The Forerunners—and the Competition

1838: Sir Charles Wheatstone invents the first stereoscope, which uses two angled mirrors to reflect a separate image into each eye. It gives viewers the sense that they're seeing one image in three dimensions.

1922: A silent 3-D film, *The Power of Love*, is released; viewers wear glasses with two different-colored lenses—red and green—to watch it.

1961: Philco employees build the first known head-mounted display, called Headsight, which features a helmet outfitted with a cathode-ray tube and magnetic head-position tracking.

1962: Morton Heilig receives a patent for the Sensorama, a big, boxy machine that shows short 3-D films on a small, one-person display, combined with sensations like smell and wind to make the experience immersive.

1985: Jaron Lanier, who is credited with coining the term "virtual reality," founds VPL Research. It sells such products as the Data Glove, which lets people use their hands to interact with a virtual environment, and the EyePhone, a head-mounted display.

1990: Boeing scientists Thomas Caudell and David Mizell build a wearable, see-through display that can superimpose lines on a board—aimed at making it easier for workers to assemble bundles of wires on boards that will then be installed on an airplane.

2010: Quest Visual releases Word Lens, an application that makes it possible to point a smartphone camera at a sign written in Spanish and have it appear in English on the screen.

2012: Palmer Luckey raises $2.4 million on the crowdfunding site Kickstarter for his stereoscopic 3-D virtual-reality gaming headset, Oculus Rift. Two years later, Facebook will buy Oculus for $2 billion.

2015: Months after Google invests in Magic Leap, Microsoft shows off the HoloLens, which also uses a technology other than stereoscopic 3-D to make virtual objects appear to be integrated with the real world. It plans to release the gadget in early 2016.

bones as they went about this work. Over and over, he says, he tried out head-mounted displays made by different companies, but he was disappointed with them all. "They were all just complete crap," he says. "You'd put it on and it would give you a headache and it was awful, and I was wondering, 'Why is this so bad?'"

At the same time, Abovitz also wanted to take Sparkydog & Friends on a virtual tour. In U2's 1987 video for "Where the Streets Have No Name," the group, in a nod to an earlier move by the Beatles, plays an impromptu show on the roof of a Los Angeles liquor store. Abovitz yearned for his band to be able to do that, but virtually, and on a thousand rooftops at once.

About four years ago, he started mulling the problem over with John Graham Macnamara, a high school friend who had dropped out of Caltech's theoretical physics program. They became captivated by the idea of displaying moving holograms like the one in *Star Wars*. Holograms—3-D images that can be viewed from many angles—are made by accurately re-creating light fields, the patterns made when light rays bounce off an object. But Abovitz figured it would cost a lot and take lots of time to project even low-resolution holographic images. At one point, he remembers muttering, "There is no display that can actually work."

The next morning, though, he awoke with an idea: why bother with the painstaking steps needed to send a hologram out into a room for multiple people to see at once? Why not, instead, essentially make a hologram that only *you* see, doing it in a way that is natural for the eyes and brain to perceive, unlike stereoscopic 3-D? "We're spending half a billion dollars–plus to effectively make nothing happen to you, physiologically," Abovitz says.

The solution he and Macnamara and the rest of Magic Leap's team have come up with is still largely under wraps, and on the record they avoid discussing how the technology works except in vague terms, citing concerns about competition. But it's safe to say Magic Leap has a tiny projector that shines light onto a transparent lens, which deflects the light onto the retina. That pattern of light blends in so well with the light you're receiving from the real world that to your visual cortex, artificial objects are nearly indistinguishable from actual objects.

If the company can get this to work in a head-mounted display, showing images near the eyes and consistently refocusing them to keep everything looking sharp, it will make 3-D images much more comfortable to view, says Gordon Wetzstein, an assistant professor of electrical engineering at Stanford who researches computational imaging and displays. "If they do what people suspect they do," Wetzstein says, "it will be amazing."