

The Rise and Fall and Rise of Virtual Reality

An oral history of a technology whose time has come again

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When Facebook bought virtual reality company Oculus in early 2014, virtual reality blew up. While game and movie studios began reimagining the future, others looked back at the “old days” of VR — a loosely remembered period in the 1990s when gloves and goggles were super cool and everyone was going to get high on 3D graphics. But things were never so simple. We spoke to 18 key VR innovators about their work and dreams. What follows is over two decades of memories and visions for what the future could be.

Some people identify the birth of virtual reality in rudimentary Victorian “stereoscopes,” the first 3D picture viewers. Others might point to any sort of out-of-body experience. But to most, VR as we know it was created by a handful of pioneers in the 1950s and 1960s. In 1962, after years of work, filmmaker Mort Heilig patented what might be the first true VR system: the [Sensorama](#), an arcade-style cabinet with a 3D display, vibrating seat, and scent producer. Heilig imagined it as one in a line of products for the “cinema of the future,” but that future failed to materialize in his lifetime.

In 1965, Ivan Sutherland — already known as the creator of groundbreaking computer interface Sketchpad — conceived of what he termed “[The Ultimate Display](#),” or, as he wrote, “a room within which the computer can control the existence of matter.” He demonstrated an extremely preliminary iteration of such a device, a periscope-like video headset called the “[Sword of Damocles](#),” in 1968.

Meanwhile, at the Wright–Patterson Air Force Base in Ohio, military engineer Thomas Furness was designing a new generation of flight simulators, working on a multi-decade project that eventually became the hallmark program known as the Super Cockpit.

A few years later, in the late '60s, an artist and programmer named Myron Krueger would begin creating [a new kind of experience](#) he termed “artificial reality,” and attempt to revolutionize how humans interacted with machines.

Jaron Lanier *Co-founder of pioneering virtual reality company VPL, musician, and technological philosopher* Ivan Sutherland proposed a head-tracked head-mounted

display in '63 as part of the initial invention of computer graphics itself. [He] built one, which is on display at the Computer History Museum in Silicon Valley. When I was a teenager in the '70s, I was so excited by Ivan's work that I used to almost jump up and down — stop random people on the street like, "Look at this! Look at this!" — and just make an ass of myself.

Ben Delaney *Market researcher and creator of VR industry newsletter ~~CyberEdge~~ Journal* It was a head-mount that was suspended from the ceiling because it was just too heavy to wear. The display was all wire frame, but they were 3D models, and you could change your position and see different views thanks to a tracking system built into the head mount. Ivan was really the father of VR.

Nicole Stenger *Digital media artist, creator of influential virtual reality film ~~Angels~~* There were two inventors who basically found the secret of VR in the '60s: Ivan Sutherland and Tom Furness. Ivan Sutherland started a major computer company, while Tom Furness was developing the technology inside the Air Force. When he started his lab, he had been kicked out of the Air Force because they didn't believe in it anymore. They were wrong, of course. After the first Gulf War, when his system was being used by the Air Force, everyone realized that [it] was a major breakthrough.

Stephen Ellis *Head of the NASA Ames Research Center's Advanced Displays and Spatial Perception Laboratory* The first time I saw something that provided full immersion experience was here at Ames [NASA's Ames Research Center]. Though I'd been in aircraft simulators, Ames was at the forefront of developing [VR technology]. In the '50s and '60s, they built a model train-like environment, with all the little buildings and aircraft, and flew a miniature camera across the surface to create a visual that could be fed into the cockpit and looked like an out-the-window scene. And then, while I was here, it actually switched to computer-based imagery using Evans' and Sutherland's equipment. Ivan Sutherland was involved in developing some of the fast hardware that would make it possible to do the perspective transformations quickly enough so you could have some degree of interactivity in the systems.

VPL co-founder Jaron Lanier in a DataGlove and head-mounted display

Jaron Lanier Flight simulation was really the first practical digital-simulation application. There are people who put a lot of effort into them and some of them are

really cool. When I was coming up in the '70s, the flight simulators were definitely the highest art.

Scott Fisher *Head of interactive media at the University of Southern California, founder of the NASA Ames Research Center's Virtual Environment Workstation Project, and co-founder of VR company Telepresence Research* [Mort Heilig] was just so brilliant and ahead of his time. He just didn't have good luck with this stuff. There are four [Sensoramas] left. I feel bad; it's groundbreaking work. He should absolutely be acknowledged and be a common name in these discussion and he's not.

Linda Jacobson *Author, founding staff member of ~~Wired~~, and former "virtual reality evangelist" for supercomputer company Silicon Graphics* A lot of new science museums have interactive displays: basically, you're interacting with projection images that are generated by a computer while your body is being tracked by a camera that interpolates where you are in space and alters the graphics accordingly. The intersection of those two technologies really are at the basis of VR as we know it today, and was first developed by Myron Krueger.

" "It just seemed to me that I was important and the computer wasn't."

Myron Krueger *Groundbreaking early virtual reality artist and innovator* When I got to the University of Wisconsin, I decided to find the biggest computer that I could use by myself and make it interactive. Because of my liberal arts background, I had a much different idea about what computers were for, and so I imagined a more romantic search for a relationship between a human and a machine. I decided to try to find the essence of interactivity. Most people were either on the far end of theory — and I mean stuff that would never be practical in a thousand years — or on the other end, making arguments about what was practical at that minute, and there wasn't much in between. I just imagined what it would be like to use a computer in the extreme, sort of, and I thought that being able to move around physically was one of the things. I don't know why I thought all of this was important, but it just seemed to me that I was important and the computer wasn't.

As I worked towards thinking about what it would mean to do the computer as a full-body experience, I got involved with a dynamic environmental sculpture called "GlowFlow." I decided from then on that I would focus on interactivity. I vowed to create an experience that would allow a person to go into a room and come out with their attitudes about computers changed.

I didn't know about Ivan Sutherland's statement that the ultimate display would have you sitting, but I knew that I wanted to be able to walk around. So that in this environment, everything you saw and everything you heard would be a response to your physical movement.

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As Myron Krueger developed his own system of projector-based VR, the computer was invading American businesses, and eventually, homes. The Apple II was released in 1977, followed two years later by VisiCalc, a groundbreaking software application that moved personal computing beyond the realm of mere curiosity. Atari was at its peak, having expanded from arcade games to home consoles in the late '70s and early '80s. Meanwhile, a new generation of researchers was coming of age, crafting successors to Sutherland's head-mounted display and Heilig's entertainment supersystem.

Scott Fisher I'd been working with stereoscopic imaging since I was a teenager in the '60s. I've always been obsessed with the idea of images that you are immersed in. I worked on many different ways to present 3D imagery. It wasn't until the late '70s and early '80s, when we started getting some new tech to track where you were in a space, that I started prototyping things to take that into account.

Tom Zimmerman *Engineer, co-founder of pioneering virtual reality company VPL, and inventor of its most famous product, the DataGlove* In the late '70s, I was an undergrad at MIT, and me and my classmate were fantasizing about virtual orchestras. We started thinking about how you could play different chords with your fingers, and that's as far as we got. It was all on paper. I finished MIT and went to the University of Amherst, and then I went to New York to study electronic music. So then, I started thinking about the orchestra thing again. This time, I was thinking about air guitar. Here I am in Queens now, luckily with no job, and I'm living at my parents' house. The dreamer in me was saying, "Wouldn't it be cool if you could play air guitar and really hear it come out of the speakers?" So I set out to make a sensor to [measure] finger-bending.

Howard Rheingold *Journalist and author of ~~Virtual Reality~~, one of the definitive historical accounts of VR* The personal computer was getting really mature because of the visual graphic user interface that Macintosh and Windows provided. When VR

came along, some people looked at that as okay, the next step. The last step was moving from a command line interface to the visual interface. Maybe the next one was when you might be totally immersed in the world.

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Tom Zimmerman I was in New York, I'm studying electronic music, and then I decided to study Assembler programming because I got an Atari 400. Someone decided to give this class on Assembler, and there were 20 people in the class and maybe four of us had Ataris. Everyone else had Apples. One of the people was a woman named Nancy Mayer, and she said, "Oh, why don't you come to my apartment..." (meaning us four people) "...and my husband, he knows Ataris really well, he can help us." Well, her husband happened to be Steve Mayer, one of the major founders of Atari.

So her husband's teaching us how to use the Atari computer and I told Nancy, "I'm moving to California, I fell in love with a ballet dancer, and she got into the Oakland ballet, so I'm leaving." Her husband said, "Oh, you know, there is this music research group forming at the Atari research lab in Sunnyvale, California; would you be interested in interviewing?" And I was like, "Damn, yeah." So I got interviewed and they accepted me and flew me out.

An early omnidirectional treadmill, used for walking in virtual reality (Ben Delaney)

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The Atari Sunnyvale Research Laboratory was founded in 1982 to explore the future of digital entertainment. The lab was headed by Dr. Alan Kay, an influential computer scientist who had previously worked at the Xerox Palo Alto Research Center. It operated for only two years, shuttering in the aftermath of the 1980s "Atari crash" that decimated the video game market. The lab employed several individuals who would go on to play major roles in the development of virtual reality — including Zimmerman, Scott Fisher, Jaron Lanier, and Brenda Laurel.

Scott Fisher I went to Atari in California to work in corporate research with Alan Kay. I started working on an immersive display for coin-op arcade environments. A head-mounted display wasn't feasible, so we built it into something more like an ar-

cade cabinet that you just look into.

[The researchers] were given a big budget and asked, “What’s the home of the future in 20 years? What’s entertainment and education?” It was a wonderful think-tank of brilliant people making stuff and trying things.

When Atari crashed, NASA Ames offered to put a position together for me as a research scientist observer. I started in '85 and we built one of the first versions of a head-mounted display using the wide-angle optics I found and was working on at Atari.

Mark Bolas *Director of the University of Southern California's **Mixed Reality Lab** and founder of VR hardware company Fakespace* My first encounter with VR really was computer music at UC San Diego. It was one of the first systems where you could synthesize sound completely from a computer. And that gave me a taste for this idea that you could create a perceptual experience that nobody had ever had before. To me, VR is just a visual extension of that. So I did graduate work in computer music. And then at the same time I was doing that work, I was building an underwater telepresence system where you would look into a display and see through the eyes of the underwater robot.

So I'm in grad school, and I'm pretty sure I'm going to get a job as a product designer. I had an offer from the company I really wanted an offer from. Then, a professor said, “Hey, go visit this Scott Fisher guy down at Ames, because he's interested in your robot work.” I visited him and put on his head-mounted display, put on the glove, and I remember staring, wiggling my fingers in front of my face. It was this horrible feeling, because I realized that I was going to have to say no to this job I just had been offered. I just had to play with this system.

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In the early '90s, virtual reality's growing appeal created a broad market for related books, magazines, and newsletters. Ben Delaney's *CyberEdge Journal* addressed the business of VR, and MIT launched *Presence* to cover virtual environment research. University of Wyoming masters student Joseph Gradecki, with the help of his wife, produced 17 issues of *PCVR*, a bimonthly how-to guide for building home VR systems.

Ben Delaney I was working for *PC World* magazine and one of my teammates there said, “Hey, there is this interesting presentation going on — it’s this new technology called VR. You want to check it out?” It consisted of about 47 polygons, all in bright primary colors, no curves, and it operated at about 5 or 10 frames per second. It was remarkably crude, but the promise was pretty amazing.

“It was remarkably crude, but the promise was pretty amazing.”

Sitting in the audience I said, “This is going to be hot and I want to be involved in it.” I arranged meetings with the two or three VR companies that were big enough to have marketing directors. One of them said, at the end of a lunch, “You know what we need? We need a newsletter. No one knows what is going on.” So, in January of ‘91, the first issue of *CyberEdge Journal* came out.

Joe Gradecki *Software engineer and creator of homebrew virtual reality magazine PCVR* In the beginning [PCVR] was just for other enthusiasts; other people that had an interest in virtual reality. It was the *Make Magazine* of virtual reality: I’m going to try and experiment with it, build it, and I’ll tell you how to do it. We were playing around with 1½-inch TVs — everything — trying to build a good head-mounted display that gave you reality within that immersive environment.

Cyberedge Journal editor Ben Delaney (left) presents an award to W Industries/Virtuality founder Jon Waldern (Ben Delaney)

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Arguably the best-known maker of virtual reality entertainment in the 1990s was W Industries (later called Virtuality), a UK-based company that produced arcade headsets. At the time of W’s first official showing in 1990, virtual reality had already received significant mainstream press coverage. Some writers were skeptical of the technology — British journalist Hunter Davies summed up Waldern’s arcade pod by saying “the helmet was annoying and the game boring.” But others saw both potential and danger in a technology that could, as one writer put it, “make users’ dreams come true.” *The New York Times* said that virtual workspaces developed by major companies like Autodesk could have “profound implications,” but it warned that “psychologists who now worry about children losing themselves in video game fantasy worlds would no doubt find artificial environments a bigger problem.”

Jon Waldern *Inventor, entrepreneur, and founder of British virtual reality arcade gaming company W Industries / Virtuality* The first show we went to was the computer-graphics show in Alexandra Palace, London. We had two interactive VR systems linked together in big wooden boxes and a little booth. We had queue lines — I'm not kidding you — all the way around the building. The original direction of the company was to use virtual reality as a development tool for computer-aided design. But very quickly somebody suggested, "Hey, this is just an amazing experience, why don't you make a game out of it?"

" "I think everyone was hopeful, and looking forward to a change in consciousness. Either that, or they thought we were a bunch of crazy hippies."

Ben Delaney Cybersex was a big titillation. People thought you would be able to put on some sort of tactile suit and have sexual encounters with real or imaginary people in a virtual world.

Brenda Laurel *Author of human-computer interaction text ~~Computers as Theatre~~, interactive media expert, and co-founder of VR company Telepresence Research* The public perception of the medium was that it was powerful, amazingly cool and that we were about to have our heads turned around by it. I think everyone was hopeful, and looking forward to a change in consciousness. Either that, or they thought we were a bunch of crazy hippies.

Virtual reality glove and full-body datasuit prototypes, developed by VPL

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Besides head-mounted displays, no technology is so strongly associated with virtual reality as the wired glove, a sensor-equipped device that tracks the wearer's movement and location. Many companies manufactured such gloves, but the best-known was VPL's "DataGlove" — created by company co-founder Tom Zimmerman with the help of engineer Young Harvill. VPL, depending on who you ask, stood for Visual Programming Language or Virtual Programming Language. Founded in 1985, the company was the product of a partnership between two former Atari lab employees: Zimmerman and Jaron Lanier, a musician and programmer who is sometimes referred to as the "father of virtual reality."

Tom Zimmerman I told Atari about my glove, and they offered me ten thousand bucks. I was considering it, and then my friend in New York said, “No, it’s going to be worth more than this dude, don’t license it to them.” And I met Jaron Lanier at an electronic music concert at Stanford — apparently he had worked for Atari, but I didn’t know him. At this point, I had left Atari. Jaron told me about his company; he invented a visual program language with the name VPL, and he had a little tablet as the interface to it. I showed him my glove, and he thought, “Wow, this is much better than a tablet.”

" "I used to say, if the resurrection happened in black and white, nobody would cover it." "

Me and this marketing guy had this little startup to do a voice-control synthesizer. So I was doing that during the day and making gloves for Jaron at night. And then, it started getting more interesting. Jaron basically said, “Why don’t we start a company? We can get funding. I know some great programmers. This language plus glove, it looks like a hot combination.” It turns out not many people wanted to program. But people loved the glove and Jaron just ran with the concept of VR.

Myron Krueger VPL had color graphics. I used to say, if the resurrection happened in black and white, nobody would cover it. And Jaron might as well have been sent from Central Casting to be the crazy scientist.

Tom Zimmerman We did a joint project with NASA Ames Research out there in Mountain View. They, and a fellow Scott Fisher, had this head-mounted display and the idea of astronauts fixing satellites [from] inside the space capsule. And so, we provided the gloves and they provided the HM display, and that created the first goggle VR system.

Scott Fisher The first commercial contract VPL had was from us at NASA; we asked them to build a five-fingered glove so we could take it to interact with the virtual spaces we had. We built one glove out of the initial fiber optic sensor material, then they improved the tech and we had several more built. They went on to sell commercial versions of that of course, which was great to see.

Tom Zimmerman When we started VPL, I added some ultrasound hand-tracking technology to the glove — little tiny speakers [that] made a little burst of sound that only dogs can hear. We made an inexpensive glove, which Jaron was kind enough to

call the Z Glove, and then we made a high-end one with some sensors. Young Harvill was very clever; he figured out how to make them using fiber optics.

The little Z Glove we licensed to a New York City game company, which licensed it and turned into Mattel. We hit the big time because they made 1.3 million of this Power Glove, based on the Z Glove.

A Virtual Technologies force-feedback glove (Ben Delaney)

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The Nintendo Power Glove was released in 1989 at an extremely low cost comparative to available tech. Outside of its normal gaming uses, it became a centerpiece of the homebrew virtual reality community.

Joe Gradecki When I went up to University of Wyoming for my master's degree, a couple guys in the computer science department had seen a thing on the Nintendo Power Glove. My wife and I were sitting there and said, "Hey, that's kind of cool." There were schematics published on connecting it to the PC, and all we needed was code. That was probably 1992, and there was nothing like that around, really.

Tom Zimmerman To me, Power Glove was the real intrigue. That was where a million people touched virtual reality. I don't think the implementation was that great, but that was probably the widest-distributed VR system.

A full-body VR capture suit by VPL

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VPL would go on to develop more hardware, including a full-body motion-tracking suit and a head-mounted display called the Eyephone.

Stephen Ellis They were probably one of the first companies to hop on the so-called virtual reality bandwagon. CAE, the Canadian Electronics simulation company, had been making head-mounted simulators from the mid-1980s, but those were really expensive. On the order of millions of dollars for the helmet and the computer-based display system — it was a very expensive thing. And VPL, the company where I be-

lieve Jaron was CEO, was selling systems costing on the order of hundreds of thousands of dollars.

Tom Zimmerman The golden year was 1987, at least for me. I had my hand on the cover of *Scientific American* and *National Inquirer*. By that time we had production going on, so my role was pretty much done. Now it was a company cranking out products, more software-oriented. Also, I was a bit burnt out from working 14-hour days, so I took off and went to a farm in West Virginia.

That was kind of it for me in the VR world. I came back to help them out in a lawsuit [over the Power Glove], which was yucky. We were a little research company doing very innovative work. But other people started catching on, and some people started trying to use our IP without licensing it. The company started spending more money on legal defense than R&D.

Skip Rizzo *Head of medical virtual reality at the University of Southern California* I started off working in injury rehabilitation, brain injury, and it's a very difficult process. It can be hard to motivate people with brain injuries to do their rehab exercises. So one of my patients, a young kid, maybe 21 years old, was sitting there one day and he had this thing called a Game Boy. He was bent over, glued to Tetris, focused on it, he couldn't put it down. And I said, "Ooh shit, what about using this for rehab exercises?"

" "What Jaron brought to the table was the ability to communicate to the public, to the press, these ideas." "

I was driving to the gym in 1992 and Jaron Lanier is on NPR doing a segment where he's talking about a virtual kitchen in a department store in Japan. Here I am, having one of those driveway moments listening to this interview. I didn't go into the gym, I just sat in my car because I had to finish the show. I thought shit, we could improve brain function with these patients, we could rehab and train these patients in a way that's immersive and fun. There was a bookstore next to the gym. I went in and I said, "Give me every book you have about virtual reality." I think they had maybe three books. I went to the gym and read while I worked out.

VPL datasuit diagram

Tom Zimmerman I think if it wasn't for Jaron I would have had this invention but

~~FROM ZIMMERMAN I THINK IF IT WASN'T FOR JARON, I WOULD HAVE HAD THIS INVENTION, BUT~~
it's not clear if it would have made the big time. Because what Jaron brought to the table was the ability to communicate to the public, to the press, these ideas.

Jaron Lanier The profile of VR, VPL, and perhaps of me was relatively... it was pretty intense. I was younger, you know? I think it got to my head a little bit at one point; I had trouble dealing with it. I wasn't mature enough to be ready for some of it.

Brenda Laurel It was just an ugly scene. [Jaron Lanier] hired a bunch of successive CEOs but was unable to collaborate. So he had to continue to be the head guy, and he wouldn't take advice from people about running a company, so there would be this revolving door of people coming in trying to straighten him out.

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During its rise, VPL accepted funding from French electronics and defense company Thomson-CSF and put up its patent portfolio as collateral. But Thomson later foreclosed on its loans, driving VPL into bankruptcy by early 1993 and acquiring its VR patents.

Ben Delaney VPL went bankrupt in late '92. They were — and Jaron Lanier is — one of these organizations that's sort of like the Kardashians: famous for being famous, more so than for what they had actually produced. VPL was, for some reason, a media darling. They did a lot of good stuff, and produced some good systems. But ultimately, much of the most important work was done by other people. And they didn't last very long. They were a bright star that burned out quickly.

" "They were a bright star that burned out quickly." "

Linda Jacobson Thomson later auctioned off the VPL patent portfolio, I guess to recoup their investment because apparently that company never implemented any of the designs or inventions. A number of companies bid on it, including the company where I worked at the time, Silicon Graphics. But Silicon Graphics was outbid by Sun Microsystems, which did purchase the portfolio. I never heard again of any kind of hardware innovation coming out of that patent portfolio.

Jaron Lanier The thing to remember about the fall of VPL is that I was gone by then. I left VPL for a lot of reasons — mostly personal — in '92 or so. VPL fell a year or two after that. If you were to believe what's in the papers, it's a pretty exotic thing that

happened: the Justice Department uncovered a plot by the French Secret Service to infiltrate it to steal technology. [It] struck me as absurd because there wasn't much hidden or proprietary. I mean, it wasn't like there was anything to really steal there. It wasn't like a death ray or anything, it was really just some code to simulate, like, a gall bladder.

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The Lawnmower Man, released in 1992, introduced VR to a broad audience. The film starred Pierce Brosnan as a scientist testing virtual reality therapy on a mentally disabled man played by Jeff Fahey. Brosnan's character, Dr. Lawrence Angelo, develops superintelligence, and eventually, virtual godhood. Despite his heavily fictionalized depiction of the technology, writer and director Brett Leonard drew on work by real-world companies like W Industries and VPL.

Brett Leonard *Director of ~~The Lawnmower Man~~ and *Virtuosity**: When I made my first little zombie movie called *The Dead Pit*, which did very well and launched my career, they came to me with this seven-page short story by Stephen King. I said, "Well, I don't really want to make that movie. I actually want to make a movie about virtual reality." I couldn't really make a feature film out of a seven-page short story about a guy being chased by a lawnmower.

" "I couldn't really make a feature film out of a seven-page short story about a guy being chased by a lawnmower." "

I wanted to make something around this computer revolution that I was literally living in the middle of. When I moved from Ohio to Santa Cruz, I was hanging out with people that were hanging out with Wozniak and Jobs. As a young filmmaker, I got a view into that culture, into the thought processes that were going on.

David Traub *Film producer and virtual reality consultant on ~~The Lawnmower Man~~* I got hired as head of technology for a children's company in '90. In maybe '92, we hired a young director [Brett Leonard] to do a music video for us. He came up to me and said, "You're the technology guy here, have you ever heard of something called VR?" I showed him my two-year-old thesis and he goes, "Oh man, I need your help."

Brett Leonard I actually had to create a video that described what virtual reality was and showed what computer graphic effects were. I mean, the only effects going on at

that time were on a 100 million dollar movie. *The Lawnmower Man* was a \$5 million film, and so I had to find a way of putting over 20 minutes of high-end digital effects into a low-budget film.

Jon Waldern They were a real small production company before that movie. I met Brett Leonard at a rock concert in London, and we agreed to provide all the support and training so that people could get a whole experience of it. For various reasons they didn't use our headsets in the movie. But we were actually on the lot with the machines training everybody and giving them VR experiences. And of course the movie went on to become a huge hit. It was great for us, because it was right around our IPO time.

Ben Delaney *The Lawnmower Man* made [VR] accessible to the general public in a way that it hadn't been before. People who weren't familiar with the technology or computing cybernetics took it pretty seriously — there was a lot of talk about how to prevent these terrible things from happening. It was pretty much a joke in the industry. People either liked the movie or not, but no one actually working in the field took it very seriously.

Jaron Lanier The funny thing about the fall of VPL is it turned into this weird movie called *The Lawnmower Man*. The director had licensed a Stephen King horror thing, but then thought the VPL story was more interesting. He turned it into this thing and I was played by Pierce Brosnan, who was an unknown. They used real VPL equipment.

Tom Zimmerman So I'm watching this movie and Pierce Brosnan is putting on my glove on and I'm like, "You're going break the fiber optics. You're tugging it too hard." It was really amazing to see my brainchild come to life.

That was my greatest reward. Not as much the movie, because it was a little too unreal and a little sinister, but seeing a product out there and actually being able to parlay that to help teach kids about inventing and get their excitement up.

Palmer Luckey *Inventor of the Oculus Rift virtual reality headset and co-founder of Oculus VR, acquired by Facebook in March of 2014* I love *Lawnmower Man*. I think it's awesome. In most fiction about VR, the technology is causing some terrible problem; or it's caused the end of the world, or used to enslave humanity. But that's because it wouldn't be interesting science fiction if you said, "Well, guess what? There's this

world and they have perfect VR technology, and people have a healthy balance between real life and VR that makes everyone more productive and happy.”

Virtual reality concept art by Jaron Lanier

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Beside scientific and gaming applications, virtual reality also emerged as a medium for interactive art. In the '70s, Myron Krueger projected video images over participants in a dark room, creating the illusion of an artificial reality. The dreamlike nature of VR drew artists and thinkers interested in psychedelic experiences, sometimes in surprising ways: Timothy Leary spent years promoting VR, at one point appearing in a demo video for the predominantly business-focused design company Autodesk. After trying the technology, onetime Grateful Dead lyricist and Electronic Frontier Foundation co-founder John Perry Barlow wrote that, “I have become a traveler in a realm which will be ultimately bounded only by human imagination.” Through the '80s and '90s, a new generation of artists repurposed cutting-edge (and often extraordinarily expensive) technology to craft virtual reality experiences, including Nicole Stenger’s immersive movie *Angels*, Char Davies’ interactive virtual environment *Osmose*, and the folklore-inspired *Placeholder*, made by a team that included former Atari researcher Brenda Laurel.

Myron Krueger In one exhibit of mine, *Metaplay*, when people came in the room the lights were on and they could see their own live video image on the screen. Most people had never seen a video projection in any circumstance, and they had not seen themselves on a video projection. Some of the people would simply sit down and gape at themselves in awe. I would use a data tablet to draw on the screen. And the camera picked up what I drew on that computer, superimposed it on the video image from the gallery, and projected it in front of the people.

“West Coast VR has a lot to do with acid, I think, because people were kind of mind-prepping for alternative realities.”

When I would move the cursor to start drawing on them, they would treat the cursor like it was a living thing: they would hide from it, or try to hit it away. So then I made the cursor into a ball and put the ball on the screen. I had them playing virtual volleyball with a nonexistent ball without saying a word to them. What struck me was that

people just accepted this. They had never read about anything like this. They had never thought about this. It was as if in their DNA, they'd been waiting for this moment and knew exactly what to do.

Char Davies *Artist, founding director of 3D graphics company Softimage, later acquired by Autodesk* I first became interested in 3D graphics in the mid-'80s. As a painter, I was looking for ways to cross over the 2D picture plane, to find a way to work on the other side of the picture plane. That led me to the virtual space of 3D computer graphics. I got involved in building a software company, Softimage, because I wanted good access to the tools.

Brenda Laurel [Virtual reality] during the ['90s] was very idealistic. It was consciousness-expanding in a lot of ways. West Coast VR has a lot to do with acid, I think, because people were kind of mind-prepping for alternative realities. But there was a concatenation between the LSD scene, and Mondo 2000 and all those guys. Timothy [Leary] and Terence McKenna even got into it.

Char Davies I started writing about *Osmose* in 1993, when the VR that I was aware of and most computer games were shoot-'em-up games. They all involved either a gun, or a pointer, or a mouse. They all involved a hand. I believed that if you made the interface centered on the hand, it reinforced a way of approaching the world in terms of doing things *to* things as an instrument — either shooting it or manipulating it in some way. So we introduced a hands-free interface that relied on breathing and balance. This shifted the experience from one of “doing” to one of “being”.

" "People cried, usually men." "

Brenda Laurel Char's work, both *Osmose* and *Emphemere*, were just poetic. They were a new art form and I take my hat off to her. I was looking at it as a structuralist, “Okay, what can we turn inside out here about this?” But her sensibility is much more of a fine artist, and so the stuff that she did was just outrageously beautiful. One of the guys who installed it at the museum in Toronto, I think, got his head in it and came out 10 minutes later weeping and saying that his life had been changed forever.

Char Davies People cried, usually men. I had a number of people come to me and say that when they experienced *Osmose* they felt that they had experienced dying; they had experienced what death was and they weren't afraid of death anymore. I think this was due to the sensations of buoyancy, of floating through semi-transpar-

ent fluxing landscapes, all very deliberate on our part.

The only work that I think I found of interest, that actually preceded *Osmose*, was Brenda Laurel's work, *Placeholder*. I think Brenda was one of the few people who was trying to do something with VR outside of the commercial mainstream. Everyone else was basically doing games; entertainment and military, basically.

Virtuality VR arcade pods (Ben Delaney)

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By the early- to mid-1990s the VR business was in full swing, VPL's sudden bankruptcy and takeover notwithstanding. Former NASA researcher Mark Bolas moved on to create Fakespace Labs, which released multiple head-mounted displays by 1994. Between 1994 and 1995, Jon Waldern partnered with Atari, Philips, and IBM to produce cheaper business and home-entertainment models of its arcade headsets.

By the mid-'90s, it became apparent that the virtual reality bubble was about to bust. In 1993, Brenda Laurel added a chapter to her book *Computers as Theatre* entitled "Post-Virtual Reality: After the Hype is Over." Atari scuttled the partnership with W Industries / Virtuality and merged with a hard drive manufacturer. The headset market as a whole began to collapse, making it harder to pursue VR for art or research. Companies that remained in business, like Mark Bolas' Fakespace and Silicon Graphics, did so with a lower profile. Once a synonym for the future, virtual reality faded from public consciousness, replaced by booming internet technology.

Myron Krueger At SIGGRAPH '93 or '94 [Dan Sandin] demonstrated what was called a CAVE: a stereo projection on all four walls and on the floor. It was incredibly effective visually, very powerful, and it was replicated 60 times within a year. If you had a research lab, and somebody was sponsoring work, you'd show them what you were doing with their money. But then you'd show them the [lab's] big project, which in this case would be the CAVE. Whatever they thought of what you were doing, they would always be knocked out by the CAVE. When you put on the head mount, it was always a little bit of a disappointment. I used to say that it was vaccinating virgins against virtual reality. Because once you'd done it, you didn't have an urge to do it again.

" "After 1995, virtual reality was promising as a technology but it was clear that it wasn't ready for gaming." "

Jon Waldern Our challenge at the time was, how do we now take this from an industrial \$60,000–\$70,000 machine that sold to arcade operators and Universal Studios and entertainment providers to consumers? We did a joint venture with Atari and showed the consumer version at CES around '95, '94. Unfortunately our timing was not good, and despite the storied name, [Atari] went bust.

Skip Rizzo After 1995, virtual reality was promising as a technology but it was clear that it wasn't ready for gaming. The engineering challenges required Manhattan Project-levels of funding, and that was going to come from the gaming industry.

And what else happened in 1995? The internet. Suddenly everyone was connected, and virtual reality was this ugly little brother lagging behind. It was the butt of jokes from uninformed fucking idiots.

VFX1 Headgear virtual reality system (Ben Delaney)

Linda Jacobson The web really changed things. The fact that there was a proliferation of online access to 3D design tools meant a lot of people starting focusing there and not on the hardware.

Ben Delaney To a large extent, the internet and the World Wide Web did the VR community a tremendous favor. [The internet] became the new breakthrough technology that was going to amaze everybody. The mainstream press found other, more exciting things to talk about; especially toward the end of the '90s when very few of the wild [VR] promises had been fulfilled. People just walked away from it.

Ben Delaney People thought that there would be addictions to VR — that people would end up living in virtual worlds and never coming out. There was concern that there would be physical damage as well as mental damage, and that's part of the reason that head-mounted displays didn't take off. Sony came out with the first consumer-oriented head mount in the '90s. Ultimately, they never released it widely because their lawyers said they faced too much liability if people wore it and did stupid things. People were concerned about the possibility of people trying to drive while wearing head-mounted display. People were concerned that somebody would

be using it in their living room and trip over the cord and crash through a table.

Linda Jacobson Businesses were turned off by the press's celebration of VR as some kind of mind-blowing trip to another world where you could have sex with avatars and create havoc. One of the interesting discussions we had at Silicon Graphics in the late '90s was about not using the phrase VR. It sounded like it was just about games, and everybody knew that that was also a euphemism for pornography.

Mark Bolas Companies came out with displays that they said were VR, but they [had a] narrow field of view. People tried them, and basically it was this little window. Yeah, the graphics changed when you turned your head, but there is an art to making you feel like you're immersed, and they weren't getting that. You'd look around and go, "Oh yeah, well, whatever, I'd rather play on my flat screen; it's sharper, I still get my 3D graphics." So those hurt the industry rather than helped it.

Intel virtual reality advertisement (Ben Delaney)

Scott Fisher I ended up doing more work in Japan than anything else because Japan in general is so tech-smitten and obsessed that they just love the whole VR development. The Japanese government in general was funding research, building huge research complexes just to focus on this. There were huge initiatives while there was nothing happening in the US. I ended up moving to Japan and working there for many years.

Ben Delaney I could never figure out how to make any money with *CyberEdge Journal*. Ultimately, the internet did me in because when the World Wide Web happened, people started saying information wants to be free and I kept saying, "But my printer wants to get paid." I offered the mailing list to a competitor and he managed to keep going for another couple of years.

" "VR didn't bust from my perspective. The VR hype busted." "

Mark Bolas VR didn't bust from my perspective. The VR hype busted; but frankly Fakespace was doing great. We were selling lofty displays to people solving real problems. They could do 3D visualizations of where an oil well should go; they could get really abstract data and visualize it in a 3D world. For the consumer market, 3D games on a flat screen was a pretty big step. So I never viewed VR as dying; I viewed VR as just being put onto a 2D screen.

Nicole Stenger [Tom] Furness said there would be a winter of VR and he was absolutely right. But the seeds that have been planted before the winter don't necessarily die. There's spring sometime, where they start blooming again. I'm cautiously optimistic. I believe that it will come back and it will bloom and be so much the better.

A Division Pro-vision 100VPX virtual reality system (Ben Delaney)

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Throughout the late '90s and early 2000s, virtual reality companies continued to operate, but with a lower, more pragmatic profile. The military became the biggest advocate for VR's utility. 3D graphics continued to advance, but referring to them as "virtual reality" became increasingly rare. Companies periodically showcased virtual reality systems and peripherals, but despite protests from Lanier and others, the "death of VR" had become a standard narrative.

Then, in 2012, a young entrepreneur named Palmer Luckey revealed a \$300 virtual reality headset called the Oculus Rift. While the Rift became a symbol of VR's resurgence, the groundwork had been laid years before. Luckey had worked with researchers like Skip Rizzo, who used VR to treat cognitive and motor rehabilitation — including post-traumatic stress disorder — and Mark Bolas, who had moved to the University of Southern California's interactive media program. Improvements in computing power and display technology, meanwhile, had solved some of the problems that had proved intractable in the 1990s.

Skip Rizzo The war broke out, and I had the idea for virtual reality and PTSD, knowing that this was going to be a health problem for the military. My boss said, "I think the military will push this under the rug anyways, so don't spend time on it." So I said fuck it, and took the idea to ICT [Institute for Creative Technologies]. They jumped on it.

1995 to 2000 era was a dark period. But then, in 2000, you could start doing virtual reality with a PC. That brought costs down, and it gave us some momentum. From 2002 onwards, we started seeing a lot more innovations that showed promise. But the military, the war, that's what really catapulted my own work — they had the need,

and they had deep pockets, and I was able to do cool shit.

Mark Bolas In 2006 we came up with this thing called the Wide Five display, and that changed everything for me. It had a really wide field of view, like 150 degrees, and it could use off-the-shelf LCD displays. And we had a contract with the Office of Naval Research to figure out a way to do virtual reality for training. We basically bet that things like mobile phones would come out and drop the price of larger displays.

Palmer Luckey I think the first head-mounted display I tried was a Myvu Solo. I was like, "This isn't very good. This is pretty bad." I didn't know that that was actually the cutting edge for consumer head-mounted displays at that point. It wasn't until I was in my mid-teens that I started researching it more and realized that actually, VR was not as great as I thought it was when I was six or seven.

In late 2009, when I was more into PC gaming, I thought, "Well, what's the best?" I spent months and months researching everything on the market. I just kind of went crazy and started buying all kinds of different HMDs in government auctions and eBay. I kept aiming higher and higher. I was like, "Well okay, consumer VR isn't that good, but the military uses this for training, so surely the military gear is the real sweet stuff." And then as I got my hands on some of that stuff, I realized that even that wasn't very good. So I decided that I was going to try to do something myself.

Tron (1982)

Mark Bolas The one thing I do think that is getting lost in the VR story is the role of research. It sounds like it all just happened all of a sudden. There has been this consistent thread of funding, largely government-funded projects and European-funded projects, that has been pushing it along step-by-step, and has been creating these labs where these things could happen. It didn't just come out of thin air.

Jaron Lanier Lately, Mark has been a professor at USC. In a class, he came up with most of the distinguishing features of the Oculus Rift and posted them as an open resource. The things that distinguish Oculus Rift from other head-mounted displays is basically a use of computation. What they do is compute some changes to the image to make it workable with a cheaper lens system. But Mark kind of did that, with some students — it was pretty much Mark's work. Then Facebook buys it for billions of dollars. I don't know what happened, but I would imagine that some administrator at USC probably wanted to talk to Mark after that.

" "I just wish people would dig a little bit and build on stuff." "

Scott Fisher I just wish people would dig a little bit and build on stuff. Most of all, I would hope for the acknowledgment for the work that Mark has done in this area.

Palmer Luckey I spent a huge amount of time reading through basically every single published piece of literature on VR. I think that there were a lot of people that were giving VR too much credit, because they were working as VR researchers. You don't want to publish a paper that says, "After the study, we came to the conclusion that VR is useless right now and that we should just not have a job for 20 years." There were a few people that basically came to that conclusion. They said, "Current VR gear is low field of view, high lag, too expensive, too heavy, can't be driven properly from consumer-grade computers, or even professional-grade computers." It turned out that I wasn't the first person to realize these problems. They'd been known for decades.

Ben Delaney I got a real chuckle out of Oculus' literature when they were claiming an extraordinarily wide 100 degree field of view — a lot of head mounts had better 100 degree field of view 20 or 30 years ago. That's not adequate. It still feels like you're looking through a tube. So, none of those problems were solved when I was active in the field; and as far as I know, they're not really solved yet.

Stephen Ellis I just saw the Morpheus system that Sony is developing for video games, and it's extremely high quality. The people working on it have actually been doing it for some years — they've developed displays and tracking technology that's really, really good. It makes Oculus look like Model T in terms of the quality of the tracking, and the imagery is very good. An interesting thing about it is they're using viewing optics that were used in some of the very early virtual reality headsets — these optics harken back to some early patents that were used in viewing systems that we had in our lab 25 years ago.

Palmer Luckey Here's a secret: the thing stopping people from making good VR and solving these problems was not technical. Someone could have built the Rift in mid-to-late 2007 for a few thousand dollars, and they could have built it in mid-2008 for about \$500. It's just nobody was paying attention to that.

Jaron Lanier I'd predicted, based on Moore's law type of thinking, that [VR] would become cheap enough for consumers by 2020. That was my sort of my standard

become cheap enough for consumers by 2020. That was my sort of my standard answer. And I think it'll turn out that I was a few years pessimistic. I think that it's coming a little faster than that.

" "Look, even if we sell 300 developer kits, that's a huge success for VR." "

Palmer Luckey I reached out to Mark Bolas in July of 2011. I had actually purchased a Fakespace Boom 3C on eBay really cheaply. It looked like I was missing a part that only someone at Fakespace would have. We ended up hanging out and I was able to get a job there as a lab technician.

My first job was supposed to be sorting and stacking boxes in their storage room, because I knew quite a bit about old VR systems. Later I got the chance to work on a lot of different VR HMD hardware, especially with Skip Rizzo's team on the post-traumatic stress disorder treatment project. It was a blast working there. There are a lot of really smart, brilliant people at ICT.

Jaron Lanier and Howard Rheingold

I left in May or June of 2012. I had been working on the Rift in my own time, and I'd announced the Kickstarter a couple months earlier, but I kept working with ICT on the side. Right around June, I decided I was going to do this Oculus thing full-time and give it a real go.

I was worried about the number of people who would back [the Kickstarter]. I think we were going to have a goal of maybe \$500,000. The night before, we had a discussion and I was like, "Guys we need to push this down." I was like, "Look, even if we sell 300 developer kits, that's a huge success for VR. No one has gotten that many game developers interested in VR." We compromised at \$250,000. It was kind of a silly worry in hindsight.

Char Davies I was very pleased when the Oculus Rift appeared, because I have always believed that a sense of immersion is most fully enabled via a headset with a wide field of view. I had been waiting a long time for such technology to reappear. I say "re-appear" because the last wide-field-of-view helmets I used were from the mid-90's, and nothing suitable has come along since, until the Oculus Rift. But when I heard that Facebook had bought the company, I was disappointed. Twenty years after Osmose, I still believe that immersive virtual space has rich potential for enabling people to step outside their habitual assumptions about reality to see freshly: that the technology will be used instead to maximize advertising revenue is a profound

technology will be used instead to maximize advertising revenue is a profound shame.

Palmer Luckey A lot of people have asked, “Why Facebook? Why not a company like Microsoft or Google, or a company that does hardware?” And to be honest, we’re not looking for a partner who knows hardware, because we have an incredible hardware team. We didn’t want to be bought by somebody who was going to shred us apart and make us part of their product line.

Jaron Lanier There is something that kind of made me happy about Facebook buying Oculus because there wasn’t some big population of people, like there was with WhatsApp, that you could spy on because you captured them. It was the first major acquisition in Silicon Valley in a while that was really motivated by just pure technology love. And I love that. That’s why things should happen in Silicon Valley. The fact is they tried the demo, they said, “Oh my god, this is the future, it’s incredible, let’s get into this.” That’s what should happen.

“It just feels like they’re recycling the same old press releases and nonsense that people were talking about 20 years ago.”

Ben Delaney I used to make these buttons that said, “VR hype” with the negatory crossbar on it. It was always a big deal. And it never stopped. People imagine this as a technologically manifested dream world, and want to do everything they can do in their dreams. I’ve been really, really getting a chuckle out of reading the hype about the Oculus, because it just feels like they’re recycling the same old press releases and nonsense that people were talking about 20 years ago.

Jaron Lanier The thing that’s really struck me is how many of the little tropes and stories and controversies and press reports and little weird clichés of the saga of the Oculus company are so similar to the ones that happened for VPL so many years earlier. It would be a project for someone someday [to] correlate ’80s press with the press of the last couple years. You could find a lot of the same headlines.

Linda Jacobson I really believe that we were talking about a new medium of artistic and creative expression. And that’s my personal thing, rather than it being just a game machine. I still kind of get that sense that when Oculus talks about consumer VR, that’s a euphemism for gaming and pornography, which was definitely the albatross around VR’s neck in the early days.

" "To me it was a beautiful idea."

Skip Rizzo There's a risk if all this is only driven by gaming. I just hope that doesn't happen, because with these headsets we've got now, there's so much other stuff you can do. I can see a renaissance, in education, in health, in so many things. If you've got a \$300 head-mounted display, and you can run it off a laptop or even a computer in the headset itself, you've got a low-cost device that will change the way we do clinical things: for rehab, for psychologists, for educators. It could be transformative.

Myron Krueger It's just a sin that virtual reality wasn't recognized early on. I mean, the gesture interface is the signature technology of Apple, it is the Kinect system, and every news program has a map where people are drawing with their fingers. Virtual reality is, if not exactly an industry, certainly an idea that permeates everything.

I'm not sure where people think virtual reality is today; it may be where it's always been: full of promise and a little slow on delivery. But it was the idea. To me it was a beautiful idea.

Compiled by Adi Robertson and Michael Zelenko with additional reporting and interviews by Katie Drummond, Casey Newton, and Melissa Smith