

A Magic Tou

Studios share the work to make the latest Harry Potter film a more sophisticated effort than ever

By Barbara Robertson

For nearly a decade, visual effects studios have been creating the magic required to bring *Harry Potter* to the silver screen. It all began in 2001, with *The Philosopher's Stone*, and this summer will culminate with *Deathly Hallows: Part II*. During that span, the movie series' visual effects have set the creative and technical bar in a number of areas, including water, fire, and creature development.

Most recently, VFX facilities both large and small, some from the UK and some not, completed a range of effects for *Harry Potter and the Deathly Hallows: Part I*, which marks the beginning of the end of this beloved boy and his friends, who grew up before our very eyes. In that film, we witness the bizarre transformations of Harry's friends into Harry in an attempt to fool Voldemort and his Dementors. We also sit at the edge of our chairs as the Harrys allude the evil ones in a perilous aerial escape in which Harry's beloved pet owl is killed (see "On the Road Again" in the January/February 2011 issue of *CGW*). Yet that is only the beginning: These complicated effects occur within the first several minutes of the film. They are also a promise of more excitement to come in the rest of the movie, a promise that is upheld thanks to the work of these VFX facilities.

DNeg: Witchcraft at the Wedding

After Harry and his friends escape from Voldemort and the Death Eaters, they land near the Weasleys' house. The house, rebuilt after burning down in the previous film during a Death Eater raid, was a partial interior for the front and side of the bottom-story on set; DNeg added the rest. "We built a single, high-resolution, higgledy-piggledy crazy house in sections," says David Vickery, visual effects supervisor. The modelers worked from art department sketches and drawings, and from a survey of the



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Double Negative added to a partial interior and bottom story of the Weasleys' on-set house, and created much of the environment surrounding it.

set. Still photos taken with Canon DS cameras provided textures and reference for the lighting under a range of conditions.

"We needed an accurate representation of the exact scale and proportions of the set so when we extended it, we could line up accurately to the materials," Vickery explains. "And, we needed to simulate or calculate the way the materials respond to the light."

Also on location was a section of grass 10 meters in diameter, surrounded by rows of reeds. The crew at DNeg extended the reed bed and cut deep channels winding into the distance through the reeds to create a sense of depth.

"We decided we couldn't render millions and millions of reeds in every direction for every shot, so we created a set of 2D elements," Vickery says. "We rendered little bunches of 3D reeds with simulated movement under different conditions—moving fast, gently bending in the breeze." For reeds in the distant background, the artists used Paint Effects rendered through Autodesk's Maya. For the hero foreground plants, they converted the Paint Effects reeds into geometry they could export into Side Effects' Houdini, ran a simulation, and exported the RIB archive to Pixar's RenderMan.

"Houdini had a flexible simulation setup for us and was fast for simulating a large number of what were essentially hairs," Vickery says.

Near the house, Mr. Weasley and his sons manage to erect a huge marquee tent for the wedding between Bill Weasley and Fleur. But during the wedding, a Patronus races toward the house. "It's a melon-sized ball of light that lands inside the marquee, unfurls, and transmits images," describes Vickery. "We produced hundreds and hundreds of elements to create

it. It became quite an amazing collaboration between 2D and 3D."

The DNeg artists generated a dry ice structure in Maya, created ethereal ribbons stretching from the ball of light using cloth simulation in Houdini, and, with the studio's in-house fluid renderer and solver, created an optical, light-based effect. The light pulsed in time to an audio track describing the fall of the Ministry of Magic.

Then, director David Yates decided that when the Patronus pulsed, it would send ghost-like forms and structures. So, the crew filmed stuntmen and stuntwomen running on treadmills as if they were escaping from the Ministry of Magic. "They used extreme rim lighting," Vickery says. "The people were screaming. Hair was flying. And, they distorted the images."

DNeg artists blended those elements into

the shot. "It became a beautiful effect," Vickery says.

After the warning, the Death Eaters burst into the tent and set fire to the cloth interior. DNeg created the evil creatures and integrated them into plates shot on set of the fiery tent. "In the first shot, we see a sphere of black smoke," Vickery points out. "In the second, we begin to sense a screaming head leading the smoke, but it's still primarily smoke. In the third, we started with a plate that had one Death Eater as a live-action element standing up in the middle of the chaos and firing a spell." DNeg animators placed a digital Death Eater over the live-action actor and created a slow reveal of a tortured human character inside the smoke.

The studio also helped the Death Eaters destroy the Lovegood house. "Mr. Lovegood comes out of the house, holds his hand up, and tells the spiraling Death Eaters to 'Stop, stop, stop,'" Vickery says. "On set, special effects rigged the house with pop caps to set off mini explosions. But later, to add more violence and peril, we removed the practical explosions and added fewer, more forceful explosions that tore the house apart."

To destroy the computer-generated version of the house, the visual effects crew used Dynamite, the same in-house tool the studio had used to explode Yellowstone Park in 2012 (see "Sphere of Destruction," November 2009). They started with one lit and rendered beauty model and a second model that represented the destroyed building. "We would pick a frame and draw on [the second model] to show how we wanted the destroyed version to look," Vickery says. "And then we built it with chips and ragged

Dumbledore's Ghost

To prevent people from going through a particular corridor, Dumbledore had created a special spell. "Dust gathers from the floor, rises up into a tornado form, and you see the character inside," says Holger Voss, CG supervisor at Cinesite.

To create the shot, the crew started with plates of Michael Gambon shot on greenscreen. The Cinesite artists match-moved Gambon's image through several frames, created a match-move character, projected his performance onto the character, and used it to emit particles in Maya. "All the particles have his color and seamlessly blend into patches that evolve over his body," Voss says. "We see through some areas. Others are more opaque and are streaming particles."

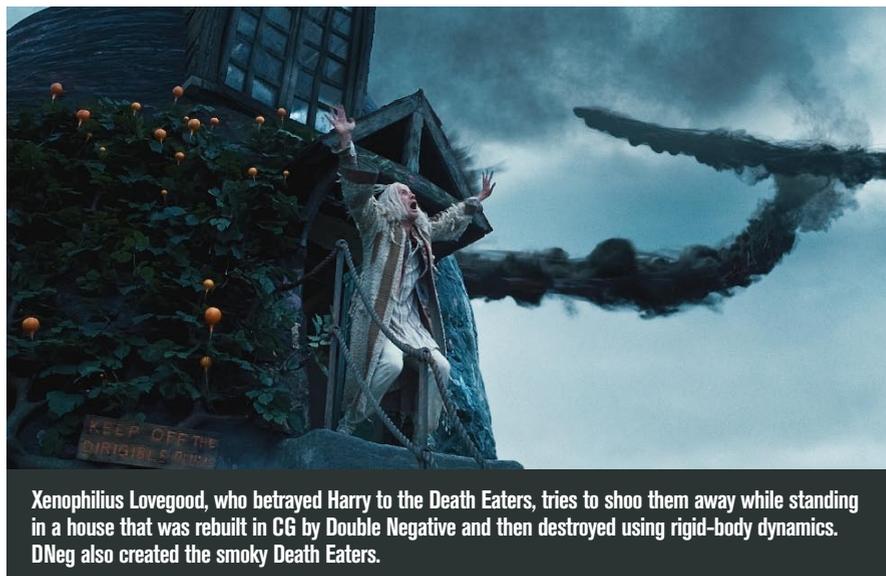
The team used a proprietary caching format and rendered the particles with RenderMan. Then, compositing artists projected textures within blocked mattes that moved across him in a fractal pattern. "It was a long process," Voss says. "But, it went smoothly. It wasn't groundbreaking, but we were doing volumetrics in RenderMan for the first time with hundreds of millions of particles. It was really about getting the job done well!" —Barbara Robertson

edges of stone left as it would look after it was destroyed.”

Next, they built components needed to temporarily fill the hole that would be created after the explosions. The components would fly out and become debris. They coated each brick, stone, and staircase with digital plaster that glued the pieces together until released. Technical directors specified the strength of the force connecting each piece to the next.

“We even decided what direction the wind would be so the dust wouldn’t just hang in the air,” Vickery says. “In a way, effects crews are observers. We aren’t trying to make things up. It makes no sense to try and guess what would happen if you hit a house with a wrecking ball. The best thing is to construct the house brick by brick and hit it with a wrecking ball.”

The studio also created small sequences—pink kittens on the plates in Umbridge’s Ministry of Magic office, digital set extensions to Dragon Alley, and even an animated Warner Bros. logo for the opening of the film with various levels of displacement maps and blendshapes applied over time to a high-resolution version of the logo modeled in Maya. “In the course of 10 seconds, we see the logo go through 100 years of cor-



Xenophilius Lovegood, who betrayed Harry to the Death Eaters, tries to shoo them away while standing in a house that was rebuilt in CG by Double Negative and then destroyed using rigid-body dynamics. DNeg also created the smoky Death Eaters.

rosion,” Vickery says. “It shows the effect of the Horcruxes, the evil of Voldemort. It sets a great tone for the film.”

Framestore: Dobby & Kreacher

Similarly, Framestore conjured up small bits of magic—for instance, wand effects, a jinx that makes Potter’s face swell, and sequences in which the majority of the studio’s 100

shots were of Dobby and Kreacher.

To develop the sequences, Yates had actors on set play the parts of the house elves. “David [Yates] is a real actor’s director,” says visual effects supervisor Tim Burke. “We didn’t storyboard or previs the sequences. He developed the scenes with the actors. Simon [McBurney] and Toby [Jones] stole the show.” The animators at Framestore then used the performances of Simon McBurney (Kreacher) and Toby Jones (Dobby) as reference for the digital elves. To provide Framestore with proper eye lines and lighting reference, two small people wearing the house elves’ costumes also played the roles on set. For Dobby’s death scene, though, Radcliffe held a weighted maquette. Although Jones never appeared in plates, McBurney, the doubles, and the maquette did, causing Framestore to painstakingly remove them and paint clean plates.

To create digital Dobby, Framestore started with the maquette provided for the second Potter film and the cyber-scan done eight years ago. “We also had the [new] maquette made for the death scene, and that was our key reference point,” says Christian Manz, Framestore visual effects supervisor. For this film, Yates and Burke wanted to humanize Dobby a bit more than in his earlier appearances and to have him look more like Kreacher, who had a somewhat humanly proportioned face.

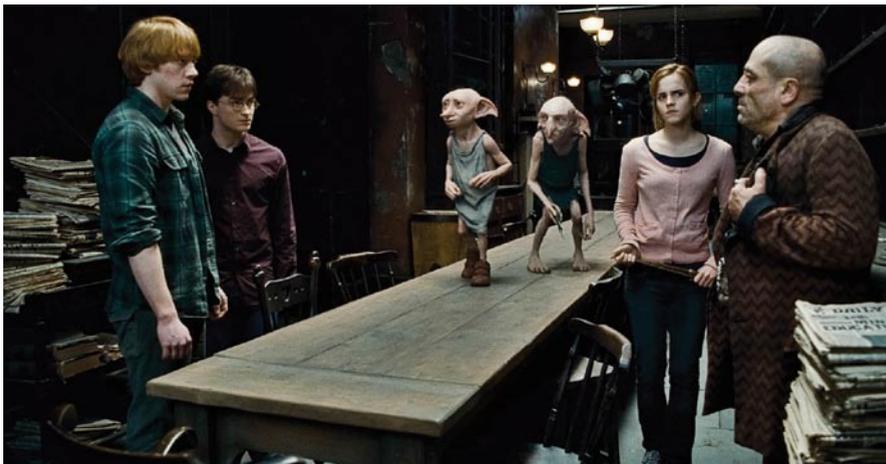
“In our first iterations, Dobby was so detailed he looked like a walnut,” Manz says, “much more detail than you’d perceive in a human face. And, he had huge eyes. So we slowly worked the detail back and back and back, and reduced the size of his eyes. He needed to look more adolescent than Kreacher, but he looked older because his face was so lined. In film two, Dobby was almost brown and leathery looking (see “Pivotal Role,”

Voldemort’s Nose

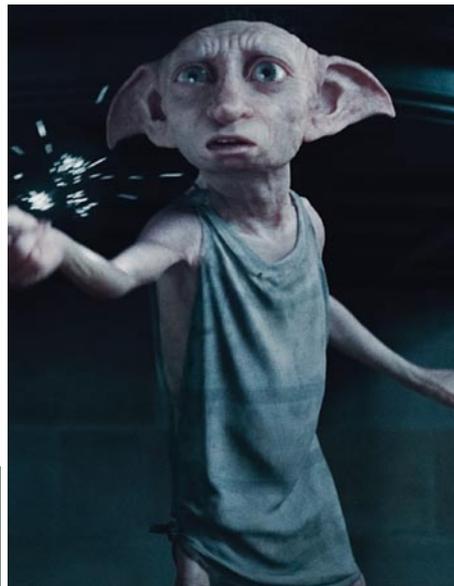
For previous films, The Moving Picture Company replaced Ralph Fiennes’ nose with a snakey one, but the digital plastic surgery moved to Cinesite for this film, where Holger Voss was a CG supervisor on the shot.

“We used a common approach,” Voss says. “We cyber-scanned Ralph Fiennes, and shot polarized and unpolarized images of his face to extract specular gain maps and displacement and bump maps from the skin. We rebuilt the full head that the match-move department used to replicate the movement in the plate. Then, we created a second head with the snake nose. So, the compositors had a fully rendered head with the snake nose to work with and could replace everything occluded by the real nose. Cinesite has done a lot of talking-animal shows, so we had a good pipeline for augmenting a face with CG. It was the first time we had worked fully with Nuke rather than Shake, though, so that was a big improvement. Because we tracked the entire head, it was easy for compositors to use the full 3D space in Nuke.” —Barbara Robertson





Above, Framestore artists humanized both house elves, Dobby in front and Kreacher behind, by adjusting limbs and forearms, and reducing the size of their ears. At right, in addition, the artists smoothed Dobby's skin to make him look younger than Kreacher.



February 2003). Now, he has the look of human skin, and we connect more with him as a little human when he dies.” Although Framestore had previously built Kreacher, for this film, they rebuilt him to humanize him a bit more, too, by adjusting his limbs and forearms, and shrinking his ears.

Rather than lighting the elves with diffuse lights, CG supervisor Andy Kind used a new method that incorporated color bleeding and point clouds to achieve subsurface scattering. “Toward the end, we rendered one shot with diffuse lights, and we could really see the dif-

ference,” Manz says. “Suddenly, all the subtlety of the human skin was gone. With the new method, we had different levels of scattering—deep, shallow. The renders that came out of the box and arrived at compositing looked stunning.”

Animators keyframed the elves using a rig that took three man-years to implement for both creatures. Animation supervisor Pablo Grillo referenced video of the actors’ eyes and had reference of the facial movement from Mova captures. “You could see that the human face is never really still,” Manz says. “For

past shows, we’d do a rig, animate, and rely on creature effects to make the skin jiggle. For this one, we did that with hundreds of blend-shapes, rigs, and animation. Modelers worked alongside riggers alongside animators to make adjustments as we went, even quite near the end. The pure animation renders had muscle deformation and moving tendons. They were really a work of art. Extra jiggle and skin slide was just icing on the cake at the end.”

A team of six people in creature effects worked on the skin, hair, and cloth simulation, using proprietary Framestore tools. “We had a

Ministry of Magic; Demented Courtroom

On set, the Ministry of Magic is approximately 15 feet tall. In the film, it’s hundreds of feet tall with many interlinked chambers. Rising Sun created the virtual architecture by starting with a model created at The Moving Picture Company for previous films. “We probably built another 30 or 40 percent to add areas we looked at in this film that weren’t in the previous films,” says Sean Mathiesen, visual effects supervisor.

The architecture is complex, but lighting was the most difficult challenge. “It’s very shiny,” Mathiesen says. “Inside, the tiles are glossy with a high sheen. So we had to remove the reflections of the lights in the set and then build reflections into those tiles of things that didn’t exist. We divided the work into what we needed to do in 3D, and enhanced the building with matte paintings where we could.”

Similarly, the crew had to work with reflections in shiny tiles for a courtroom that they built with shiny metal tiles to match the on-set environment using art department plans, photographs of the set, and HDRIs. And then, they filled the courtroom with 30 Dementors.

“We received a model from ILM and used it with our cloth pipeline to give it an underwater flowing cloth effect,” Mathiesen explains. “We did our own texture work in cahoots with Tim Burke to make them seem old and decrepit.”
—Barbara Robertson



lot of to-ing and fro-ing over Dobby's costume design and ended up going more toward what he wore in his first appearance," Manz says. "Plus, he's a free elf now and has fetching red trainers (tennis shoes)." As for the cloth simulation, Manz moved toward subtlety.

"I think CG cloth is often over-animated," Manz says. "Except in a couple of shots, [the elves] aren't doing much action. The cloth is mostly hanging, swinging, blowing in the wind." But, when Dobby dies at the end, the simulation team needed to make the digital costume react as if it were wet with blood.

"Potter cradles Dobby's neck, so we tried to retain a little bit of that direct interaction with the maquette because we got that squashing for free," Manz says. "We had to re-grade the maquette skin, though, to match what we had done."

Rising Sun: Kill the Horcrux

Harry and Hermione (Emma Watson) are hiding in a forest when a beautiful, silver-white doe appears, a Patronus that leads them to a pond (see "The Patronus Effect"). Harry is wearing a Horcrux in a locket that he captured earlier. To kill it, he needs the Gryffindor sword, and he sees that sword in the pond. But, when he reaches for it, the locket tries to choke him. Fortunately, Ron shows up, saves Harry, and strikes the locket with the sword.

"It erupts into 15 feet of evil created from the environment," Burke says. "And then this thing gives birth to Harry and Hermione. They're like doppelgangers, taunting Ron, semi-naked, kissing, trying to torment him. It was an intense sequence."

Rising Sun created the sequence; Sean Mathiesen supervised. "In the script, it was two sentences: 'Ron destroys the locket. It defends itself,'" Mathiesen says. "But, we spent almost a year developing the effect. We wanted to incorporate all the visual languages that represented him in the past. We built it layer upon layer, evolving it much like the evolution of a creature. It was all Houdini-based, or almost all."

They started with simple gray spheres animated to give the creature-cum-vortex a sense of motion and added interesting textures—algae, pond scum, dripping mud. Then, they inserted facial data from Mova capture sessions with Fiennes and Hero Fiennes-Tiffin who had played young Tom Riddle in a previous film.

"It was too explicit," Mathiesen says. "The heads were too obvious inside the pond scum. So we looked at ways to make the faces into more of a creature that couldn't hold itself together. Eventually we came up with deformers and texture tools and geometry replacement things to create shifting, distorted faces that show up as accents inside the swirling mass. It's Voldemort, but never solidly Voldemort." Also swirling inside the vortex is inky black smoke and, before long, Harry and Hermione.

For these elements, Yates filmed Radcliffe and Watson on greenscreen, then sent the elements to Rising Sun. "We did many iterations and ended up with a black-and-white, infrared film treatment that, combined with the make-up they had on set, made them look spectral, weird, and fitting for this effect," Mathiesen

says. "In Nuke, we composited them inside the monster and then in front of it. We used 2D trickery and created 3D passes around them to integrate them with the monster."

All these studios and others are already working on postproduction for the final film in the *Harry Potter* series, scheduled for release July 15, 2011. "It's big and explosive," promises Burke. "A great contrast to the first film. The challenges are definitely bigger. Things have definitely gotten more sophisticated in the 10 years or so since the first film." ■

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Slo-mo Apparate

When a wizard apparates, he or she teleports from one location to another. To show Dobby's apparations, director David Yates asked Framestore to create something nebulous and gaseous, according to visual effects supervisor Christian Manz, so the crew started with concept art developed in Photoshop. "It's one of those things that no one knows what they want until they see it," Manz says. "We describe it like chewing gum unwinding and solidifying in eight frames."

Yates shot the apparating actors with a Vision Research Phantom high-speed camera at 625 frames per second. Framestore artists then tracked the actors in the plate and animated them into elongated chewing-gum shapes using lattices in Maya.

"We wanted to lock down the overall movement before starting on effects," Manz says. "We knew we didn't have to work into any pipeline. We could just yank them around. Then, it was a combination of rendering out of Maya to RenderMan, Maya deformations, nCloth simulation, and particle-based effects in Houdini generated from the shapes that had been animated. We sent about 40 different bits of renders, little bits of simulation we liked, to Nuke." —*Barbara Robertson*

The Patronus Effect

A Patronus in the shape of a female deer leads Harry and Hermione through a forest to the sword of Gryffindor sunk in a pond. "We've seen her before, but the brief for this film was to make her more photoreal, even though she's a creature made of light," says Holger Voss, CG supervisor at Cinesite. "So first, we built a creature with fur and animated it. Then we decided what kind of effect to put inside."

The effect is of a creature that's transparent, translucent, and never quite solid. "We basically filled the volume with a fluid effect that evolves and moves, a cloudy evolving fractal. Things reveal, become apparent, and then fade away. There's no internal structure; we rendered it with volumetric noise inside. In the parts that are shiny, you get a hint of the fur, but it's more like a fringe. You see a rough detailed edge that's translucent."

Rising Sun created Harry's Patronus, a stag, and Dolores Umbridge's cat. "In the past, the creatures moved fast and left long trails," says Sean Mathiesen, VFX supervisor at Rising Sun. "We needed light radiating from within. We used a standard Maya pipeline for creating the model and animation rig, moved the geometry cache into Houdini to create waves of plasma energy with particle passes, and then moved into Nuke to put everything together." —*Barbara Robertson*