Technology; Loping Toward the Death Star, With Every Sense but Smell

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FOR years, airlines and the military have used flight simulators to train pilots for equipment failure or bad weather. But lately, the still-evolving technology has been put to use to allow novices to accompany a fighter pilot on a strafing run over the Death Star or to ride a flying sports car down the throat of a tyrannosaurus rex.

In some ways, this is easier to simulate than landing a 747 in a fog-bound airport. A real-life simulator, after all, must measure up to the operators' previous experience. But the fantasy rides -- though called "flight simulators" by amusement park designers -- can take some poetic license.

What the entertainment medium requires is a realistic feel, and in that area the new rides have surpassed the industrial simulators in some ways. There are magnificent visual displays, vast sound systems, motion platforms to give the sensation of flight, if not in the cerebral cortex, at least in the gut.

The newest and biggest flight simulator is a $40 million "Back to the Future" ride at Universal Studios here. It uses the same cast of characters as the three "Back to the Future" movies and boasts that it plays to every sense except smell. Walt Disney World, nearby, runs two older models that are slightly less ambitious but still impressive: Star Tours, based on the "Star Wars" movie, and Body Wars, a simulated trip through the body on a tiny submarine-like vehicle.

The function may be merely entertainment, but the technical effort is substantial, a level of information overload that approaches what computer designers call "virtual reality," or stimulation of the entire sensorium with artificial input.

Back to the Future, which opened in May, employs an Omnimax film projected on an 80-foot diameter screen shaped somewhat like the inside of an egg with an end cut off. The size and curve allows the horizontal axis to fill 270 degrees of the viewer's vision; in other words, not only the front, like a television set, but everything within easy sight even if the rider swivels his head.

The difference between this image and the one on a TV screen is like the difference between listening to a symphony orchestra through the earplug of an AM radio and sitting in a concert hall.

The negatives on the film itself are triple the size of the largest format now in use in movie theaters. Conventional movie film is measured in millimeters, for the width of each frame, and perforations, a count of the holes along the side of the frame by which the film is pulled along. The largest conventional film uses 70 millimeters and five perforations. But the Omnimax film is

horizontal, 70 mm high and 15 perforations wide. The result is a negative with about 10 times as much information as a regular film negative, according to Douglas Trumbull, the director.

That is a lot more information than comes across on many commercial simulators. Richard S. Bray, a recently retired developer of flight simulators at the NASA Ames Research Center in Moffett Field, Calif., said commercial airliner simulators show the pilot only what would be seen from the cockpit windshield and one side window.

Simulators for fighter pilots sometimes show the entire sphere around the plane, he said, but because these are computer generated and the computer cannot create detailed images as fast as the pilot can move, they present limited information. "Most of them are aimed at air-to-air combat, so they don't have to put much in-scene but the visible horizon, maybe some clouds and then the target aircraft," he said.

One company, CAE Industries, of Toronto, uses eyepieces mounted on a helmet and changes the view as the wearer's head moves, he said. Others have tried showing great detail in the area immediately in front, and less in areas seen by peripheral vision, where detail is less detectable anyway.

In those cases the simulator is interactive, meaning that it is the viewer, not the simulator, who decides which way the "plane" will fly and what will be seen next.

But the Back to the Future ride makes up for the rider's passive role with vividness. The film, a $16 million effort, lasts only 4 minutes but the body says it is longer. Except for the last few seconds, when the time machine returns home with live actors and full-size props, it was shot entirely of miniatures, representing the mythical Hill Valley, Calif., in 2015 and in primordial times.

AT the heart of the ride is the integration of sight with motion. Visitors sit in one of 12 mock-ups of an eight-passenger DeLorean sports car, with the trademark gull-wing doors but no roof. Each "car" sits on a motion platform.

According to Terry Winnick, the producer of the ride, the platform can move as much as two feet forward or back, right or left, and can tilt front and back, left and right. It produces a force on the rider of up to 1.8 G's. (One G is the normal force of gravity. Producing a force of one additional G, or reducing the natural 1 G to zero, requires a change in speed of 32 feet per second, in a single second.)

While 1.8 G's is not a challenge to an average person, it is a lot more than people encounter in everyday life. John K. Lauber, a member of the National Transportation Safety Board, the Federal agency that investigates plane crashes, said that an airline passenger generally feels forces no greater than 1.5 G's.

The motion platform does not really produce the sensations that the real maneuvers would, just as a real flight simulator, as Mr. Bray put it, "is only able to present a pretty small part of the whole

motion envelope the airplane's going through." But, he said, the motion "supports the environment that's being described to you otherwise." By combining the suggestion of motion with the full visual impact, the ride induces the mind to accept that the rider is fully involved in the action.

Integrating the platform with the movie is critical. Aviation experts say that movement perfectly handleable in a real vehicle can produce "simulator sickness" if the visual cue differs from the motion perceived by a rider's inner ear.

The movie was shot with a computer-controlled camera, which moved the lens from point A to point B at a rate and along a trajectory set by human operators. That computer was then yoked to a control computer for the motion platform, said Mr. Winnick. The ride is essentially a chase scene, in which the visitor's DeLorean is careering through time and space in an attempt to overtake a DeLorean hijacked by the all-time miscreant, Biff Tannen, who threatens to run rampant and "disrupt the space-time continuum," as an ever-breathless Dr. Emmett Brown (Christopher Lloyd), tells visitors via videotape as they board. If the combination of sight and motion did not achieve the desired effect, then the scene was reshot or the motion platform recalibrated slightly, Mr. Winnick said.

The ride begins and ends with a whiff of nitrogen gas, which creates a ghostly fog. During the ride, cold wind blows over the audience to simulate motion. A 10,000-watt multichannel stereo system helps too.

Mr. Winnick said that the motion of the DeLoreans is adjusted slightly to account for individual angles of perspectives and that the combination of different motion and different perspective gives each visitor a slightly different ride.

Disney would not discuss the technology behind its flight simulator rides, the first of which opened in January 1990. They are larger compartments, also on motion platforms, facing a smaller screen.

BUT a spokesman for Disney World, John Dreyer, said that rides that move people in dramatic ways, as opposed to simply showing them things, are definitely at the cutting edge. Disney is building a "Twilight Zone Tower of Terror" in which visitors will descend 13 stories in free fall, he said.

Eventually, with faster and cheaper computers, amusement-park rides could become interactive, but Mr. Winnick said that on his ride, a passenger would have trouble holding onto a joystick. Instead, he said, Back to the Future offers "an artificial reality, a very personal reality."