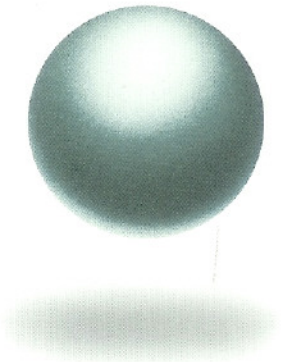
Computer Graphics spawn *The Abyss* Pseudopod

"With the Pseudopod, what you see in the film is exactly and precisely what I visualized. It's the only time that's happened."

Director James Cameron



That's high praise from a director — especially for a creature brought to life through computer graphics. The Pseudopod was the strange, gentle creature that undulated, snakelike, through the labyrinth of the underwater drilling complex in *The Abyss*. In a key scene, the Pseudopod encounters Lindsey (Mary Elizabeth Mastrantonio) and Bud (Ed Harris), reconfiguring its face into a three-dimensional mirror image of theirs. Enchanted, Lindsey dips her finger into the creature's face and discovers it's made entirely of seawater.

"It was a leap of faith to use computer graphics," admitted Cameron. "But it was a unique scene. We were trying to create something that had never been seen before."

With one day's notice, the computer graphics team from Industrial Light & Magic, the special effects division of Lucasfilm, did a test on their modeling and animation system. Cameron was enthused with the results and with Dennis Muren on board as visual effects supervisor, the team moved ahead.

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The shape of the Pseudopod was not complicated — a snakelike tube with a rounded tip. The animators gave the pod an imaginary spine, basically a line through the center that connected a series of pivot points. "By manipulating the points, the animator could create whatever snakelike movement he desired," said computer graphics supervisor Jay Riddle.

Although the Pseudopod was built in three-dimensional computer space, it had to be incorporated with the two-dimensional background plate material shot on stage in Gaffney, South Carolina. To provide the computer graphics team with the exact spatial parameters, project designer John Knoll meticulously documented every background plate as it was photographed, noting the position, pan, and tilt angle of the camera, plus the focal length of the lens and location of the lights. Back at ILM, the team digitized this data, essentially creating three-dimensional scale models of each set in a computer environment for the Pseudopod to move in.

Cameron wanted the surface of the pod to be constantly undulating with a sort of random rippling, like the surface of a swimming pool. Texture was created by "bumping" the pod's surface using specially written software, and then animating and timing the bumps to react and look like water. Maintaining the aesthetics of the pod was a major challenge. "What finally worked was a blend of things. Playing with the scale and speed of the ripples, determining the right mix of reflection and refraction," said Knoll. "If the ripples weren't the right scale and speed, the surface looked like jello or molten glass. With too much reflection, it looked like chrome."

In the scene where the pod reconfigures its face to mimic Lindsey and Bud, the team used a three-dimensional digitizer to make a separate scan of the actor's expressions. This raw data was fed into the ILM computer graphics system and manipulated electronically.

"The exciting thing," commented Knoll, "is that we discovered we can get computer graphics to do things that were once thought to be impossible. Computer graphics used to have a reputation for being slow, expensive, not looking real. Now we have the tools for high-quality effects with fast turnaround and realistic, even organic, results. Almost anything can be modeled and brought to life."

The successful creation of a real-looking creature via computer graphics has major implications for the motion picture industry. For Muren, it's the opportunity to expand the filmmaker's storytelling pallette. "I'm hoping writers, directors, and artists will create more characters using this technology. It's there."

Director Cameron concurs. "The end goal of effects technology should be to expand the possibilities. Computer graphics will fill in that last gulf of information, where the only limit is the filmmaker's imagination."

ILM Closeup: Dennis Muren

At first glance, visual effects supervisor Dennis Muren's bio reads like that of other filmmakers: attracted to visual effects at the age of six, Muren got his first movie camera when he was 12, working his way up from 8mm to 16mm film. However, when the time came for college, Muren took a look at the film schools, and majored in business instead — a decision he never regretted.

Muren freelanced as an effects cameraman on commercials and educational films before he joined George Lucas' *Star Wars* effects team. Since then, he has won five Academy Awards (*The Empire Strikes Back, ET, Return of the Jedi, Indiana Jones & the Temple of Doom,* and *Innerspace*), two British Academy Awards and an Emmy.

Muren doesn't know why he chose special effects over other filmmaking disciplines, except that he "likes the spectacle of creating characters for storytelling." Most recently, he helped director James Cameron realize his vision of the Pseudopod — a creature made entirely by computer graphics.

Awards aside, it's Muren's feel for an entire film, and how successfully the visual effects tell a film's story, that matter most to him — and to directors. "The thing about Dennis is, he's really a filmmaker," says Cameron. "Some effects people don't think in terms of dramatic usage. Dennis understands when a shot has value. He puts his energy on the needs of the film — not just creating beautiful visual effects."

Indy III villain killed by computers

In *Indiana Jones and the Last Crusade,* the villain Donovan rapidly ages 400 years to a horrifying skeletal death in what appears to be a single, continuous shot. Traditionally, the scene would have been created with several puppets in various stages of decomposition, with the transitions between shots masked by cutaways.

"Since this was the movie's climax," visual effects supervisor Mike McAlister explains, "Steven Spielberg was adamant that Donovan's destruction be onscreen without cutaways."

"Digital compositing has the potential to revolutionize the special effects process, making it faster and less expensive."

The sequence involved the efforts of both ILM's creature shop and computer graphics. Creature shop project supervisor Stefan Dupuis and his crew built a mechanical reproduction of Donovan from the waist up. The head, shoulder, and arm movements were controlled by stepper motors hooked up to a motion-control camera system to allow for precise repeatability of movement. Latex skins showing various stages of decomposition were sculpted to cover the skull of the mechanized Donovan. A vacuum inside the puppet's skull slowly sucked the skins into the creases, producing an increasingly wrinkled effect.

Computer graphics played two key roles in the success of the scene. First, a technique the ILM computer graphics team calls "morphing" was used to create a smooth transformation between the shots of different puppet heads. The morphing technique was originally designed by software engineer/animator Doug Smythe for the movie *Willow.* "Imagine a picture placed on a rubber sheet," explains Smythe. "You can take a piece of the picture and align it with another picture by pulling and stretching. The stretched pictures are then cross-dissolved for the final effect."

Additionally, the elements of the shot were digitally composited, or assembled, in the computer rather than on the traditional optical printer. "We were in a time crunch," project supervisor Les Dittert recalls. "Since the data was already in the computer, we tried it. George (Lucas) was amazed with the results."

One of the chief advantages of compositing a shot digitally is that it gives the director a chance to work on a high-resolution video format before the shot is scanned out to film. Once the picture is in the computer, it can be checked for matte lines and the contrast, resolution, and sharpness of the images can be adjusted.

Digital compositing has also made whole new techniques available that used to be reserved for video post-production. Manual touch-ups and artificial sharpening are two examples. Douglas Kay, co-manager of the computer graphics department, believes that "digital compositing has the potential to revolutionize the special effects process, making it faster and less expensive."

Fx breakthrough in *Back to the Future, Part II*

Traditionally, when a special effect calls for an object to fly through space, the model or actor is rigged with wires, shot against a blue screen, and matted into the scene. The supporting wires are later removed with rotoscoped mattes. Then the entire shot is optically composited with the background, models or actors, and rotoscope matte to create the final shot.

But that was the past and this is *Back to the Future, Part II.* The scenes where Michael J. Fox zips around on his futuristic skateboard were shot practically—on location, sans blue screen. The 2" pipe that supported Michael's skateboard was later removed digitally, rather than using standard optical compositing techniques.

With wire removal, "the control of the effect is given back to the director."

Loosely called "wire removal," this technique allows the computer graphics animator to remove the wire (or in this case, the 2" pipe) by "healing" or melding the surrounding edges together. "We add in the exact type of film grain that should have been there," explains project supervisor Les Dittert, "so that the space where the wire was is undetectable."

This breakthrough reduces multiple post-production steps to a single step, thereby reducing costs. It also gives both the director and actor more creative freedom when shooting.

"When an effect is shot practically and all we do is remove the wires, the control of the effect is given back to the director," suggests camera operator Sandra Ford. "Furthermore, the technique can enhance an actor's performance by allowing him to interact with objects that are really there, rather than playing to a blue screen."

10 steps to producing computer graphics

1. **Storyboarding.** Special effects sequences are storyboarded to clarify the client's vision and define the scope of the work, saving time and money, and ensuring better results. The boards can be furnished by the client or produced in collaboration with an ILM art director and effects supervisor.

2. **Bidding.** This process breaks down the script or storyboard into a detailed **fx breakdown** and **fixed bid** of costs.

3. **Modeling** (or **Digitizing**). In this step, numerical information is entered into the computer to create three-dimensional objects.

4. **Scanning.** Information from live-action plates is scanned into the computer to provide backgrounds. Textures from other sources can be scanned and mapped onto modeled objects for realistic effects.

5. **Motion tests** (or **Animatics**). These are made to arrange and choreograph the objects scene by scene, and to check their placement and motion.

6. **Lighting** and **Look**. Like live-action cinematography, computer-generated objects are lit using shadows, highlights, reflections, and refractions.

7. **Low-resolution rendering.** This test of a scene ensures that no technical errors exist in the work before devoting large amounts of computer resources to produce the project at high resolution.

8. **High-resolution rendering.** Here, the scene is computed at a deliverable resolution.

9. **Digital compositing.** This step assembles all elements—modeled objects, backgrounds, mattes, etc.—to create the scene. **Image processing** techniques, such as blurring, sharpening, and hand touch-ups, can be used to enhance the final scene.

10. **Final recording.** The last step is printing the scenes to film or transferring them to videotape for final delivery.

For more information on Behind the Illusions, call Gini David, Industrial Light & Magic, 415/258-2000.