ANTZ-PIRATION

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PDI shows its adventurous side by adding live-action techniques and cel animation to create the second fully animated 3D film

Barbara Robertson

Any studio given the opportunity to create the world`s second feature-length film animated entirely with 3D computer graphics would have two choices: imitate or innovate. They could play it safe and imitate Toy Story, the wildly successful first CG-animated film from Pixar Animation Studios and Walt Disney Feature Animation, or they could break new ground.

Fortunately for the future of this fledgling art form, this opportunity was presented to Pacific Data Images (PDI), a studio based in Palo Alto, California, that has enough experience in CG animation to confidently offer a somewhat different look for Antz, PDI`s first--and the world`s second--fully animated feature. That look has evolved from the combined experience of the programmers and animators at PDI, who have created visual effects for live-action films during the past 10 years and animations and effects for television commercials and prime-time specials during the past two decades. PDI has woven together elements from these areas and from the studio`s in-house production of short animated films to create the tapestry for Antz.

Antz, produced by DreamWorks SKG (Glendale, CA) and scheduled for release Oct. 2, tells the story of one ant`s attempt to find individuality despite living within a colony consisting of thousands of ants. This disaffected worker ant, Z-4195, has Woody Allen`s voice, so it`s no surprise that the movie begins with Z stretched out on a couch discussing his predicament with his psychiatrist. Other ant characters include a somewhat spoiled and adventurous Princess Bala, voiced by Sharon Stone. Gene Hackman provides the voice for the villain, General Mandible, while Sylvester Stallone plays Z`s buddy, Weaver.

The film follows Z as he stumbles through a series of amazing adventures that begin when he bumps into Princess Bala at a bar. In an errant attempt to get close to Bala again, the unfortunate Z finds himself in an army marching to battle against the Termites. Miraculously, he escapes with his life only to once again land in an unexpected place. This second major adventure occurs outside the ant colony in the mysterious Above World, a place inhabited by humans. But Z has heard talk in the bar about a wonderful place called Insectopia, a land of plenty where an ant can be his own ant. So with a surprised and unhappy Princess Bala in tow, he decides to search above ground for this fantasy world. Through Z`s and Bala`s travels and travails, moviegoers are treated to a fascinating and amusing look at the human world from an ant`s point of view.

"In one sequence, Bala is caught in gum on the bottom of a sneaker. The sneaker looks like an aircraft carrier," says Patty Wooton, a vice president at PDI and one of three producers on the show. In another scene, we watch as Z and Bala cross what appears to be a vast desert--until it`s revealed to be only a simple bike path. Other adventures and mishaps propel the movie forward as Z struggles with his search for his individuality, his

love for Bala, and his quest for Insectopia, but the most dramatic are undoubtedly the flood scenes during which Z is given the opportunity to become a hero. In these scenes, PDI highlights one of its major innovations for the film--a water simulator.

Making a Splash

"We made a conscious decision to make this film like a live-action film," says Wooton. Thus natural phenomena such as water were incorporated into the film, as were live-action camera effects such as lens flare and rack focus. Furthermore, PDI artists borrowed an idea from live-action films and cel animations and created matte paintings for some backgrounds in Antz rather than building entire locations with 3D models.

The water-simulation system was largely developed by Nick Foster as a doctoral thesis while studying at the University of Pennsylvania. "What`s great about Nick`s system is that he focused on the needs for animation, not on making it 100% physically accurate," says Ken Bielenberg, effects supervisor.

Explains Foster: "The basis of my thesis was that in computer animation, we had height fields that could behave like water but could never splash, or we had particle systems that could have full-3D motion but didn`t look like water. Our concentration was to try to get the total freedom of real water and to calculate it fast enough to put it together for a three-minute sequence in a film."

Bielenberg adds: "Nick came up with clever ways of simplifying the fluid-dynamics equations so they would be usable in production; otherwise it would take weeks to simulate the water. We use it to create just about every type of water you can have--for ocean-type shots, lake shots, flowing streams, splashes, big water drops, little water drops, mist, foam...." The water flows out of the simulator through "hoses." If a shot calls for a wall of water, a bunch of hoses are used; for a faucet, one hose might be used. To control the flowing water`s placement, direction, and shape, the effects team--taking advantage of the fact that the water is physically based--created a set of real-world tools. They gave the animators a library of preset objects, such as a rough wall, a smooth chamber floor, and rocks, although the animators are free to develop their own objects and surfaces. Either way, no one has to worry about setting numbers to control things like friction, explains Foster.

An animator would start by using these objects and other 3D models to build a set--a 3D model of the environment--to house, control, and direct the simulation. To create a river, for example, the animator would model a channel in the shape of the river to contain the water, then place hoses at the headwaters for the river. To create white water, an animator would simply place rocks in the riverbed. For bigger splashes, the animator might place hoses behind the rocks, then set the hoses to begin emitting water when the river water reaches them.

To show on-screen where the water from the mathematical system flows, particles are used as place markers. Foster quickly cautions, though, "It`s not a particle system. We`re actually calculating 3D water motion. The underlying model is visually very accurate."

The final task for the water simulation was creating a system to render the fluids. That fell to Apurva Shah, effects supervisor. "My biggest job was in getting away from the particulate nature that CG water typically has because we really wanted to give a sense of mass," he says. "We think of the water being made of little particles and also think of it as a piece of geometry. We shade the particles using normals to give each particle a unique color based on the form, so you get a sense of the water mass, and we also use the individual particles to get streaking, so it looks like the water is flowing. We play between those two things. Then for a higher level of detail, we use Alias|Wavefront`s Dynamation software to add another layer of detail." Thus in an Antz "ocean" the audience will see a constantly moving interplay between the reflections on the water and refractions beneath the water, with perhaps a bit of foam floating on the surface.

"This water is highly detailed and stylized to fit within the confines of the movie, but we could tweak it a bit and put it over a live-action plate and have photorealistic water," says Bielenberg. "We could also use it to simulate other fluids, as well as gas and smoke."

Adds Foster: "We have photorealistic motion. The look can be stylized, but the motion is real." The same could be said of other visual effects used in Antz, such as dust, which also has photorealistic motion and a stylized look. To create the dust found in more than 200 shots, the effects team again relied on Dynamation, one of the few commercial

software programs used in the film. "The nice thing about Dynamation is that it`s a separate package that we can take into our particle renderer," says Bielenberg. Effects such as heat waves and lens flares, on the other hand, were created with PDI`s own 2D image-manipulation tools.

"I think the amount of effects in this film are equal to the number in a summerr blockbuster movie," Bielenberg adds. "We came from a live-action and effects background, so we brought that knowledge to this film."

In the Background

Director Eric Darnell points to another technique borrowed from the studio`s work in live-action movies: matte paintings. "We`ve found ways to merge matte paintings with 3D scenes seamlessly," he says. One technique used was morph animation--not to do transformations but simply to move pixels around to add atmosphere to a scene and give it a sense of depth. As is often the case in both live-action movies and cel animations, PDI used the matte paintings primarily for wide establishing shots and, in doing so, saved hours of time in modeling and rendering.

Lighting supervisor Janet Rentel estimates that matte paintings were used in 15% to 20% of the total number of scenes--sometimes for little parts of the scene, sometimes for larger parts. "Just enough to give it that overwhelming edge," she says. The high fidelity of these background paintings in Antz is nicely balanced with highly detailed painted texture maps used on the 3D characters and other 3D objects in the foreground.

Again, applying a technique often used in live-action movies to give creatures a more realistic look, the studio relied on hand paintings rather than shaders for all the textures, according to Rentel, "for all the characters--even the little rocks," she emphasizes. "Sometimes we`d have to have different textures for the same character depending on whether they were in the sun or underground."

For lighting, Rentel used the studio`s interactive-lighting software, allowing her to work with a complex variety of scenes that might have as many as 60,000 ants underground at night or a few ants above the ground at high noon, at sunset, or at night sitting around a campfire.

Of course, underlying all the technical innovation is a lot of hard work being done by creative artists. "We could see that we would need a lot of innovation, and a lot of us have worked together for many years, so there`s a lot of trust in place," says Wooton. "But I don`t think any of us had a true handle of the scope of this. Our customary projects were commercials, which take six to 12 weeks, and films, which take six months at the longest." The studio tripled in size to take on the film, growing from 85 to 265 people. The new personnel needed to learn about production; the experienced people found they had something yet to learn about story and character development.

"Two and a half years ago, we began our relationship with DreamWorks," Wooton says (DreamWorks now owns approximately 40% of PDI). "They had a property, a treatment called Ants. We spent the next two and a half years working through the story. We didn`t realize we`d do work on the story all the way through, and that we`d have multiple recording sessions because the story was evolving."

Such Characters

Raman Hui, supervising animator and lead character designer--who has been with PDI for nine years and counts the Pillsbury Doughboy, characters for Batman Forever, and Homer Simpson 3D to his credit, among others--had a similar awakening. "For me, if I`m designing a character for a commercial, I might do 10 or 20 designs," he says. "Z-4195 took one year and more than 3000 drawings."

Once Z`s design was nailed down, the character was sculpted in clay, digitized, modeled, wired up with controls by technical directors, and sent to the animators. The other seven main characters and 10 generic workers/soldiers went through the same evolution--although the initial design phase went much faster once Z`s design was approved.

In addition to character design, Hui worked on about a dozen movie sequences, animating 11 minutes by himself--mostly scenes with Z and Bala. For character animation PDI extended its proprietary award-winning E Motion system, which runs on Silicon Graphics workstations, adding flexibility, speed, and control. Besides innovative visual effects, the people at PDI proudly point to their crowd-animation and facial-animation systems as technological innovations (both of which were reported on in some detail in "Faces and Crowds," July 1998). Indeed, technical sketches of these animation systems were presented during the SIGGRAPH conference in July. The crowd system gives the studio control over the placement and individual motion of as many as 60,000 ants in a scene without 2D cutting and pasting.

For individual ants, Hui and other animators worked with models that had hundreds of animation controls. If he wanted to move an arm, he could control four rotations (up/down, swing, twist, orbit) each for the upper arm, elbow, lower arm, hand, and fingers. In addition, he could add scaling. "With the new system, I can have characters locking hands or have one character`s hand on the shoulder of another," he says. "Before, I would try to avoid this."

Hui credits PDI`s new facial-animation system--which is based on moving muscles rather than interpolating shapes--with giving him the necessary tools for finely detailed work, particularly on characters` eyes. "You can do a lot of acting with just the eyes," he says, describing such subtle things as changing the shape of the eyelids as a character`s eyes move to look in a different direction.

Supervising animator Rex Grignon agrees. "The first place you look is at a character`s eyes," he says. "The eyes are the biggest challenge and the biggest payoff." Grignon has been with PDI since 1988 except for a 15-month stint during which he boomeranged to Pixar to work on Toy Story, then swung back to PDI in 1996. For Antz, he primarily worked on the villainous character General Mandible, a character he particularly liked because the general`s intensity was an interesting animation challenge.

"A great actor will say one thing and suggest that something else is happening inside his head," says director Darnell. "To do that with an animated character, we need discreet degrees of control." And this is something the animators believe PDI`s latest human- and facial-animation system provides.

Grignon adds: "We can animate with a bare-bones set of tools, or we can polish the motion and actually tense a lid or a brow. You might not actually see it, but you would feel the muscles. We push it because we have a lot of shots with full characters on the screen. The original drawings were a lot looser than what we ended up animating," he adds. "We don`t get cartoony. We tried to get physically based characters that are consistent within themselves."

Darnell believes that the sum of the parts--the innovative live-action techniques, such as the water simulation, combined with their own style of character design, animation, lighting, and rendering--add up to a movie with a unique look and feel. "One of the exciting things about CG animation is that it`s so flexible," he says. "I hope CG films stay fresh and that people keep innovating."

As for the story--we`ll just have to wait and see.

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One of the innovations in Pacific Data Images` first feature-length animation, Antz, was the company`s new 3D water simulator, which was used in a number of scenes, including this one, in which ant characters react to a flood. The water renderer takes into account the entire volume of water and uses individual particles to create streaking in the volume to heighten the feeling of movement.

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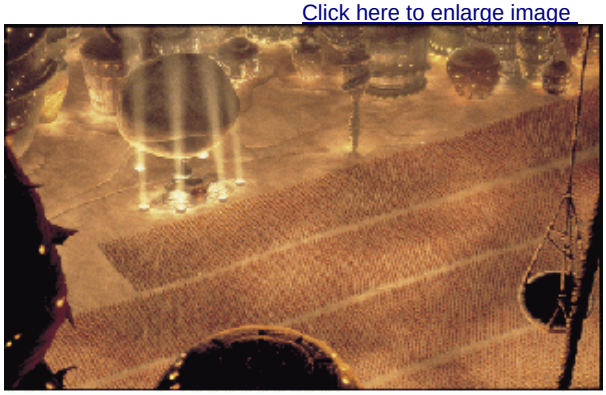

Because the story takes place both above and below ground, lighting for the movie ranged from dark, wide shots (such as this underground scene of thousands of ants marching to battle) to close-ups of individual ants above ground in broad daylight. Matte paintings were used for the roof and sides of the underground world; the foreground structures are 3D models.

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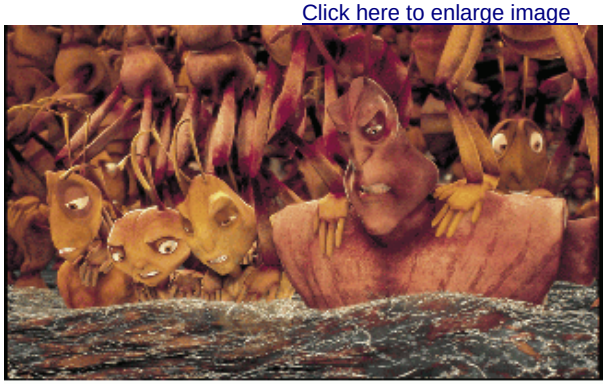

Standing shoulder-deep in the water are Z (second from left) and several ant characters whose reflections and underwater images are possible because PDI`s fluid simulator provides full-3D data rather than simply generating height fields to create water.

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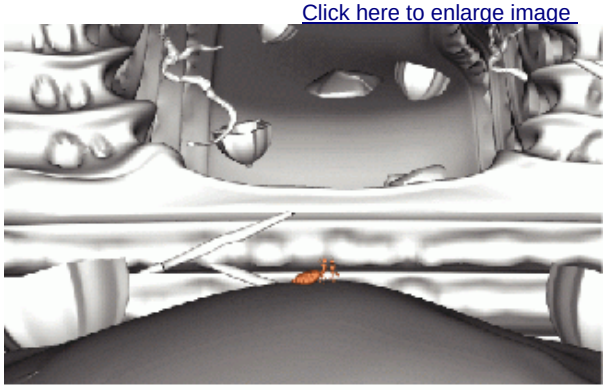

Creating a scene with water involves building an environment in 3D that will contain the water and direct its flow.

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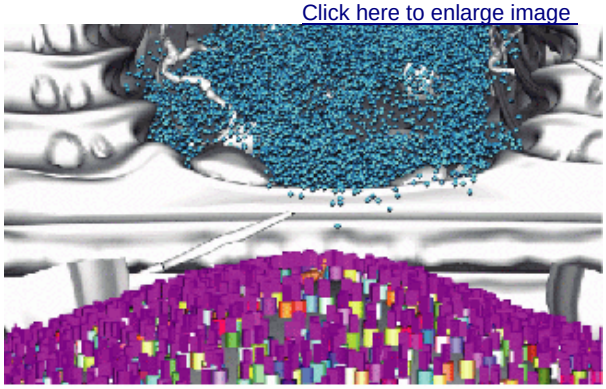

The water flow is then represented with particles for a visual check.

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Shown with early lighting.

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Fully rendered.

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Discovering the wonders of cellophane are Z (left) and Princess Bala. Matte painting is used for the sky in the background, and visual effects are used to create the cellophane distortions.

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Computer Graphics World October, 1998