Undersea and in the Air: VR Offers a Thrill a Minute

Virtual reality in public entertainment has been called a zero-billion dollar industry. For three or four years, we've read and heard a lot of hype about the potential profits in taking VR technology developed for the military and using it to make people smile. But as yet only a handful of companies have attempted to create systems that can generate profits as well as graphics. Here's a look at some of the most successful ventures.

Get the heart pumping

Virtual World Entertainment has been perhaps the most successful at creating themed urban entertainment centers using virtual reality. The company has opened 22 centers around the world, most in the US and Japan, with several in Canada and Australia, and a London center opening soon. Each costs between $1 million and $1.5 million to build.

Players (average age 24 years old and one in four a woman, said the company) pay about $9 for a 30-minute experience. Less than 10 minutes is spent in the VR environment; the rest is pre-show and debriefing. Before playing, customers assemble in a themed environment (described by the company as “a mix of Jules Verne and Bladerunner”). To date, the centers offer two adventures: BattleTech (in which players piloting 30-foot-tall walking robots called BattleMechs fight each other or fight in teams) and Red Planet (where players in hovercrafts race and play tag through the canals of Mars). Three more games are in the works.

Each center has a fleet of cockpits (up to 24), and up to eight players compete in a networked environment. A Motorola 68020 serves as the host CPU in each cockpit, a Texas Instruments 34020 acts as the image generator, and three other processors handle sound, radar-screen graphics, and I/O.

Founders Jordan Weisman and L. Ross Babcock opened the first BattleTech center in Chicago in August 1990. They spent two years working out the bugs, using the US government's Simnet training system as a model. In the first-generation system, scenes and objects were texture-mapped offline, cached, then combined on-screen during the game. Resolution was limited by memory and relatively low (500-750 polygons per frame, 10 frames per second), even though they stretched the limits on RAM. “In 1988, when we first built that system,” Weisman said, “32 megabytes of RAM on one system was pretty much unheard of. Nowadays, anybody who works on Photoshop has it.”

By August 1992, they had worked out enough bugs in this first system to open a second center in Yokohama. These second-generation graphics were polygonally modeled, so they lacked the texture-mapped detail of the previous generation but yielded more fluid motion and offered an infinite number of perspective views.

At this year's Siggraph meeting in August, Weisman introduced their fourth-generation system, called Tesla. Tesla offers fully texture-mapped graphics and renders up to 100,000 polygons per second (in 18 to 30 frames per second).

At Virtual Reality 94 in San Jose, California, Weisman explained that VR entertainment, because of the cost of initial investment, must churn through lots of paying A player in a cockpit controls a gladiator robot in Virtual World Entertainment’s BattleTech. Up to eight players are networked in a virtual environment, where they compete to disable each other.
As you wipe the windshield across, you have to incrementally take these spots off the screen," Evans & Sutherland flight simulator, originally developed for the military. Eight submarines are networked to an Evans & Sutherland image generator. Imagery is rear-projected onto a large screen, which serves as the sub's window, and players wear polarized glasses to enhance the 3D effects. A digital audio system delivers the sound effects in sync with the sub's movements.

Throughout the $1-million project's nine-month development, the programmers and artists—a team of about 50 people at both companies—worked closely together. Pearce said she is a strong advocate of bringing customers quickly—no more than 5 or 10 minutes each, for which they pay up to $10. How do you get someone to spend $10 for 10 minutes and still feel they got their money's worth? You've got to thrill them, get their hearts pumping and adrenaline flowing. And the easiest way to do that, Weisman explained, is to make them feel like they're going to get killed.

Other entrepreneurs are trying the same formula. Magic Edge in Mountain View, California, targets their networked X-21 Hornet flight simulators as a business motivator tool: bring the team in for a dogfight and cocktails. Like Virtual Worlds, Magic Edge offers a themed pre-game environment, including a prefight briefing (players wear flight suits). The 12 flight simulators are controlled by an eight-processor Silicon Graphics Reality Engine, which also renders the graphics.

**Is excitement as good as fear?**

Iwerks Entertainment and Evans & Sutherland decided to take a different tack and see if they could create a nonviolent, cooperative (yet still competitive) virtual reality game in their Loch Ness Adventure. In the attraction, which plays at Nauticus Amusement Park in Virginia Beach, up to six players cooperate in a mini-submarine module (a motion-based simulator mounted on hydraulic arms) as they explore a 3D environment representing Loch Ness. The premise: the existence of the Loch Ness monster has been confirmed, and players are volunteer scientists who must dive into the murky depths and rescue Nessie's eggs from bounty hunters.

Up to six submarine crews compete in a single environment, with an interesting angle that VR enables: each crew sees themselves as the heroic scientists, while other submarines appear as marauding bounty hunters.

Creative Director Celia Pearce believes the game differs from traditional VR action in several respects, some designed to appeal to a broader demographic than the 14-to-44-year-old male. First, the crew members work as a team (up to six of them together in one pod) and each has a task, whether navigation, controlling the robot arm, or operating a periscope. Second, the game is fairly nonviolent; about the only thing subs can do to each other is fire a projectile of "nonlethal immobilizing" that covers the target sub's windshield with colorful splats for a few moments until that crew can get the windshield wipers going. (Wiping the screen, Pearce added, was one of the toughest programming tasks of the project. "As you wipe the windshield across, you have to incrementally take these spots off the screen," and reveal the scenery behind.)

The technology behind Loch Ness Adventure is an Evans & Sutherland flight simulator, originally developed for the military. Eight submarines are networked to an Evans & Sutherland image generator. Imagery is rear-projected onto a large screen, which serves as the sub's window, and players wear polarized glasses to enhance the 3D effects. A digital audio system delivers the sound effects in sync with the sub's movements.

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"I love finding a technology that's already ripened for a particular application and then finding a different application," Pearce said. For example, the Evans & Sutherland flight simulator offered good fog effects. Since this application had to give texture to a water environment, they decided to color the fog green and blue to create murky depths, as well as to blur and hide objects to reduce the polygon count.

They also used lighting for effect. The first two minutes of the adventure take place near the surface, where ambient light shines from above, illuminating a castle and other sunken scenery. Then, a whirlpool sucks the sub down into Loch Ness' depths, where you can see only what's in the headlights. The monsters looming in and out of the headlights, as well as the green fog, create "a much more creepy kind of environment," Pearce said.

**Adding movement and mood**

Los Angeles production company Rhythm & Hues also chose an underwater environment for its Seafari, a four-minute, motion-based ride, now an attraction at a
Matsushita theme park in Wakayama, Japan. *Seafari* combines live footage and computer graphics—not actually VR by most definitions, but still using computer graphics to create an immersible virtual environment. Rhythm & Hues spent 18 months on Silicon Graphics workstations generating the 6,300 frames for the four-minute film. (The company said production costs are about $1 million per minute.)

Viewers file into a Jules Verne-style submarine for what starts out as a tour but develops into a rescue mission: another tour sub has gone down in the hull of a sunken tanker. A computer-generated dolphin (whose sophisticated backpack allows it to talk) leads the sub through the ocean and into the remains of the tanker’s hull, where a giant moray eel-type monster lies in wait. That’s when the fun really begins.

Computer graphics supervisor Kathy White said the most challenging aspects of the animation were creating a life-like and threatening monster and creating atmospheric effects that added substance and mood to the liquid environment. To build the monster, they sculpted several 3D models and digitized them with a 3D scanner. Then Rhythm & Hues artist Min added details and texture mapping to the creature in a production phase called prelighting.

“That’s another place where our tools were pushed much further,” White said. “Our software allowed us to build mattes for mapping, to allow gradual changes instead of the hard polygonal boundaries that most software uses.” The renderer let them combine multiple maps, allowing smooth transitions of textures.

The creature’s movement was also complicated, as its body had 13 segments and its head 15 moving parts. To deal with the movements, animator Larry Weinberg set up a hierarchy so that moving one object caused others to move. “I was able to use inverse kinematics to animate just the end of the leg, and the whole leg would move.” Weinberg set up dependencies based on combinations of sine waves, so that by dialing sine wave controls, the whole body moved. “I would say two to three months were spent just setting up these controls and making it work,” he said, “more time spent setting up than actually animating.”

**Coming to a lobby near you . . .**
For those who don’t have the lead time or budget to produce a high-end VR attraction, Virtuality Entertainment sells arcade-style VR games, which are less expensive and can be placed in smaller spaces. Players pay $3 to $5 for a three-minute turn in the helmet-mounted display. The system has a library of five games, one driving and several shooting games. Chris Yewdall,
The interior of a sunken ship’s hull, where much of the action takes place in Rhythm & Hues' Seafari. Designers added free-floating particles to the 3D model to create the look of an undersea environment.

general manager for Virtuality in Irving, Texas, said the firm has placed more than 1,000 units in 34 countries. The company sells two models, the 2000 SU (stand up, where players stand on a ringed platform) and the 2000 SD (sit down, for driving simulations). The units in these second-generation models cost $35,000 per seat, about $20,000 less than their predecessors, and have lighter helmet-mounted displays, weighing only 1 pound, 7 ounces. Part of the cost savings came in networking two systems to a single 486 processor, with a Motorola 88110-based graphics board for each player.

Yewdall said the company is making alliances with firms that can place its units, like United Artists’ theater chains, Q-zar laser tag centers, and Dave and Buster’s entertainment and food centers. The game’s current price makes it prohibitive to retail-style vendors like mall arcades, but Yewdall expects those markets to open in a few years, as the cost of technology drops and players can take a turn for $1 or $2. A key to generating return business—and to staying ahead of competitors whom Yewdall expects to enter the market within a few years—is developing and releasing new games. Virtuality will soon release its first game developed by a third party, Gremlin Interactive’s Shoot for Loot. Prior to that, the company developed all the content itself. Yewdall is setting up other developer agreements, including one with a Dallas-based defense contractor. Owners of the units pay about $9,000 for new titles, and Yewdall said that investment can be reclaimed in two to six weeks, depending on the location.

The company is also venturing into home entertainment, providing inexpensive head displays for Atari’s Jaguar console later this year. It’s also developing new peripherals for its public games, including a compressed-air recoil rifle, expected by year’s end. With the rifle, players will actually feel the kickback against their shoulders as they fire at virtual villains.

One of Virtuality’s competitors may be Sega Enterprises of Japan, which said it wants to install 100 of its VR-based entertainment sites around the world, with at least 50 in North America. (It currently has two in the US, one at Las Vegas’ Luxor Hotel and one at Epcot Center’s Innoventions, as well as a handful of others in Japan.) Sega’s systems are networked consoles that link up to eight players in virtual environments where they race cars or fly spacecraft. Sega USA spokesman Greg Chiemingo said the company sees the centers as having a big advantage over traditional theme parks, since they can be placed in smaller spaces. “You can be more urban,” he said.

Not yet proven

Even given these efforts and their relative successes, some analysts say VR is not yet ripe for location-based entertainment because it’s still too expensive and too primitive. Clark Dodsworth of Osage Associates in San Francisco advises companies considering investing in VR entertainment. “Most of the time I advise them not to,” he said. “The numbers just aren’t there yet.” For such attractions to become sure bets, he said a few things have to happen. “You have to allow people to choose the world they want,” he said, adding that Virtual World’s choice between two games isn’t enough. Technological advances must make rendering software faster, to generate more satisfying graphics. And you need a brand identity, so customers trust the name enough to plunk down $5 or $10 dollars. “Right now,” Dodsworth said, “the money’s on roller coasters.”