanging ideas. “We didn’t have an opportunity to integrate anything new in terms of tool sets for this film, but we could see how Pixar implemented hardware,” says Hammel. “We could see what they were doing with their disk system, and that helped us make our choices. I’ve always said that I’d love to spend six months or a year at another studio to see how their pipeline works, and now we’re getting that opportunity at Pixar.”

“I’m really energized about the future. We’re moving forward,” Hammel adds. “And I just realized I quoted my own movie.”

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For new industrial designers, the road to success usually contains many bumps and unexpected twists and turns. However, one young person found a way to avoid many of those unwanted obstacles and, in the process, put himself on the fast road to success. This led him to the ultimate reward of having his concept vehicle displayed at the prestigious North American International Auto Show in Detroit.

Uros Pavasovic, an automotive and yacht designer, used Autodesk’s AliasStudio software to create an extremely unique concept vehicle, Fiat Scratch, and then entered his submission in The Michelin Challenge Design competition at the 2007 Auto Show earlier this year. His entry, titled Fiat Scratch, reflects the latest trends in concept car creation—personality and lifestyle.

In fact, Pavasovic received more help from Autodesk than just the use of the company’s industrial design and visualization tools; Autodesk sponsored Pavasovic and his design. According to Paul Dyck, product marketing manager for AliasStudio, this is the first time the company has backed someone in the competition. “This project was attractive [to us] because it involved a number of areas that are important to Autodesk, primarily transportation design and design education,” Dyck explains. “Also, [our sponsorship] enables Pavasovic to showcase the work he has done with AliasStudio software at the high-profile North American International Car Show.”

As Dyck points out, Pavasovic, a recent graduate of the prestigious Royal College of Art, was proactive in obtain-
Pavasovic’s car concept showcases a minimalist design with one-of-a-kind scratch patterns and paint effects. The designer compares his car design to a “character-infused pair of old blue jeans” and intends for the scuffed car body to “capture the spirit of unfettered freedom and individuality.”

The design was inspired by the iconic Fiat 500, the small, cheerful urban city car from the 1960s—“one of the Italian icons on the order of the Vespa or pizza,” says Pavasovic. “My goal was to capture its character and interpret it in a contemporary way rather than creating a retro-nostalgic design. I also wanted it to be a positive and optimistic vehicle, so I looked at ways of providing a more relaxed driving atmosphere and carefree ownership of the car, and scratch-happy bumpers are a good answer.”

According to Pavasovic, the scratch-happy concept makes the design especially unique, as does its vintage, weathered, one-of-a-kind casual aesthetic, which shows no signs of fading. As a result, the idea is a perfect fit with current trends, he notes.

Pavasovic describes the scratch-happy concept as this: The body of the model is painted with several textured and colored layers. When scratched, the colors surface, creating colored patterns.

“With every nick and scuff, the car becomes more personalized to its owner, and a truly unique exterior is created,” Pavasovic says. “Every Fiat Scratch owner, therefore, drives a unique car that is custom-designed by that person, reflecting his or her cool and carefree attitude—an attitude that is widely admired.”

Pavasovic created the textured surface on the model by applying a very thick layer of primer and three layers of paint, which were subsequently sanded down. If this were a production car, body panels would have been made of injection-molded plastic with a textured surface invisible inside the material where the colored layers meet.

Digital Design
The transition from quarter-scale model to a full-size model, however, required a complete redesign within AliasStudio, as the proportions and volumes changed when the scale was altered. Moreover, the full-size model was designed completely digitally, since this was the only possible way in which the car could be conceived and built “long distance”—Pavasovic supervised the fabrication process from London while the car was being made in Slovenia and Germany.

Pavasovic more or less created the car in his free time, as he was primarily focused on his work with the yacht design studio Andrew Winch Designs in London. As a result, it took the designer about six months to create the full-size model, which was then exhibited at several events and shows.

The tool’s dynamic-shape modeling capability allowed him to quickly experiment with various shapes.
weeks to craft and build the 3D model of the car body, which was milled in Slovenia and then transported to Germany for the final modeling and paste-layer application; afterward, it was again milled in Slovenia to obtain the final shape. “During the modeling, I had the time to model the details [in 3D], such as the rear-view mirrors, air intakes, and door handles, all of which were built with laser-sintering technology,” he says.

Four weeks before completion, Pavasovic traveled to Slovenia to see the actual car “in the flesh” for the first time. By then the car already was milled and ready to be painted. And the designer actively participated in the last and most sensitive part of the process—the painting and scratching of the body.

Using a digital process, says Pavasovic, was the only way to design and build this car considering the remote manufacturing and the designer’s limited budget, as the tools enabled an optimized fabrication process. “The AliasStudio model was the main communication tool between me and the suppliers. Using the model and visualization tools, everyone involved in the process had a clear picture of the desired shape and end result,” he explains. “Although this was a high-risk project with potentially a lot of room for error in every step of the process, everything went very smoothly, and the car I exhibited in Detroit was pretty much exactly the same car I saw on my laptop screen a few months earlier.”

In the early design stages, advanced dynamic-shape modeling functionality gave Pavasovic a quick way to experiment with and modify shapes at all stages of the process. And, AliasStudio allowed him to keep the original concept intact through multiple iterations—a critical function when he moved from one-quarter scale model to full size. Later, key modeling tools accelerated the process of creating high-quality surfaces. Last, AliasStudio provided Pavasovic with a photorealistic interactive visualization, offering real-time feedback and design communication without the time and expense of having to construct a physical prototype or wait for software rendering to occur.

“I found the most useful features AliasStudio’s interactivity and visualization tools,” Pavasovic says. “Interactivity allowed me to fine-tune the basic volumes and character lines that retained the full construction history almost to the finished model level. Meanwhile, the visualization tools that simulated metal allowed me to see and understand the surfaces so there were no surprises when I saw the ‘real’ milled car.”

Pavasovic also used the basic modeling tools within the software, such as rail surfaces and square surfaces, which he then manually manipulated to achieve the desired effects. “Real-time visualization tools were extremely useful to see and feel the car’s volumes,” he notes.

So what was Pavasovic’s biggest technical challenge throughout the process? “Everything, because it was done in such an unusual way,” he says. Typically, show cars are built in one location by a large team in a car design studio that is backed up by a large car corporation. But in Pavasovic’s case, he used materials and processes that were never tried before. “I involved some suppliers that were unfamiliar with the materials and the techniques I proposed, and the car paint shop never tried my textured and colored paint layers idea before,” he says. “Also, I only had a fraction of a normal show car budget, I managed everything from 1500 miles away, and my time was severely limited and did not allow for much experimentation. However, with AliasStudio, careful planning and creative engineering improvisation as we went through fabrication made everything go smoothly, and the car was built to the highest professional level.”

Dream Car

“Pavasovic’s was a fresh and interesting outlook on the exterior aesthetics of a vehicle,” says Dyck. “It goes directly opposite to our typical attitude toward new vehicles, which is to try and preserve them as pristine as possible. We dread the arrival of the inevitable first ding or paint scratch, and mourn the loss of showroom perfection. His design is more consistent opposite to our typical attitude toward new vehicles, which is to try and preserve them as pristine as possible. We dread the arrival of the inevitable first ding or paint scratch, and mourn the loss of showroom perfection. His design is more consistent with fashionable choices used to cover our own exterior surfaces, such as faded, distressed jeans and distressed leather.”

At the car show, Pavasovic was one of four finalists whose full-size cars were exhibited in the space provided by Michelin, Volvo, Honda, and Polaris. “Being presented at the same level as the big corporations was a great success,” the designer says. Moreover, the work, says Pavasovic, has strengthened his design reputation among the companies he already works with and has opened the doors to other companies and projects in the area of product, car, nautical, and aeronautical design.

In the more distant future, Pavasovic hopes to present his design to Fiat’s management. Will he use the idea to design other scratch-happy objects? “I don’t know,” he says. “I think I exploited this idea enough right now, and it’s time to come up with a new one.”

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While first-person shooters still dominate the computer gaming landscape, interactive titles based on feature films are gaining in popularity. And game developers are not waiting for box-office figures before investing their own dollars into these properties. Rather, most of the film-based games are being developed in conjunction with the respective movies, often with the game artists working alongside the visual effects artists (see “Game Films,” February 2007, pg. 12). Usually, the goal is to release both titles simultaneously for cross-marketing.

The problem, however, is that game artists need at least 18 to 24 months to create their digital assets, while visual effects and CG artists typically work on much shorter cycles. As a result, vital film assets are still in the planning stages when the game artists need them. This was the situation that Stormfront Studios encountered when working on its Eragon game. Because many of the film assets had not yet been created, communication between the film and game groups became imperative in achieving consistency in the look and feel of both offerings.

Like the film, the game Eragon is based on the book by Christopher Paolini. This mythic adventure, set in the fantastical land of Alagaesia, tells the story of a farm boy named Eragon, who finds a mysterious egg that yields a baby dragon—a species long thought extinct save for the dragon of Alagaesia’s evil king, Galbatorix, one of the last of the great Dragon Riders. After two hooded figures—known as the Ra’zac—inveade Eragon’s village and kill his uncle in search of the egg, the boy vows to become a Dragon Rider, setting off with his newly
hatched dragon, which he names Saphira, in search of a hidden rebel encampment called Varden. On the journey, the boy is aided by an old storyteller named Brom and a stranger named Murtagh. Together, they’re beset by scores of enemies, from the barbaric Urgal warriors to the regimented soldiers of the evil Durza.

Lush and varied in its locales, Alagaesia was extremely challenging to re-create both on film and in the game. In addition, the director’s vision was to not only follow Eragon’s arc from a seemingly insignificant farm boy to a mighty hero, but to make the environments grow in scale and majesty to reflect the boy’s gradually enlarging worldview and his sense of importance within it. In following this path, the game begins in the small pastoral village of Carvahall, moves on to the larger town of Daret and the great city of Gil’ead, and culminates in the grand Beor Mountains, home of the Varden.

For Stormfront Studios, which developed The Lord of the Rings: The Two Towers game, Eragon fit hand in glove with the studio’s experience in the fantasy genre. However, the developer encountered a typical problem still handicapping film-based game development: “A lot of what is needed early on in a game’s development doesn’t exist until later in a film’s production,” says Ray Gresko, design director for Stormfront Studios. “This was especially true for Eragon, since there was no prior film to draw from for content, an advantage we had during development of The Two Towers game.

“To combat this problem and achieve the highest level of consistency, it’s crucial to maintain close communication among all parties involved. Even the smallest scraps of information or direction can prove useful at the early stages,” Gresko says. “For instance, we knew from the outset that the film would contain a large amount of CG effects (including a fully realized CG dragon), so the assets that helped the most included Saphira’s concept art and animation tests. But, we also made great use of costume designs, set designs, weapon and prop designs, discussions with the stunt coordinator, and a brain dump of the overall vision for the film from the director.”

Stormfront also drew heavily from the book to expand on the mythology presented in the film. “In many ways, the game helps to lead up to key film events by exploring back stories and side stories. For instance, in the Xbox 360 version, Stormfront added two new levels that introduce key novel locations and a new enemy not presented in the film, the Kull,” says Gresko.

While honoring the book and film were important, Gresko stresses the importance of never forgetting that a film and a game are two entirely different types of entertainment experiences. “We want players who haven’t seen the film to jump in and have fun and know what’s going on; and it has to be a good game in its own right without considering the film,” he says. “But we also don’t go overboard in re-creating extensively the story elements from the film. It’s usually enough to hit the narrative high points and move into some great gameplay.”

Mythic Game-Making

Gameplay is always king, Gresko emphasizes. In planning this approach to a film-to-game adaptation, Stormfront began with a diagram of the core themes of the film “license,” and then identified the gameplay elements that captured and expanded on those themes. For example, during the story, Eragon is accompanied by Brom, an ally who aids him in his quest. To support this theme, the team developed a rich, cooperative element that provides a full-featured AI ally in single-player mode, and also allows another player to jump in and take over the ally at any time.

“We have the appropriate companion around to help capture key story moments and also to add tons of depth to the experi-

At left: Saphira, shown here in polygonal form, was still in development by the film group when the game artists had to begin their work, requiring Stormfront to revise its model to reflect the final movie version of the character. Above: The facial animation system used 25 blendshapes to achieve a range of basic character emotions in addition to the lip sync.
ene," says Gresko. "It’s not only great fun, but the gameplay is directly tied into the license."

During the film’s production, Stormfront received character and location concept art, detailed set-design plans— including blueprints of the extensive Varden set—various drafts of the script, and some of the early animation tests for Saphira. The art director and concept team also visited the set locations in Budapest, Hungary, capturing images of the weapons, props, and actors in full costume.

The team visited the Carvahall set and a little of the Daret location, and got early glimpses of Gil’ead and the Varden encampment, which were both midway through production. Artists referenced the photos while creating the many digital matte paintings that captured the grand, sweeping vistas seen in the film. The photos served as style guides and construction reference for the general design of the digital sets, which artists had to modify for the sake of better gameplay. Most of the texture maps were also derived from the photos, though artists also digitally painted textures in Adobe’s Photoshop to replicate the feel of each location.

“In Hungary, we also were able to speak directly with the stunt coordinator and learn about the various fighting styles each character would use, which was extremely important information for the animators and subsequently fed directly into our combat system designs,” says Gresko.

### Archetypal Characters

Using photographic references, the artists built the principal actors in Autodesk’s Maya, with approximately 4000 to 5000 triangles. To make the facial animation and lip sync more expressive, they also sculpted high-resolution models of each actor’s head. Since the screen teems with hordes of enemies, the group created a variety of “mood modifier” cycles. These cycles convey the many nuances and emotional beats of a dramatic scene. Motion capture was reserved for hit reactions and traversals, which were recorded using Vicon’s 4MP system at Mova’s 4000-square-foot motion-capture stage in San Francisco. Autodesk’s MotionBuilder was used for animation transfer, and Autodesk’s Maya for final cleanup.

In addition to the standard walk and run cycles, animators created a variety of “mood modifier” cycles. These cycles convey the character’s emotional or physical reaction to the adverse conditions of a scene. For example, characters will shiver or cower in fear as they creep along through the current of rushing streams deep in the Beor Mountains, fearful of an Urgal ambush.

### Mythic Lands

Cutting through Alagaesia’s mountain ranges are many rivers and streams requiring realistic effects for crashing waves, foam, and sea spray. For water simulation, Stormfront continues to use a complex shader developed for the PS2. It combines procedural shader effects, animated textures, specular

The art director and concept artists visited the film set to get an accurate vision for the weapons and clothing, which they re-created for the game.
we created animated reflections using geometry to add the look of and wet surfaces through alpha blends between each shader.

across all the environments are the ubiquitous dynamic light and a veil of mist to cloak the land in a mystical atmosphere.

while the enemy models were limited to approximately 2000 triangles. The principal characters were built in Maya, using 4000 to 5000 triangles,

up T-shirts saying ‘I survived Durza’s Tower,’ ” says Gresko. In the Xbox 360 version of the game, normal maps adorn many surfaces, especially rock formations—although with greater subtlety than you’d see in other games, he points out.

“We’ve observed that some next-gen games have gone overboard with the use of normal maps and specular effects, making everything look plastic and fake just for the sake of showing off the technology. In our implementation, we hit a nice balance of increased detail, but not at the expense of the scene as a whole,” adds Gresko. “One of the best places to see the effect of dynamic lighting on a normal map is in one of the new Xbox 360-only levels: The Ruins of Orthíad. Using his magic, Eragon illuminates some gems set within a great hall of stone carvings, and the effect of the light spreading across the surface is fantastic.”

No fantasy game would be complete without a shroud of fog and a veil of mist to cloak the land in a mystical atmosphere. Stormfront used z-buffer fog for adding depth to a scene, and particle effects for creating localized fog patches, smoke, airborne soot, light beams, and so forth. Dancing perpetually across all the environments are the ubiquitous dynamic light sources, from the sun and the moon to the torches, burning arrows, and eerie light from Eragon and Saphira’s magic.

Maps, and particle effects for the foam and the spray.

“Our fast-moving stream water is particularly convincing after using this method, but it also works well for still water. We also used vertex painting to place scum and foam around still objects in the water,” notes Gresko. “In areas such as Daret’s waterfront docks, we created animated reflections using geometry to add the look of movement to the water.” Artists handled transitions between dry and wet surfaces through alpha blends between each shader.

The most difficult levels to create were those set in Gil’ead, due to their size and open-ended gameplay. “Durza’s looming tower is such a complex maze of interconnecting floors and vertigo-inspiring views that the environment team wanted to make up T-shirts saying ‘I survived Durza’s Tower,’” says Gresko. In the Xbox 360 version of the game, normal maps adorn many surfaces, especially rock formations—although with greater subtlety than you’d see in other games, he points out.

“Some of the best focus-test feedback we’ve received was centered on the ‘alive’ and helpful ally AI,” Gresko says. “Having a second human join in the fun is where Eragon really shines. A friend can just plug in a second controller to start playing (even in the middle of a level), and the AI will adapt seamlessly.”

Just like the film, the interactive version of Eragon proved a hit with audiences, immersing them further into the rich fantasy world—one of gaming’s most valued features.

Stormfront used vertex lighting, light maps and, in the Xbox 360 version, dynamic lights. According to Gresko, the dynamic lighting accentuated the detail in the normal maps, but also made it harder to maintain the carefully honed atmosphere established by the light maps and baked-in vertex lighting.

Magically Assured Destruction

With Eragon wielding his magic powers over his enemies and Saphira unleashing fire-breathing mayhem on hordes of Urgals, you’d be correct to expect that the world of Alagaesia is primed for massive destructibility. Orchestrating the medieval carnage is Stormfront’s internal physics engine, code-named The Storm Engine.

“During the game, you’ll direct Saphira to smash large structures to bits, whip enemies into the air with her tail during dragon-flight sequences, make your way across a bridge that’s literally falling apart as you traverse it, and pull down rocks to smash your enemies with Eragon’s magic,” notes Gresko. “We also capitalize on the simple fun of ‘cliffing’ enemies by throwing them off perilous ledges or propelling them with Eragon’s magic.”

The Storm Engine’s AI technology is tailored specifically to support the gameplay mechanics of Eragon. Besides providing autonomous behavior in the enemies and the AI-controlled allies (such as Brom or Saphira), designers can also create specific “brains” that characters can use to fit a situation. For example, in some sequences, Saphira will focus on aiding the player in battle by swooping down, snatching up Urgals, and dropping them to their deaths. In other scenarios, she will respond to Eragon summoning her to target a specific threat, usually smashing it to bits or burning it to ash.

“The game’s combat system offers tons of ways to approach a combat situation, presenting a challenge that couldn’t be addressed with a simplistic AI solution,” explains Gresko. “Our AI-controlled allies are able to perform moves as unique and dynamic as Eragon’s, and will select attacks that fit specific situations in an intelligent way.” For example, when an AI Brom grapples with an enemy, he’ll look for nearby cliffs to toss him over. If Eragon knocks down an enemy with magic, Murtagh will finish him with a coup de grace, providing some dynamic cooperative gameplay.

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Martin McEachern is an award-winning writer and a contributing editor for Computer Graphics World. He can be reached at martin@globility.com.

The principal characters were built in Maya, using 4000 to 5000 triangles, while the enemy models were limited to approximately 2000 triangles.
After studying digital art and animation for a number of years, many students on the cusp of graduation often wonder whether they are truly ready to begin their careers. Do they have the necessary skills, talent, and confidence? If the submissions by students at recent animation festivals are any indication, they are indeed ready to make their mark. At one such event, E-magiciens, the European gathering of young digital creators, the talent was abundant, as budding animators competed for prizes, participated in roundtable discussions and debates, attended conferences, and viewed multimedia and video projects by their peers.

Of particular interest was the two-minute chained animation event, whereby 13 teams of three students created a snippet of animation adhering to the theme The Englishmen’s Promenade. The artists then had a limited time to complete their segments on-site at
E-magiciens. The animations were composited together and shown to audiences during the last evening of the event.

Another popular event was the Webjam, a “live performance” whereby teams of three students used Flash to produce a graphic work (on site at the show) based on a given theme.

The highlight of the non-commercial exhibition, held in Valenciennes, France, and organized by the local Chamber of Commerce, were the film debuts. The juried selection of 200 short films—totaling more than 17 hours of animation—ran throughout the festival. The event culminated in the E-magiciens Awards honoring submissions (shorts and others, including those from the chained animation and Webjam). A selection of still images from the film festival is shown on these pages. For a complete list of the winners, see www.cgw.com. —Karen Moltenbrey

Clockwise from top left:
Ah By Simon Moreau, Bastien Dubois, and Joris Bacquet from Supinfocom.
Goodbye Canine By Simon Lallement, Gregory Fatien, and David Vandenbroecke from Supinfocom.
Frigo By Gasztowit Alexandra, Hocquet Tristan, and Michaud Claire from Supinfocom Arles.
SOFTWARE

ENGINEERING

Extended Design Review

Win Autodesk has expanded its Design Review DWF-based review and collaboration software for engineers, service technicians, and others in product design and project teams. Autodesk Design Review provides on-demand access to ThomasNet’s industrial product and service information, enabling users to search the ThomasNet database directly from within the software, as they are working on a design. Now with contextual search capabilities, Autodesk Design Review accesses metadata in the published design model and part characteristics in the design to connect the user with relevant information in ThomasNet’s catalog. The software enables professionals to share information securely throughout the supply chain, collaborate with team members on designs, access critical design specifics, and speed time to market. Autodesk Design Review is priced at $199 for a single-seat license, $895 for five seats, and $1740 for 10 seats.

Autodesk; www.autodesk.com

CHARACTER ANIMATION

Endorphin Enhanced

Win NaturalMotion has unveiled Version 2.7 of its Endorphin and Endorphin Learning Edition 3D character animation software. Version 2.7 includes a new library of standard simulation and prop characters, support for the Acclaim 2 file format, additional tutorials, and a revised user guide. Characters and objects in Endorphin are now able to interact with fluids realistically, taking into account buoyancy and drag forces, and including support for moving fluids and waves. A new Endorphin Control Panel plug-in for Autodesk Maya, a stickiness parameter for modeling the effect of sticky surfaces, and extended forces and torques round out the new version. Endorphin 2.7 is priced at $9495, and can be rented on a monthly basis for $1195. Existing NaturalMotion customers with a valid maintenance contract can upgrade at no charge.

NaturalMotion; www.naturalmotion.com

BROADCAST

Integrated Innovation

Vizrt has integrated its Viz/Curious World Maps software with its Viz/Artist graphics design tool, Viz/Trio real-time CG software, Viz/Content Pilot content management and control utility, and Viz/Weather real-time broadcast system. Vizrt’s Map Server serves as an Active X plug-in, bridging Curious World Maps with the other graphics applications. Curious World Maps also offers integration with Microsoft’s Virtual Earth platform, enabling broadcasters using Curious World Maps to take advantage of high-resolution satellite and aerial imagery from the popular Microsoft platform.

Vizrt; www.vizrt.com

VIDEO

Graffiti Gains

Win • Mac Boris FX has upgraded its Boris Graffiti 2D and 3D vector title animation plug-in to Version 5.0. Based on Boris Red 4.0, the latest Boris Graffiti boasts a new ergonomic user interface, enhanced compositing and effects creation utilities, and EPS import and extrusion. Additional features in Version 5.0 include more than 40 title treatment filters, new browser templates, and support for Intel-based Macs, 16-bit color, and additional nonlinear editing hosts, such as Avid models, Canopus Edius 4, and Sony Vegas 7. Boris Graffiti 5.0 is now available for $299. Existing Boris Graffiti users can upgrade to Version 5.0 at a cost of $199.

Boris FX; www.borisfx.com

3D MODELING

Extending 3ds Max

Win Autodesk has introduced 3ds Max 9 Extension: Productivity Booster, software that provides Autodesk subscription customers with more than 30 productivity enhancements in animation, rendering, and overall usability. Design visualization customers also benefit from improved interoperability with AutoCAD 2008, AutoCAD Architecture 2008, and Revit Building 2008. The new software solution also offers DWG import options, an optimized import memory management system, and compatibility with Microsoft Windows Vista with DirectX 10 support. The extension’s Select Similar tool uses metadata
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to isolate content having similar characteristics, simplifying the identification and manipulation of objects in a scene.

Autodesk; www.autodesk.com

Archipelis Addition
Win Archipelis Company has upgraded its Archipelis Designer to Version 1.1. Geared for 3D professionals and beginners alike, Archipelis Designer enables users to quickly create 3D models by sketching shapes and then enhancing them with textures and photographs. The latest version of the product offers compatibility with Google SketchUp, as well as the ability to generate C code automatically for rendering models based on OpenGL. For further cross-application modeling, Archipelis Designer Version 1.1 enables export to a wider array of formats, including VRML, OFF, DXF, DirectX, STL, X3D, and .asc for Autodesk’s 3ds Max. Archipelis Designer 1.1 is now available at a cost of roughly $64.

Archipelis Company; www.archipelis.com

Sculpt in Mudbox
Win Skymatter has announced a free trial of Mudbox 1.0.4, advanced 3D sculpting software for professional digital sculptors. Mudbox is a brush-based 3D sculpting offering 3D layering, a 3D camera for perspective and orthographic views, texture baking, and a library of 3D brushes Mudbox integrates with such industry applications as Autodesk Maya and Softimage XSI. The freer trial version, offering all the capabilities of the professional edition, can be downloaded at www.mudbox3d.com/downloadTrial.html.

Skymatter; www.skymatter.com

3D NAVIGATION

Acrobatic Content
Win • Mac 3Dconnexion’s 3D navigation devices now offer support for Adobe Acrobat 3D software through Version 3.1 of the company’s 3DxSoftware. Users of 3Dconnexion SpacePilot, SpaceExplorer, SpaceTraveler, and SpaceNavigator can pan, zoom, and rotate 3D content in PDF documents via Acrobat 3D Versions 7 and 8, as well as Adobe Reader Version 8. 3DxSoftware Version 3.1 is now available via download free of charge to owners of the SpacePilot, SpaceExplorer, SpaceTraveler, and SpaceNavigator. 3Dconnexion anticipates releasing its 3DxMacWare Macintosh-compatible driver software, compatible with Adobe Reader 8, by June.

3Dconnexion; www.3dconnexion.com

ASSET MANAGEMENT

Managed Media Distribution
Win A developer of digital media distribution and management solutions for the media and entertainment industry, Signiant has upgraded its Digital Media Distribution Management Suite. The software suite is designed to aid creators and producers of rich media content in better managing file-based workflows and their distribution of digital content. The Signiant Digital Media Distribution Management Suite helps users exchange, repurpose, and move digital files, as well as secure and automate digital media workflows. The enhanced solution combines the Central Media Manager, having a Web-based user interface, with Media Agents that handle the distribution and collection of data. Optional modules for use with the suite include the Media Accelerator, Media Exchange, and High-availability Central Media Manager.

Signiant; www.signiant.com

PLUG-IN

Art in a Snap
Win • Mac Snap Art, an image-editing plug-in from Alien Skin Software, provides a variety of effects to artists, photographers, and designers. The new product aids in the production of pen and pencil line drawings with shading and cross-hatching, comic-book art with shading and half-toning, Neo-impressionist pieces, and dry-brushed watercolor or textured impasto creations. Able to emulate traditional artistic effects such as colored pencils, charcoal, and oil pastels, Snap Art includes hundreds of presets, an intelligent stroke engine, and various brushes, pencils, pastels, pens, and canvas and paper types. The Snap Art plug-in is compatible with Adobe Photoshop CS or later, Adobe Photoshop Elements 4 or higher, and Corel Paint Shop Pro Photo XI or later. Snap Art is priced at $149; registered users of other Alien Skin products can purchase the new product for $99.

Alien Skin Software; www.alienskin.com

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